Master's thesis

NTNU
Norwegian University of Science and Technology
Department of Economics

Solbakken, Jakob T.
Bjørke, Oliver M.

Regulatory Impact on Credit Card Debt Repayment: The Roles of Behavioral Finance and Liquidity Constraints

Master's thesis in Financial Economics
Supervisor: Snorre Lindset
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Acknowledgments

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Lastly, we wish to thank all those who indirectly contributed to this thesis. Your support, encouragement, and patience have not gone unnoticed.

Jakob T. Solbakken

Oliver M. Bjørke

Sammendrag

I denne oppgaven undersøker vi effekten av «Forskrift om fakturering av kredittkortgjeld mv.» fra 2017 på forbrukernes tilbakebetalingsatferd. Reguleringen gjorde at finansforetak ved betalingshenvendelser skal angi størrelsen på samlet utestående kreditt som foreslått beløp for en betalingstransaksjon, i stedet for minimumsbeløpet, slik det var før. Vi undersøker innvirkningen ved hjelp av et omfattende datasett med 22,567,695 observasjoner fordelt på 701,488 unike kredittkortkontoer over en åtteårsperiode fra 2015 til 2022. Funnene viser en betydelig endring i tilbakebetalingsatferden etter reguleringen. Den gjennomsnittlige tilbakebetalingsraten økte med 5.58 poeng, som indikerer innflytelse fra «anchoring bias». Andelen minstebetalinger falt med over 52%, mens maksimale betalinger (nedbetaling av totalt utestående) økte med nesten 27%, som stemmer overens med konseptet «default effect». Vi identifiserte distinkte juni- og desember-effekter, noe som tyder på en grad av likviditetsbegrensninger på tilbakebetalingsatferd. Studien presenterer sterke empiriske bevis på at eksterne regulatoriske tiltak og sesongmessige likviditetsbegrensninger kan påvirke kredittkorttilbakebetalinger betydelig. Imidlertid finner vi variasjon i størrelsen av reguleringens effekt på tvers av forskjellige forbrukergrupper, som tyder på at individspesifikke faktorer spiller en betydelig rolle. Undersøkelsene viser at forskriftsendringen har anvendt atferdsøkonomiske prinsipper til å «nudge» forbrukere mot bedre tilbakebetalingsatferd, og dermed fremme ansvarlig kredittkortbruk.

Abstract

This research presents an in-depth investigation of the 2017 Norwegian credit card regulation's effect on consumer repayment behaviors. The regulation mandated financial institutions to specify the total outstanding credit as the default payment amount rather than the minimum payment requirement. We examine its impact using a comprehensive dataset of 22,567,695 observations across 701,488 unique account holders over an eight-year period from 2015 to 2022. The findings show a significant shift in the repayment behaviors post-regulation. The average repayment ratio increased by 5.58 points, evidencing the influence of the anchoring bias. The proportion of minimum payments decreased by over 52%, while maximum payments increased by nearly 27%, aligning with the default effect. We also noted distinct June- and December effects, implying the presence of liquidity constraints on repayment behaviors. The study offers strong empirical evidence that external regulatory measures and seasonal liquidity constraints can significantly influence credit card repayment behaviors. However, we found variations in the magnitude of the regulation's effect across different consumer groups, indicating the influence of individual-specific factors. In conclusion, the 2017 Norwegian credit card regulation has successfully employed behavioral finance principles to nudge consumers towards better repayment behaviors, thereby promoting responsible credit use.

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1 Introduction

Credit card debt is a global concern, with consumers often finding themselves trapped in a cycle of escalating debt and interest charges. While financial institutions have implemented measures to encourage responsible credit usage, understanding the effect of these strategies remains an important research area.

This thesis explores the impact of external regulatory measures on credit card repayment behaviors in Norway, and provides insights into the field of behavioral finance, exploring how changes in regulatory frameworks and liquidity constraints influence repayment behavior. Specifically, the focus is on the 2017 Norwegian credit card regulation and its effects on repayment dynamics.

The central research questions guiding this study are: How has the 2017 Norwegian credit card regulation affected repayment behaviors? What impact does liquidity restrictions have on credit card repayment behaviors? These questions are underpinned by three key hypotheses which aim to guide the analysis of the effect and other factors affecting credit card debt repayment.

This study employs a quantitative research methodology, utilizing a rich dataset from a leading Norwegian credit card issuer. A fixed effects model is used to account for unobserved time-invariant factors, while also accommodating for the effects of time-variant unobserved factors. In particular, year and month dummies are employed to capture potential seasonality effects.

The thesis is structured as follows: Chapter 2 presents an overview of the Norwegian credit market, setting the context for understanding the subsequent analysis. Chapter 3 reviews relevant literature in the fields of behavioral finance, credit card debt, and nudge theory, providing a theoretical framework for the study. Chapter 4 lays out the methodology and data analysis techniques used in the study. Chapters 5 and 6 discuss the findings of the study, looking at the impact of the 2017 regulation and the influence of seasonal liquidity changes, respectively. Chapter 7 reflects on the study's limitations and potential areas for future research.

By understanding the dynamics of credit card repayment behaviors, this thesis hopes to shed light on the effectiveness of regulatory measures and the potential of behavioral finance principles in promoting responsible credit use. The findings of this study could have important implications for policymakers, financial institutions, and future research in behavioral finance.

2 Institutional Background

2.1 The development of the regulatory change

In 2013, the Norwegian Financial Supervisory Authority (NFSA), established guidelines for billing credit card debt (Finanstilsynet, 2013). The rationale behind these guidelines was the observation that many credit card issuers did not sufficiently inform their customers about the costs associated with using the cards (Finanstilsynet, 2016).

Despite the initial guidelines, there was still room for improvement in the transparency of credit card billing practice. As a response to this practice, the NFSA updated the guidelines in 2016. One of the key changes was the stipulation that the total outstanding credit card debt must appear in the payment field on all invoices (Finanstilsynet, 2016). This change aimed to make it easier for customers to understand their outstanding balances and make informed decisions about their credit usage.

Later in 2016, The Ministry of Finance requested the NFSA to draft a regulation that would enforce stricter guidelines in the interest of consumer protection. The experiences with the previous guidelines showed that a more robust framework was needed to ensure that customers were well-informed and to encourage responsible credit card usage (Finanstilsynet, 2016). A regulation would also ensure that the rules were effectively enforced, allowing the NFSA to impose corrective measures and daily fines for non-compliance. The regulation ultimately replaced the guidelines, resulting in the implementation of "Regulation on Invoicing of Credit Card Debt, etc." (Forskrift om fakturering av kredittkortgjeld mv) (Forskrift til finansforetaksloven, 2017).

The regulation was enacted by the Ministry of Finance on April 4, 2017. It pertains to the design of payment requests for credit agreements about open-ended credit, including credit cards, between a consumer residing in Norway and a financial institution.

One of the key elements of this regulation is that, when issuing payment requests, financial institutions must specify the total outstanding credit as the suggested amount for a payment transaction. They must also inform the consumer that this amount can

be changed to another amount, equal to or higher than the minimum amount the consumer is obliged to pay. The payment request must clearly indicate what part of the amount is due and the due date. The regulation came into effect immediately, with financial institutions given a deadline of June 15, 2017, to comply. It applies to all future payment requests for credit agreements entered into before the regulation came into effect.

2.1.1 Motivating factors

The initial motivation behind this regulation was the growing concern about the increasing levels of unsecured debt and credit card usage in Norway. Consumer loans in Norway have been growing at double the rate of total household credit, which we can see from Figure 2.1, with interest rates on consumer loans being higher than those on other types of loans (Norges Bank, 2016). Although consumer loans make up only 3% of household debt, they account for roughly 12% of household interest expenses.

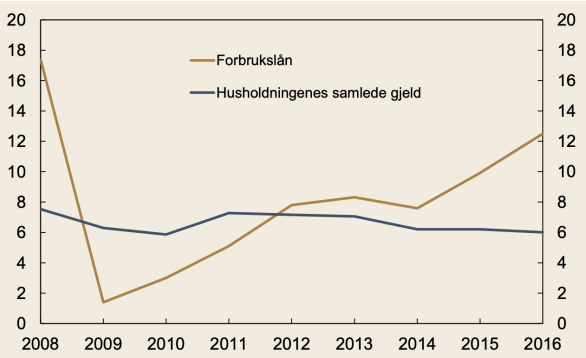

Figure 2.1: Total household debt (blue line) and consumer loans (orange line) for Norwegian customers, showing annual growth percentages from 2008 to 2016. Figure adopted from (Norges Bank, 2016).

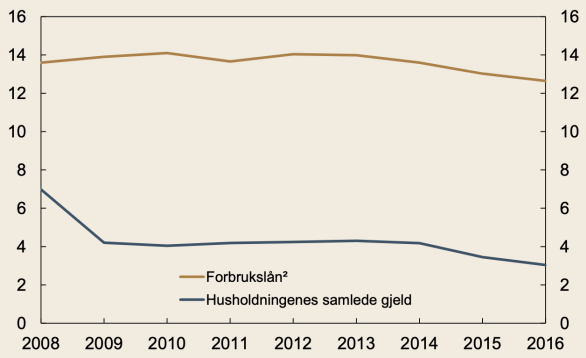

Figure 2.2: Lending rates. The estimated consumer credit rate (orange line) is based on the interest rate margin, measured as a percentage of the management capital of selected consumer banks and the deposit rates of households; compared with the total lending rate for households (blue line). Percentages from 2008 to 2016. Figure adopted from (Norges Bank, 2016).

While consumer loans represent a small share of total household credit, they carry high interest rates compared to other loans, with an average interest rate exceeding 12%

since 2008, presented in Figure 2.2. The proportion of household interest expenses accounted for by consumer loans has risen from 5% in 2008 to 12% in 2016. With interest rates as they were in mid-2016, a consumer loan of 200,000 NOK would have the same interest expenses as a mortgage of around 1 million NOK (Norges Bank, 2016).

The Norwegian Consumer Institute (SIFO) revealed that from 2014 to 2017, the proportion of individuals with at least one credit card remained at 80%, while the proportion of those with credit card debt increased from 15% to 19% during the same period (Poppe, 2017).

The Norwegian government took this trend seriously and sought to limit it through more strict regulations. The Minister of Finance in 2017 stated that the purpose of the regulation was to make customers more aware of the costs associated with the use of consumer credit and to make it easier to repay expensive debt (Finansdepartementet, 2017). Previous studies showed that about half of credit card customers paid the total outstanding credit amount or more, while about a quarter paid more than the minimum, and the remaining quarter paid the minimum amount (Finanstilsynet, 2016).

The NFSA believed that the regulation could encourage more customers to pay off their total outstanding credit at the first billing to avoid incurring debt that could later impose a significant financial burden (Finanstilsynet, 2016). Moreover, The Norwegian Consumer Authority (NCA) received several inquiries from consumers who reacted to the minimum amount being invoiced as a default instead of the total outstanding amount. The NCA, in a related manner, claim that it would be most loyal to credit card customers to establish an invoicing solution that encourages customers to make the most economically sensible choice (Finanstilsynet, 2013).

3 Behavioral Finance in Credit Card Repayment

3.1 Default effect

The default effect is a phenomenon in which people are more likely to choose an option that is presented as the default choice, rather than considering other available alternatives. The power of the effect has been studied and documented by numerous researchers in various fields, including psychology, behavioral economics, and marketing (Johnson and Goldstein, 2003).

Johnson and Goldstein (2003) argue that the default effect can influence choices in three ways: firstly, decision-makers might believe that defaults are suggestions by the policymaker; secondly, making a decision often involves effort, and defaults can save that effort; thirdly, defaults often represent the existing state, and a change usually involves a trade-off.

Fowlie et al. (2021) study the default effect in the context of an electricity program. The study compares the behavior of two treatment groups: one group is given the option to opt-in to time-varying pricing, while the other group is defaulted into the program but allowed to opt-out. Only 20% of the customers opted into the new pricing program when it was a choice, whereas over 90% of the customers stayed in the program when it was the default option. The results provide dramatic evidence of the default effect on program participation. This finding suggests that it is possible to "nudge" people into beneficial behavior based on default options.

The default effect has important implications for various domains, including consumer credit card repayments, as it demonstrates the influence of default options on people's decision-making processes. Understanding this effect can help policymakers and financial institutions design interventions to promote better financial decision-making among consumers.

3.2 Anchoring bias

Anchoring is a cognitive bias in which individuals rely heavily on the initial piece of information they encounter when making decisions (Tversky and Kahneman, 1974). This initial information, or anchor, serves as a reference point against which subsequent options are evaluated. Anchoring can lead to simplified judgment operations, but it may also result in severe and systematic errors.

Anchoring has been widely applied in studies exploring human decision-making patterns, especially in the context of loan repayments. For instance, Stewart (2009) investigate the impact of anchoring on credit card minimum repayments. The study involves 248 participants who are provided with a mock credit card statement showing a balance of 435.76 GBP. Some participants are shown a visible minimum-to-pay amount, while others are not. The results demonstrate that repayments increase by 70% when the minimum payment information is removed. This suggests that anchoring to minimum payments can have significant financial consequences.

Another study conducted by Keys and Wang (2019) investigate whether anchoring to the minimum payment leads to consumers making smaller payments towards their outstanding balance. They found that at least 22% of near-minimum payers and 9% of all accounts responded to changes in minimum payment formulas consistent with anchoring, rather than being driven solely by liquidity constraints. This anchoring response occur for both increases and decreases in the minimum payment, providing real-world evidence of the anchoring phenomenon and its implications for models of intertemporal consumption and savings behavior.

3.3 Nudging

Nudging is a concept rooted in the work of psychologists Daniel Kahneman and Amos Tversky, who pioneered the study of human decision-making and identified several cognitive biases that influence our choices. Thaler and Sunstein (2009) define a nudge as any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives.

Nudges differ from traditional public policy approaches, which often rely on regulation or incentives to influence people's behavior. Instead, nudges focus on small changes to the environment or the presentation of options to influence people's choices. This method has proven effective in various contexts, from increasing retirement savings to encouraging people to get vaccinated. Other examples are placing healthier food options at eye level in a cafeteria to encourage healthier eating choices (Wansink and Hanks, 2013) and using smaller plates at a buffet to subtly reduce portion sizes and prevent overeating (Wansink and Van Ittersum, 2013).

One key assumption of nudging is that people often make decisions on autopilot, following the path of least resistance (Thaler and Sunstein, 2009). Therefore, by changing the default option, nudging can encourage people to make better choices without exerting much effort. Nudging also assumes that people are more likely to follow through on a decision if they feel a sense of ownership over it. As a result, nudges should be designed in a way that allows individuals to feel in control of their decision-making.

In a study conducted by Navarro-Martinez et al. (2011), they explore the potential benefits of nudging individuals burdened with unhealthy levels of debt towards healthier repayment practices. They found that presenting minimum payment requirement information has a negative impact on repayment decisions, while increasing the minimum required amount leads to a positive effect for most customers. Additionally, including supplemental information like costs and time to pay has no substantial causal relationship with repayment behavior when the minimum payment amount is presented. This research highlights the potential effectiveness of using nudges alongside default options to promote better financial decision-making.

3.4 Our contribution

Our research engages with the existing literature by examining the effects of the 2017 Norwegian credit card regulation, "Regulation on Invoicing of Credit Card Debt, etc.", on repayment behavior. We draw upon the work that has been done in the field of

behavioral finance, particularly relating to the default effect, anchoring, and nudging. These theories propose that the framing of choices can considerably impact decision-making.

While there has been substantial research applying these theories in different contexts, our work adds to this conversation by applying them to the specific case of the recent Norwegian regulation. We aim to deepen the understanding of how a shift in billing practices, from presenting the minimum payment amount to the total outstanding balance, might interact with these behavioral phenomena and potentially influence credit card repayment behaviors.

We recognize that the societal implications of these regulations are complex and multifaceted. With our work, we aim to contribute to the ongoing discussions surrounding unsecured debt levels in Norway, adding a further layer to our understanding of the interaction between regulatory changes, individual decision-making, and societal outcomes in the context of consumer credit. It is our hope that this study will provide useful insights for future research and policy development in this area.

In addition to the investigations into behavioral aspects and their effects on credit card repayment, this thesis also explores the impact of liquidity constraints on consumer credit behavior. The presence of such constraints can significantly influence a consumer's repayment decisions, potentially overruling their typical behavioral tendencies. Our research delves into how the severity of these constraints interacts with the regulatory changes and their intended effects. This facet of our study bridges the gap between behavioral finance and the realistic economic conditions faced by consumers.

4 Data and methodology

4.1 Data collection

We obtained account-level data from SpareBank 1 Kreditt (SB1K), a credit card issuer in Norway affiliated with the SpareBank 1 Alliance. The dataset comprises monthly credit card account information spanning from January 2015 to December 2022, and consists of 55,363,878 observations. One observation encompass details such as the monthly closing balance, minimum payment requirement, the payment amount, credit card limit, and demographic information for every account holder.

During this eight-year period, SB1K has managed approximately 850.000 unique private accounts, all of which are contained in the dataset. It covers a diverse customer base from various regions of Norway, which makes it a suitable source for understanding credit card usage patterns and repayment behavior. The data was provided in an anonymized format.

4.2 Data preparation

Our primary focus revolves around the accounts that exhibit credit card usage in a typical manner, where account holders carry a balance and face the decision of how much to repay each month. To isolate this behavior, we remove all observations where the closing balance is greater than or equal to zero. These observations amount to approximately half of the dataset, reducing the sample size to 27,648,250 observations. Of the 27,715,628 observations we removed, only 913,559 are greater than zero, implying that the vast majority are zero-observations.

When the closing balance is greater than or equal to zero, it indicates that the account holder is not using their credit card, has either paid off their entire outstanding balance the prior month, or has a positive balance on their account due to overpayment. In these cases, the account holder is not carrying any debt from one month to another, which implies that they are not utilizing the costly credit provided by the card. Since our primary goal is to study the factors influencing repayment rates and credit card

debt management, these observations do not provide meaningful insights into the behavior we are interested in analyzing. Including the observations in our analysis could potentially introduce noise and dilute the significance of our findings.

Secondly, we remove observations where the payment amount is greater than the closing balance. When the payment amount is greater than the closing balance, it implies that the account holder has paid more than the outstanding amount on their credit card. Paying more than the outstanding amount could be due to a variety of reasons, such as an error in payment, a deliberate overpayment to create a positive balance, or using the account for purposes other than normal credit card usage. In any case, these observations do not represent typical credit card repayment behavior, which is our primary focus. After removing these overpayments, the dataset consists of 22,681,229 observations.

Lastly, we removed observations where the aggregated monthly turnover is positive. A positive turnover indicates that the account holder has received refunds, rewards, or other credit adjustments in which the amount is greater than the total everyday usage of the credit card. These cases are not representative of typical credit card usage, where charges for purchases and other transactions result in a negative turnover.

After applying these initial filters, our dataset comprises individual account-level data from January 2015 to December 2022, constituting an unbalanced panel with 22,567,695 observations. This unbalanced panel implies that not all account holders engage in consistent credit card activity every month, through occasionally overpaying or simply not using their card, resulting in an unequal distribution of observations across individuals. However, the dataset encompasses a broad spectrum of credit card usage and repayment behaviors across 701.488 unique account holders.

4.3 Descriptive statistics

The tables below provide an overview of the prepared dataset by illustrating summary statistics for various key variables. The first table displays the statistics for the full sample, while the second and third displays the statistics before and after the regulation, respectively. All monetary values are denominated in Norwegian Kroner (NOK).

Table 4.1: Summary statistics for the full sample. 22,567,695 observations.

Statistic	Median	Mean	Std. dev.	Minimum value	Maximum value
Closing balance	-9,842	-17,777	22,535	-761,677	-1
Payments amount	1,381	3,677	6,904	0	761,677
Minimum-to-pay amount	-287	-608	806	-279,432	0
Credit limit	30,000	41,215	29,376	1	1,000,000

Table 4.2: Summary statistics before regulation. 4,617,429 observations.

Statistic	Median	Mean	Std. dev.	Minimum value	Maximum value
Closing balance	-11,338	-19,533	23,104	-463,523	-1
Payments amount	1,135	3,295	6,488	0	356,629
Minimum-to-pay amount	-311	-646	858	-176,323	0
Credit limit	30,000	41,934	29,053	1	500,000

Table 4.3: Summary statistics after regulation. 17,950,266 observations.

Statistic	Median	Mean	Std. dev.	Minimum value	Maximum value
Closing balance	-9,519	-17,326	22,364	-761,677	-1
Payments amount	1,476	3,775	7,003	0	761,677
Minimum-to-pay amount	-271	-598	792	-279,432	0
Credit limit	30,000	41,030	29,455	1	1,000,000

Observing the full sample, the median closing balance stands at -9,842 NOK, and the median payment amount stands at 1,381 NOK. The wide range of closing balance and payment amounts is reflected in their high standard deviations and the large spread between minimum and maximum values. Moreover, the median value is lower than the mean value of every variable, suggesting a skewness in the data. The credit limit

averages around 41,215 NOK, showing a reasonably high credit availability for the customers.

Comparing the pre- and post-regulation periods provides some initial insights. Before the regulation, the median closing balance is slightly higher at -11,338 NOK, and the median payment amount lower at 1,135 NOK, suggesting a higher level of debt and lower repayment amounts. In contrast, after the regulation, we observe a lower median absolute closing balance of -9,519 NOK and a higher median payment amount of 1,476 NOK.

4.4 Customer characteristics

The Figures 4.1 through 4.4 display the distribution of different variable categories in terms of account level (701,488 credit accounts) and total number of observations (22,567,695). For each of these categories, we have presented data as a proportion of total credit accounts and as a proportion of total observations. The comparison of these two measurements can provide interesting insights. For example, if a category has a high fraction of accounts but a low fraction of observations, it may suggest that accounts in this category were less active. Conversely, a category with a high fraction of observations but a low fraction of accounts may suggest a smaller number of highly active accounts. Each account is placed in the category corresponding to the mean value of every observation belonging to the account.

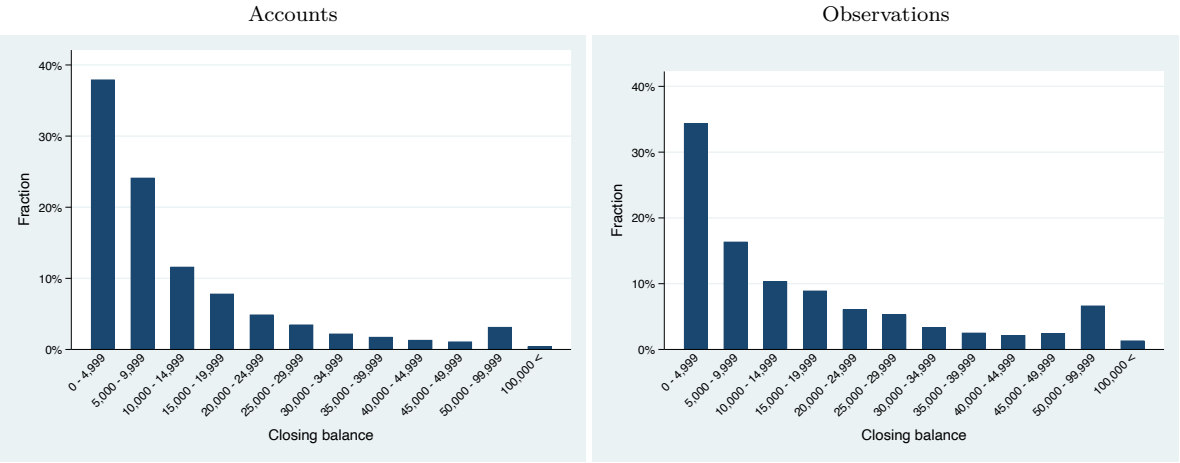

Figure 4.1: Fraction of accounts and observations - Closing balance

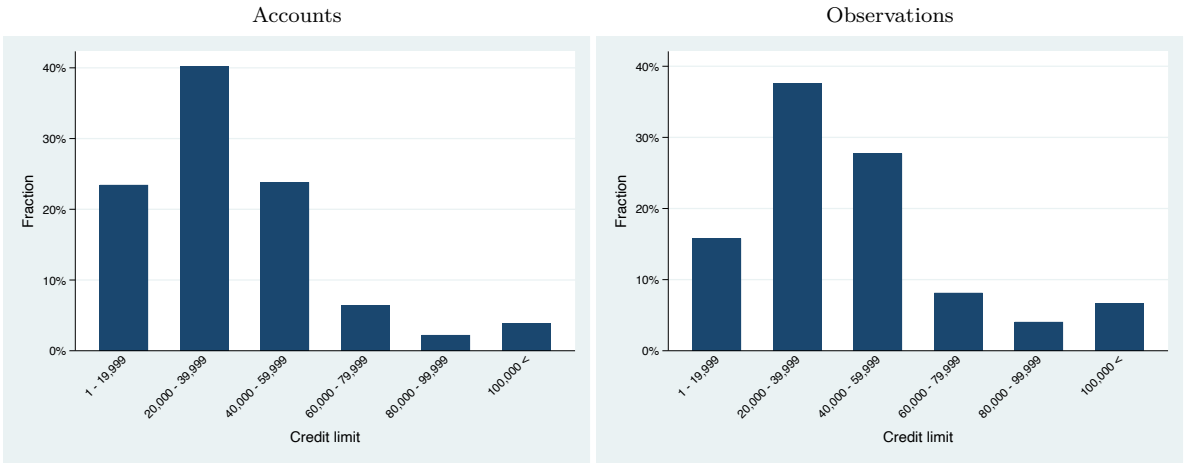

Figure 4.2: Fraction of accounts and observations - Credit limit

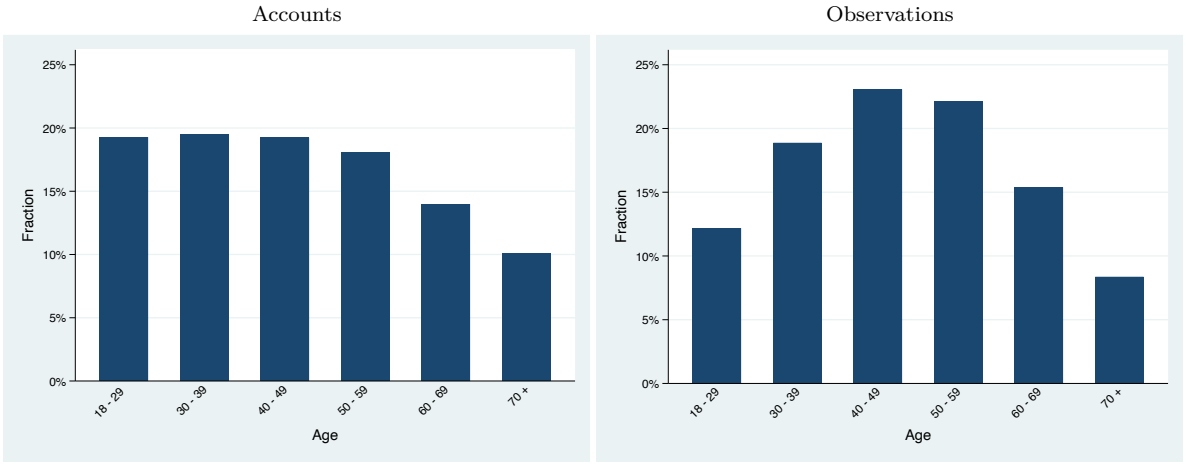

Figure 4.3: Fraction of accounts and observations - Age

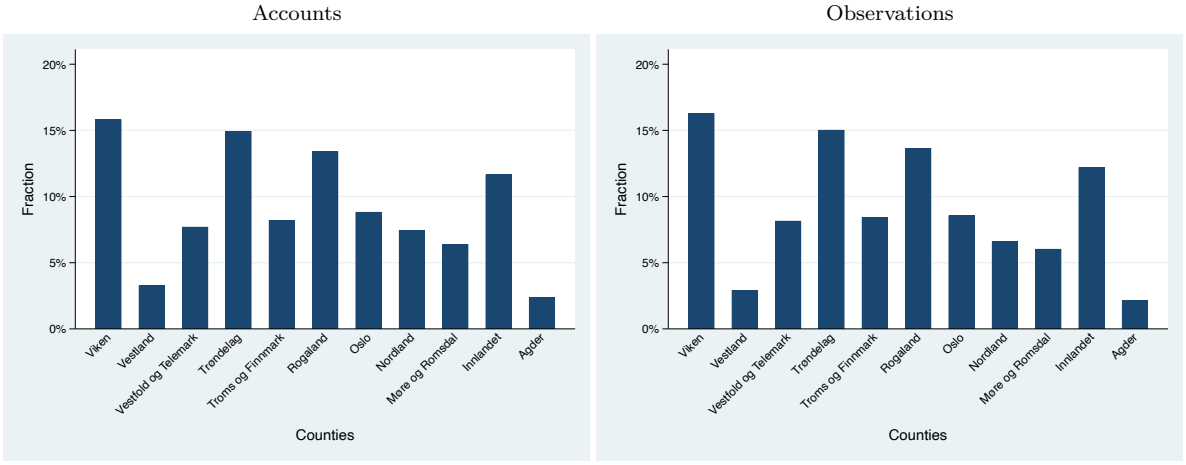

Figure 4.4: Fraction of accounts and observations - Counties

In Figure 4.1, we observe that a significant portion of the accounts in our dataset has a mean closing balance between 0 - 4,999, indicating a tendency towards lower closing balances. The distribution pattern also holds true when considering the total observations, suggesting that the majority of observations exhibit low closing balances.

Moving on to Figure 4.2, we observe that 40% of the accounts have a mean credit limit ranging from 20,000 to 39,999. The same distribution pattern is observed when analyzing the total observations.

The age categories, reported in Figure 4.3, unveil interesting insights. When focusing on individual accounts, we observe a right-skewed distribution of the age categories, with fewer accounts in the higher age segments. However, the majority of observations are associated with individuals between the ages of 40 and 59, indicating that our collected data primarily revolves around individuals within this age range.

Lastly, Figure 4.4 sheds light on the geographic distribution of accounts and observations. The highest number of accounts and observations are concentrated in the counties of Viken, Trøndelag, Rogaland, and Innlandet. This information provides valuable context and indicates the areas where our data is more representative. Moreover, it underscores that our data is to some degree geographically diverse, and our findings are generalizable across account holders in Norway.

4.5 Variables of interest

The *Repayment ratio* serves as the primary dependent variable of interest in this study. The repayment ratio is calculated by dividing the payment amount by the absolute value of the closing balance for each observation in the dataset,

$$Repayment\ ratio\ =\ \frac{Payment\ amount}{|Closing\ balance|}\ . \tag{4.1}$$

This ratio offers a quantitative measure of the extent to which account holders are managing their credit card debt and making repayments. A repayment ratio of 1 signifies that the account holder has paid off their entire outstanding balance for that month, while a ratio lower than 1 indicates that they have only made partial repayments. Conversely, a ratio greater than 1 suggests that the account holder has paid more than their outstanding balance. However, the preparation of the dataset leaves us with a repayment ratio between 0 and 1.

We also focus our analysis on the *Minimum payment* and *Maximum payment* dummies to capture specific repayment behaviors. The *Minimum payment* dummy represents instances where account holders pay only the minimum required amount, while the *Maximum payment* dummy indicates cases where the entire outstanding balance is cleared. The minimum required payment amount is equal to 3.5% of the used credit, minimum 250 NOK (SpareBank 1, 2023). For card agreements signed before 15 May 2019, the minimum amount is 2.5% of the credit used, minimum 250 NOK.

To capture the effect of the regulation, a dummy named *Post regulation* marks every observation (closing balance and corresponding payment) that took place after the regulation. SB1K implemented the change from minimum to maximum payment on the first invoices of 2017, meaning the observations for December 2016 and after are subject to the change. The dummy will act as an explanatory variable in our regression models.

4.6 Model specification

The goal of the analysis is to estimate the effect of the regulatory change on the repayment behavior of account holders by examining how the regulation affected the repayment ratio and the quantity of minimum and/or maximum payments. The primary model used in this study is developed from a base Pooled OLS model,

$$Repayment\ ratio = \beta_0 + \beta_1 Post\ regulation + v \quad . \tag{4.2}$$

This model assumes that the coefficients are the same for all account holders, and that the error term is not correlated with the *Repayment ratio*. It also assumes that all 701 thousand accounts have the same characteristics. We essentially ignore account-specific data and differences over time. These effects gets included in our error term instead, which causes bias and inconsistency. Heteroscedasticity is confirmed in Table A.2 in the appendix. A fixed effects model accounts for the effect of heterogeneity between the individuals,

$$y_{it} = \beta_0 + \sum_{n=1}^{n} \beta_n x_{nit} + w_i + \epsilon_{it} \quad . \tag{4.3}$$

In this general model, where x denotes the regressors, our previous error term v is divided into a entity/account specific fixed effect w and error term ϵ. The goal is to control for the influence of w on our variables, which will provide a more precise estimate for the effect of the regulation. Alternatively, we could compute the Random effects model (RE), which differs from the Fixed effects model (FE) by assuming that the individual specific effects are independent of the regressors, i.e. the correlation between them is zero (Brooks, 2019),

$$RE : corr(w_i, x_i) = 0 \quad ,$$
$$FE : corr(w_i, x_i) \neq 0 \quad .$$

A random effects model is where the group means are a random sample from a population, as opposed to a fixed effects model in which the group means are fixed (non-random or stable over time) (Brooks, 2019). The optimal choice between the models is verified by a Hausman test, which is included in the appendix as Table A.1. We

reject the null hypothesis that the difference in our coefficients is not systematic. The desired model is the Fixed effects model.

Similar to the fixed effect model, to account for the general development over time, we can extract the year- and month specific variation from the model. We essentially generate a dummy variable for each year or month that capture the unique characteristics for the given period. The dummy estimators, as denoted by δ in Equation 4.4, will allow us to differentiate between the years and months, and to see by how much they differ,

$$\begin{aligned} Repayment\ ratio_{it} = \beta_0 + \beta_1 Post\ regulation_t + \beta_2 Closing\ balance_{it} + \\ \beta_3 Credit\ limit_{it} + \delta_t + w_i + \epsilon_{it} \quad . \end{aligned} \tag{4.4}$$

The combined individual and time fixed effects model is supplemented with the time-variant control variables, *Closing balance* and *Credit limit*. We aim to mitigate omitted variable bias and improve the estimate precision. Moreover, even if not confounding, the variables help reduce the residual variance, which in turn increases the precision of the regulation's estimated effect.

Additionally, for some regressions, we replace the dependent variable *Repayment ratio* with our other two dependent variables, *Minimum payment* and *Maximum payment*. The change essentially produces a linear probability model (LPM). Despite not accounting for the fact that the relationship between the dependent dummy variables and the regressors is likely nonlinear, the LPM can still provide an estimate of how changes in the explanatory variables are related to the probability of the minimum or maximum payment occurring.

4.7 Hypotheses

Given the regulatory change and its intended effect on repayment behavior, we propose the following hypotheses:

Hypothesis 1: The regulation significantly impacts the repayment ratio. If the regulation was effective in its aim of increasing repayment, we anticipate a positive coefficient for the post-regulation dummy variable in our fixed effects model. This would indicate an increase in the repayment ratio following the implementation of the regulation.

Hypothesis 2: The regulation impacted minimum and maximum payment proportions. We presume that the regulation doesn't solely affect the overall repayment ratio, but also the propensity of making the minimum or maximum payment. This hypothesis will be tested using the linear probability model, with minimum and maximum payments as the dependent variables.

Hypothesis 3: Seasonal liquidity changes have an effect on the repayment ratio. As account holders' liquidity might vary throughout the year, this could impact their repayment behavior.

These hypotheses address different aspects of the regulation's impact, offering a comprehensive analysis of its effect on repayment behavior. The fixed effects model, complemented by the year- and/or month dummies, enables us to control for individual-specific characteristics and time trends. The combination ensures a more accurate estimate of the regulation's impact. The inclusion of control variables and interaction terms further refines the analysis, helping us uncover nuanced effects and potential heterogeneity in the regulation's impact.

5 Analysis

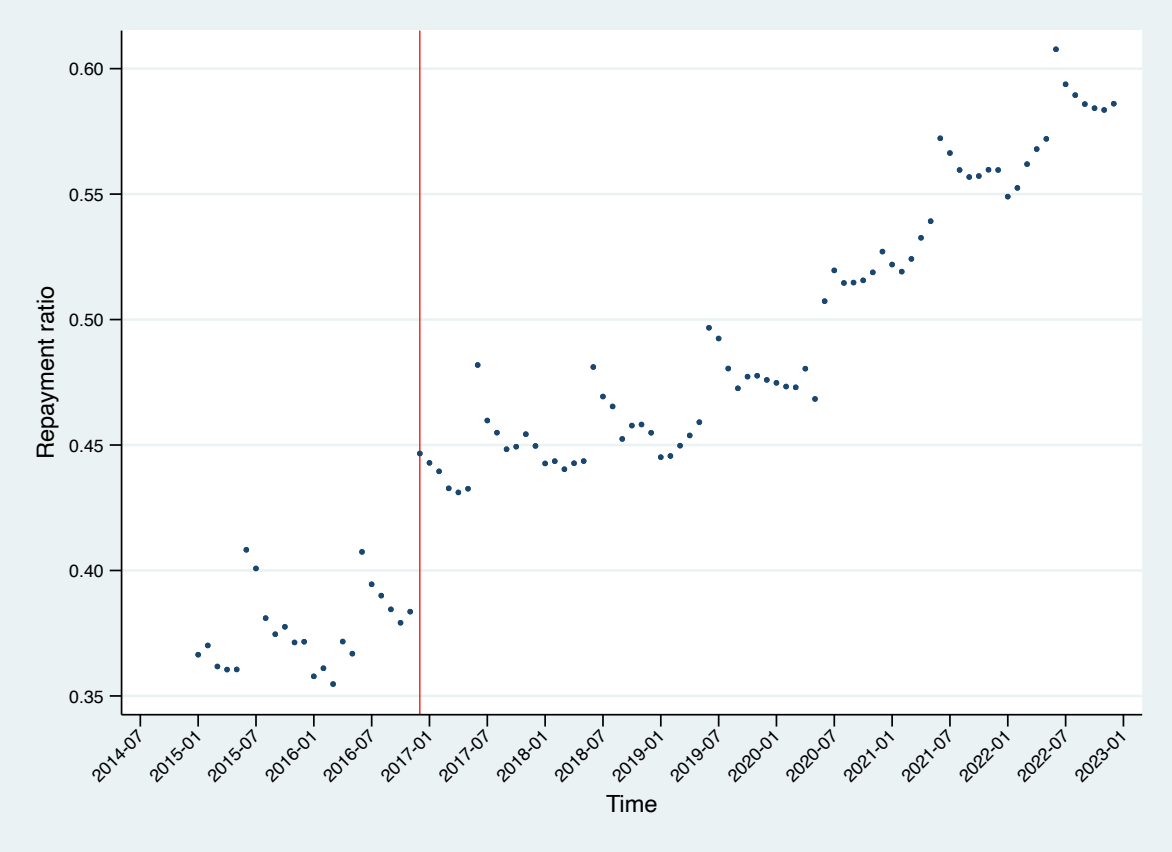

Figure 5.1: Monthly average repayment ratio across all observations in the filtered dataset. Each dot represents a monthly mean. The red line marks the specific month SB1K implemented the invoice change, from minimum to maximum default amount, in response to the 2017 regulation.

Figure 5.1 provides a visual representation of the mean repayment ratio over the sample period. A notable feature of the graph is the distinct upward shift in the repayment ratio following the implementation of the regulation, suggesting a potential correlation between the regulation and repayment behavior.

In addition to this observed shift, the data reveals a consistent upward trend in the repayment ratio throughout the sample period, indicating a progressive improvement in consumers' repayment habits. The graph also displays clear seasonal fluctuations in repayment ratios, further underscoring the dynamic nature of repayment behavior over time.

5.1 Testing Hypothesis 1: The regulation significantly impacted the repayment ratio

The results presented in Table 5.1 validate our proposed hypothesis. We observe a positive coefficient for the *Post regulation* variable across all models, varying from 0.1229 in the Pooled OLS model (Equation 4.2) to 0.0558 in the Fixed effects model incorporating two control variables (Equation 4.4). The positive coefficients suggest a rise in the repayment ratio following the implementation of the regulation. However, the magnitude of this effect declines when moving from the Pooled OLS model to those integrating individual and time-fixed effects. The decline suggests that individual characteristics and temporal factors account for a portion of the initial effect observed.

We also note a rising trend for the time-fixed effects for the years 2016 through 2022, with coefficients ranging from 0.0022 to 0.1336. This trend reflects an overall enhancement in repayment behavior over time, as also depicted in Figure 5.1. This consistent upward trajectory may be influenced by several factors such as shifting economic conditions or evolving consumer behaviors, unrelated directly to the regulatory change, yet captured within these time-fixed effects.

When control variables are incorporated into the models, the coefficients for $|$*Closing balance*$|$ and *Credit limit* are -0.00614 and 0.00127 respectively. The coefficients convey that for each thousand NOK increase in the absolute closing balance, there is a marginal decrease in the repayment ratio by roughly 0.00614, and similarly, for each thousand NOK increase in an account holder's credit limit, the repayment ratio nudges up by approximately 0.00127. While seemingly small, these effects hold statistical significance and exhibit consistency across both models.

The range of R-squared values from 0.012 to 0.085 denote that while a significant proportion of the variance in the repayment ratio is explainable through our models, a substantial amount of variation remains unaccounted for. The values hint at the presence of other potential factors influencing the repayment ratio not incorporated within our models.

The robust standard errors, as demonstrated by the parentheses adjacent to each coefficient (for instance 0.0002 for the *Post regulation* variable in the Pooled OLS model), reinforce the robustness of these estimates to heteroscedasticity.

Table 5.1: Variations of Pooled OLS and Fixed Effects models. This table presents the regression coefficients, with their respective robust standard deviations in parentheses, from six distinct linear regression models. Each model progressively incorporates additional parameters: individual fixed effects, time fixed effects, and the control variables closing balance and credit limit. All listed coefficients are statistically significant at the 1% level. *Closing balance* and *Credit limit* are presented in units of 1000 NOK.

	Dependent variable:					
	Repayment ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Pooled OLS	Ind. fixed effects	Time fixed effects	Both FE	Both FE with one control variable	Both FE with two control variables
Post regulation	0.1229***	0.0841***	0.0690***	0.0539***	0.0569***	0.0558***
	(0.0002)	(0.0004)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
|Closing balance|					-0.00592***	-0.00614***
					(0.0000)	(0.0000)
Credit limit						0.00127***
						(0.0000)
2016			0.0022***	0.0133***	0.0192***	0.0159***
			(0.0004)	(0.0003)	(0.0003)	(0.0003)
2017			0.0038***	0.0170***	0.0201***	0.0159***
			(0.0011)	(0.0007)	(0.0006)	(0.0006)
2018			0.0099***	0.0211***	0.0266***	0.0214***
			(0.0011)	(0.0007)	(0.0007)	(0.0007)
2019			0.0246***	0.0304***	0.0360***	0.0308***
			(0.0011)	(0.0007)	(0.0007)	(0.0007)
2020			0.0542***	0.0498***	0.0501***	0.0451***
			(0.0011)	(0.0007)	(0.0007)	(0.0007)
2021			0.1030***	0.0652***	0.0618***	0.0569***
			(0.0011)	(0.0008)	(0.0007)	(0.0007)
2022			0.1336***	0.0673***	0.0676***	0.0625***
			(0.0011)	(0.0008)	(0.0007)	(0.0007)
Constant	0.3765***	0.4073***	0.3754***	0.3968***	0.4975***	0.4541***
	(0.0002)	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0009)
Observations	22,567,695	22,567,695	22,567,695	22,567,695	22,567,695	22,567,695
R-squared	0.012	0.014	0.022	0.018	0.084	0.085
Number of accounts		701,488		701,488	701,488	701,488

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

To assess the sensitivity of our findings, we compare the coefficients of the post-regulation dummy between the full sample (Column 6 in Table 5.1, or Column 1 in Table 5.2) and a restricted sample, which excludes observations where the minimum and maximum payment was made (Column 2 in Table 5.2). The idea of the restricted sample is to remove the observations where the account owner has not made a deliberate choice to adjust the payment amount, and only opted for the default amount.

Table 5.2: Comparing the effects of the regulation on repayment ratios with and without minimum/maximum payments. This table presents a comparison of the effect of the regulation on repayment ratios using two different samples: one that includes all payments (Column 1) and another that excludes the observations where the minimum or maximum payment was made (Column 2). The goal of this analysis is to investigate the impact of the regulation on the repayment behavior when the account owner has made a deliberate choice to adjust the payment amount, rather than opting for the default amount.

	Dependent variable:	
	Repayment ratio	
	(1)	(2)
VARIABLES	With min/max	Without min/max
Post regulation	0.0558***	-0.0173***
	(0.0006)	(0.0006)
Constant	0.4541***	0.2323***
	(0.0009)	(0.0007)
Observations	22,567,695	10,806,164
R-squared	0.085	0.018
Number of accounts	701,488	528,450

*** p<0.01, ** p<0.05, * p<0.1

Note: Year-fixed effects, absolute value of closing balance and credit limit are included as control variables.

Robust standard errors in parentheses

The negative coefficient for the *Post regulation* regressor in the restricted sample could be explained by the increase in the average closing balance due to the removal of small- and intermediate-sized invoices, which are often more likely to be paid in full. From Table 5.3 below we observe that maximum payment observations are more common

after the regulatory change.

Table 5.3: The tables show the percentage amount of payments that correspond to the minimum-to-pay amount and total outstanding balance (maximum payment). The proportions are shown for both before and after the regulation. Note: The total cases where the minimum amount equals the maximum amount is 8.14% of all observations in the unrestricted sample.

Minimum payment proportions

Minimum payment	Fraction
Before	27.13%
After	19.91%

Maximum payment proportions

Maximum payment	Fraction
Before	25.00%
After	41.28%

With the removal of minimum and maximum payment cases, which inherently leaves a dataset dominated by higher invoice amounts, the repayment ratio appears to decline. The decline suggests that when faced with these larger invoices, account holders, on average, opt to adjust their payment amount downward.

This trend is likely driven by the inherent challenge of repaying larger invoices in full. The higher average closing balance post-regulation underscores this point. Consequently, the remaining, larger invoices in the restricted sample are more likely to be adjusted downwards due to the difficulty in fully repaying them. This downward adjustment is reflected in the negative coefficient for the *Post regulation* variable and the lower constant in the restricted sample. Table 5.4 illustrates the increased average closing balance when minimum and maximum payments are removed from the dataset.

Table 5.4: Average closing balance before and after the regulation, shown for both the unrestricted and restricted sample.

Unrestricted sample

|Closing balance|	Mean
Before	19,533
After	17,326

Restricted sample

|Closing balance|	Mean
Before	22,521
After	23,812

5.1.1 Varying impact between groups

Table 5.5: The effect of the regulation on pre-regulation mean repayment categories. This table presents the results of multiple regression analyses, where each column represents the results from a different pre-regulation repayment category. The table only shows the coeffecients for the variables *Post regulation*, *Closing balance*, and *Credit limit*, however, the individual- and time fixed effects are still included. *Closing balance* and *Credit limit* are presented in units of 1000 NOK. The regressions are run using a restricted sample solely containing observations from accounts that appear at least once both before and after the regulation. This approach is aimed at examining the effect on borrowers who exhibit similar repayment behaviors while the default amount was still minimum-to-pay.

	Dependent variable:				
	Repayment ratio				
	(1)	(2)	(3)	(4)	(5)
	Repayment	Repayment	Repayment	Repayment	Repayment
VARIABLES	0 - 0.19	0.2 – 0.39	0.4 – 0.59	0.6 – 0.79	0.8 - 1
Post regulation	0.0644***	0.0912***	0.0930***	0.0643***	-0.0076***
	(0.0008)	(0.0019)	(0.0027)	(0.0029)	(0.0009)
|Closing balance|	-0.00519***	-0.00807***	-0.00962***	-0.00893***	-0.00356***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Credit limit	0.00191***	0.00109***	0.000685***	-0.0000129	-0.0000769***
	(0.0000)	(0.0000)	(0.0000)	(8.37e-08)	(0.0000)
Constant	0.1497***	0.3491***	0.5421***	0.7424***	0.9686***
	(0.0014)	(0.0027)	(0.0035)	(0.0036)	(0.0014)
Observations	7,289,728	2,617,533	1,554,035	1,199,707	4,379,350
R-squared	0.142	0.130	0.108	0.074	0.027
Number of accounts	119,648	51,838	36,560	30,264	114,089

*** p<0.01, ** p<0.05, * p<0.1

Note: Year-fixed effects are included as control variables.

Robust standard errors in parentheses

For the categories outlined in Table 5.5, we first calculate the mean repayment ratio for each account during the period prior to the implementation of the regulation. We then classify each account based on these mean repayment ratios, assigning them to the relevant categories.

Firstly, we observe that the *Post regulation* effect is particularly noteworthy. For accounts in the lower pre-regulation repayment categories (ranging from 0 - 0.19 up to 0.6 - 0.79), the regulation has induced an increase in the repayment ratio. This suggests that the regulation was successful in prompting individuals who were initially paying lower proportions of their debt to increase their repayments.

However, a different picture emerges for those in the highest pre-regulation repayment category (0.8 - 1). Here, we witness a decrease in the repayment ratio after the regulation. This implies that the regulation might not have had the intended effect on this group of individuals who previously exhibited a tendency to repay a higher portion of their debt.

The impact of the closing balance is another key factor to highlight. Across all categories, a larger closing balance corresponds with a smaller repayment ratio, indicating that as the debt amount rises, consumers tend to repay a smaller fraction of their debt.

Table 5.6: Impact of the regulation on repayment ratios across distinct credit limit groups. Similar to Table 5.5, the table shows the results of multiple regressions. Each column provides the coeffiecients from a regression with the observations in each category, showing the effect of the regulation on groups with different credit limits. *Closing balance* and *Credit limit* are presented in units of 1000 NOK.

	Dependent variable:					
	Repayment ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
	Credit limit	Credit limit	Credit limit	Credit limit	Credit limit	Credit limit
VARIABLES	1 – 19 999	20 000 – 39 999	40 000 – 59 999	60 000 – 79 999	80 000 – 99 999	100 000 <
Post regulation	0.0651***	0.0575***	0.0562***	0.0457***	0.0475***	0.0472***
	(0.0019)	(0.0010)	(0.0011)	(0.0019)	(0.0025)	(0.0019)
|Closing balance|	-0.0265***	-0.014***	-0.00787***	-0.00564***	-0.00442***	-0.00292***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Credit limit	0.00487***	0.00496***	0.00277***	0.00217***	0.00185***	0.000536***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Constant	0.4609***	0.4362***	0.4708***	0.3877***	0.3937***	0.4527***
	(0.0030)	(0.0029)	(0.0090)	(0.0173)	(0.0511)	(0.0083)
Observations	3,561,115	8,492,693	6,256,089	1,837,137	914,464	1,506,197
R-squared	0.081	0.114	0.110	0.127	0.118	0.113
Number of accounts	187,597	334,856	215,256	60,194	27,879	36,045

*** p<0.01, ** p<0.05, * p<0.1

Note: Year-fixed effects are included as control variables.

Robust standard errors in parentheses

From the results in Table 5.6 we observe that the *Post regulation* variable consistently exhibits a positive coefficient across all categories, indicating that the repayment ratio generally increased post-regulation across all credit limit groups. The size of this effect, however, decreases as the credit limit increases, suggesting that the regulation may have had a more pronounced impact on repayment behaviors in lower credit limit categories.

Moreover, the table reveals an intriguing interplay between the *Closing balance* and *Credit limit* variables across these categories. As the category of credit limit increases, the impact of an increasing closing balance on reducing the repayment ratio becomes less pronounced, while the effect of a rising credit limit on increasing the repayment

ratio similarly diminishes. This trend indicates that consumers with higher credit limits have different credit usage and repayment habits, perhaps due to differing financial circumstances.

Table 5.7: Impact of the regulation on repayment ratios across different age groups. This table outlines the effects of the regulatory change on repayment behaviors in various age brackets. Each column provides the coefficients from a regression with the observations in each category, illustrating how the post-regulation environment influenced repayment patterns among different age demographics. *Closing balance* and *Credit limit* are presented in units of 1000 NOK.

	Dependent variable:					
	Repayment ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
	Age	Age	Age	Age	Age	Age
VARIABLES	18 - 29	30 - 39	40 - 49	50 - 59	60 - 69	70 +
Post regulation	0.0444***	0.0603***	0.0590***	0.0543***	0.0519***	0.0516***
	(0.0019)	(0.0014)	(0.0012)	(0.0012)	(0.0015)	(0.0022)
|Closing balance|	-0.0109***	-0.00704***	-0.00563***	-0.00546***	-0.00546***	-0.00556***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Credit limit	0.00272***	0.00163***	0.00123***	0.00109***	0.000916***	0.000394***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Constant	0.4301***	0.4013***	0.4170***	0.4639***	0.5384***	0.6139***
	(0.0018)	(0.0016)	(0.0019)	(0.0023)	(0.0033)	(0.0050)
Observations	2,747,382	4,259,363	5,205,702	4,995,915	3,471,656	1,887,661
R-squared	0.054	0.069	0.077	0.089	0.091	0.075
Number of accounts	159,077	192,499	197,664	189,679	146,413	90,220

*** p<0.01, ** p<0.05, * p<0.1

Note: Year-fixed effects are included as control variables.

Robust standard errors in parentheses

In Table 5.7, similar to our previous observations, the *Post regulation* variable consistently shows a positive coefficient across all age groups, indicating an overall increase in the repayment ratio post-regulation. Interestingly, the middle age groups (30-59)

appear to have experienced a more significant boost in their repayment ratios post-regulation compared to the younger (18-29) and older (70+) cohorts.

Further, as observed earlier, the effect of the *Closing balance* on the repayment ratio is negative across all age groups, reiterating that higher balances are associated with lower repayment ratios. However, the effect size is remarkably similar across different age groups, suggesting that the influence of closing balances on repayment behaviors is fairly uniform across ages.

The *Credit limit* variable also exhibits a similar pattern across age groups, with the effect size decreasing as age increases. This observation might indicate that older consumers, possibly having more stable financial situations, are less influenced by changes in their credit limits.

Moreover, the constant term increases with age, indicating that the baseline repayment ratio, absent other influences, tends to be higher for older individuals. This finding aligns with conventional wisdom, as older consumers are typically more financially established and might demonstrate more conservative credit usage and repayment behaviors.

The analysis conducted under Hypothesis 1 affirms a significant impact of the 2017 regulation on the repayment ratio. The increase in the repayment ratio post-regulation is observable across various models and consumer cohorts, although its magnitude and significance vary. The regulation's impact appears to be more pronounced among pre-regulation repayment categories, lower credit limit groups, and middle-aged consumers. Conversely, the effect is weaker on consumers with previously high repayment habits. Despite some variance left unexplained by our models, the robustness of these findings enables us to confidently reject the null hypothesis that the regulation had no significant impact on the repayment ratio.

5.2 Testing Hypothesis 2: The regulation impacted minimum and maximum payment proportions

Figure 5.2: Monthly proportions of minimum and maximum payments. The figure illustrates the monthly proportions of minimum and maximum payments made by account holders. The lines represent the average proportion of minimum payments (red) and maximum payments (green) for each month during the period. A value of 1 would indicate that every payment made that month was either a minimum or maximum payment, while a value of 0 would mean no such payments were made.

We observe a significant shift in repayment patterns that aligns with the time the invoice default amount was changed. The proportion of minimum payments decreases substantially, while a simultaneous increase in the proportion of maximum payments is also apparent. This major shift in repayment behavior offers initial support for Hypothesis 2, suggesting that the regulation may have influenced the propensity of account holders to make minimum and maximum payments.

In addition, we observe that maximum payments have an increasingly positive trend from the beginning of year 2020, while minimum payments are starting the decline

from the same period. Moreover, the seasonal fluctuations present in the repayment ratio from Hypothesis 1 are seemingly mirrored here, notably with opposing trends between minimum and maximum payments.

Table 5.8: Impact of the regulation on proportions of minimum and maximum payments. This table presents the results of applying our main model, where the dependent variable *Repayment ratio* is replaced with the dummy variables *Minimum payment* and *Maximum payment*, in two separate regressions. *Closing balance* and *Credit limit* are presented in units of 1000 NOK.

	Dependent variable:	*Dependent variable:*
VARIABLES	Minimum payment	Maximum payment
Post regulation	-0.1288***	0.0846***
	(0.0008)	(0.0007)
|Closing balance|	-0.00168***	-0.00612***
	(0.0000)	(0.0000)
Credit limit	0.000838***	0.00150***
	(0.0000)	(0.0000)
2016	0.0102***	0.0223***
	(0.0005)	(0.0004)
2017	0.0366***	0.0245***
	(0.0009)	(0.0007)
2018	0.0590***	0.0311***
	(0.0009)	(0.0008)
2019	0.0781***	0.0447***
	(0.0009)	(0.0008)
2020	0.1047***	0.0656***
	(0.0010)	(0.0008)
2021	0.1074***	0.0791***
	(0.0010)	(0.0008)
2022	0.1055***	0.0822***
	(0.0010)	(0.0008)
Constant	0.2458***	0.3135***
	(0.0012)	(0.0011)
Observations	22,567,695	22,567,695
R-squared	0.011	0.086
Number of accounts	701,488	701,488

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

The results of the regressions presented in Table 5.8 mirror our observations from the graph and provide strong statistical support for Hypothesis 2. As the table illustrates, there is a significant post-regulation shift in the propensities for making minimum and maximum payments. The coefficient for the *Post regulation* variable in the *Minimum payment* regression is -0.1288, suggesting a notable decrease in the propensity for making minimum payments after the regulatory change. This aligns perfectly with the graph, where we observe a substantial downward shift in the proportion of minimum payments following the introduction of the new invoice default amount. Conversely, the coefficient for the *Post regulation* variable in the *Maximum payment* regression is 0.0846, indicating a significant increase in the propensity for making maximum payments after the regulation was implemented. The clear inverse trends between minimum and maximum payments, both in the graph and the regression results, point to a meaningful change in payment behaviors driven by the regulatory shift.

The significant coefficients of the $|$*Closing balance*$|$ in both the Minimum payment and Maximum payment regressions suggest an intriguing pattern: as the closing balance increases, both minimum and maximum payments decreases. A small closing balance makes it more likely to be paid off in full, hence a higher propensity for maximum payments. On the other hand, the fact that the propensity for making minimum payments also declines as the closing balance increases is not as intuitive to interpret, but might be explained by the behavioral biases which will be discussed in a subsequent section. Similarly, the *Credit limit* coefficients in both the minimum and maximum payment regressions are positive.

The year dummies in the regression analysis echo the narrative presented by the graph. In the minimum payment model, we observe that in 2022, the coefficient is smaller than the preceding year, which is contrary to the earlier years. The maximum payment model similarly resonates with the graph's portrayal of an upward trend in the proportion of maximum payments post-regulation.

Drawing from our analysis, we can confidently support Hypothesis 2. The regulation significantly impacted both the minimum and maximum payment proportions. The

evidence is clear in the negative coefficient of the post-regulation variable for minimum payments, and the positive coefficient for maximum payments. These findings indicate a significant decrease in the propensity for making minimum payments, and a corresponding increase in the propensity for making maximum payments following the regulatory change. The null hypothesis can hence be rejected.

5.3 Testing Hypothesis 3: Seasonal liquidity changes have an effect on repayment behavior.

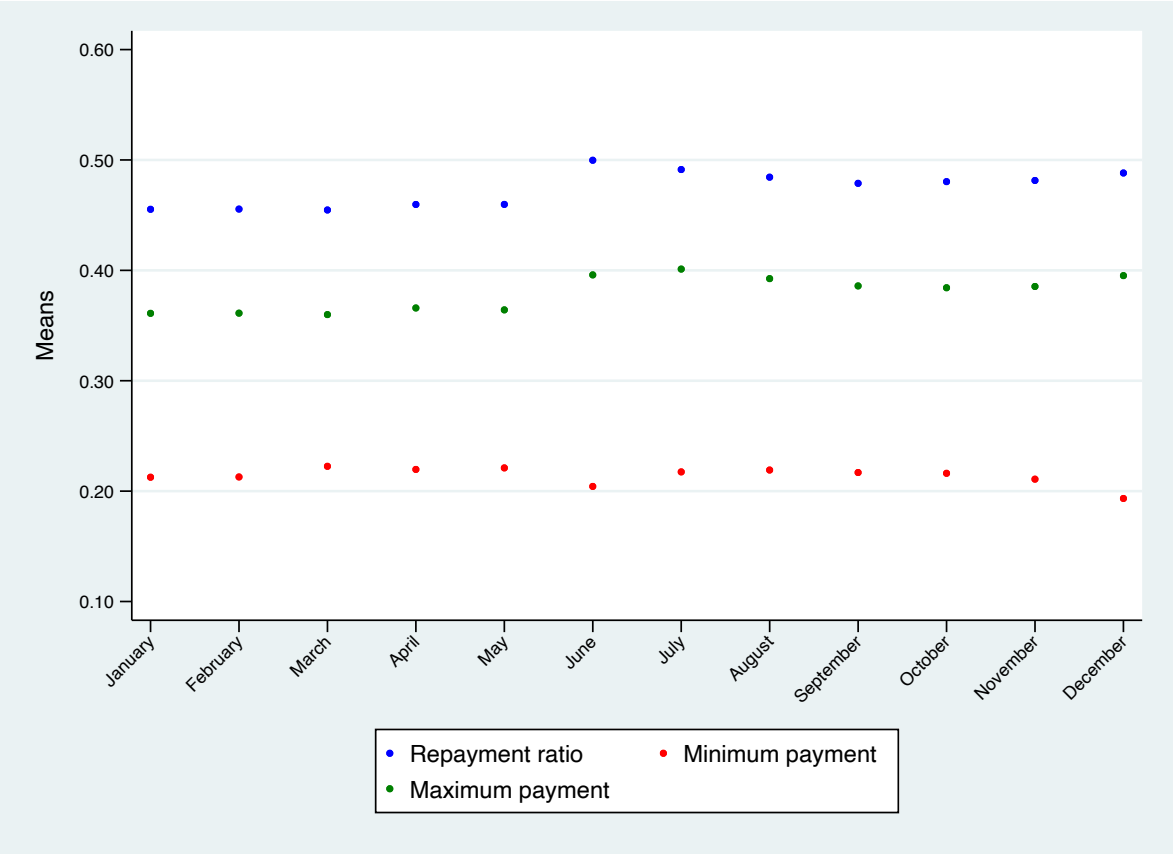

Figure 5.3: Mean repayment measures by month. The figure illustrates the monthly means for repayment ratio (blue), minimum payments (red), and maximum payments (green). Each point represents the mean value for the respective payment measure for a given month.

In Figure 5.3, we notice the distinctive 'June-effect' reflecting in the average repayment measures. There is a prominent surge in the mean repayment ratio and maximum payments in June, coinciding with a decrease in minimum payments. This pattern, seen as a deviation from the general trend, underscores the potential seasonal effects on repayment behavior which has been apparent in the previous graphs. Also apparent from the graph is a similar effect in December, especially on the minimum payment mean.

Table 5.9: Month-based regression analysis. This table outlines three regression models predicting the repayment ratio, minimum payment, and maximum payment, but in contrast to our main model, we employ month-dummies instead of year-dummies to capture potential seasonal effects on repayment behavior. *Closing balance* and *Credit limit* are presented in units of 1000 NOK.

	Dependent variable:	*Dependent variable:*	*Dependent variable:*
VARIABLES	Repayment ratio	Minimum payment	Maximum payment
Post regulation	0.0825***	-0.0589***	0.1224***
	(0.0004)	(0.0006)	(0.0005)
|Closing balance|	-0.00620***	-0.00174***	-0.00619***
	(0.0000)	(0.0000)	(0.0000)
Credit limit	0.00133***	0.000937***	0.00159***
	(0.0000)	(0.0000)	(0.0000)
February	-0.0008***	0.0005	-0.0005**
	(0.0002)	(0.0003)	0.0002)
March	-0.0000	0.0093***	-0.0003
	(0.0002)	(0.0003)	(0.0003)
April	0.0010***	0.0072***	0.0017***
	(0.0002)	(0.0003)	(0.0003)
May	0.0018***	0.0085***	0.0007**
	(0.0003)	(0.0003)	(0.0003)
June	**0.0413*** **	**-0.0086*** **	**0.0276*** **
	(0.0003)	**(0.0003)**	**(0.0003)**
July	0.0254***	0.0047***	0.0271***
	(0.0003)	(0.0003)	(0.0003)
August	0.0171***	0.0073***	0.0169***
	(0.0003)	(0.0003)	(0.0003)
September	0.0101***	0.0063***	0.0105***
	(0.0003)	(0.0003)	(0.0003)
October	0.0116***	0.0057***	0.0090***
	(0.0002)	(0.0003)	(0.0003)
November	0.0115***	0.0016***	0.0094***
	(0.0002)	(0.0003)	(0.0003)
December	0.0114***	**-0.0094*** **	0.0076***
	(0.0002)	**(0.0003)**	(0.0003)
Constant	0.4530***	0.2503***	0.3174***
	(0.0010)	(0.0012)	(0.0011)
Observations	22,567,695	22,567,695	22,567,695
R-squared	0.084	0.007	0.082
Number of accounts	701,488	701,488	701,488

*** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

From Table 5.9 we first reaffirm our findings from the examination of Hypotheses 1 and 2 through the consistent *Post regulation* coefficients across the models. These consistently observed coefficients, aligning with our previous hypotheses tests, lend robust support to the proposition that the regulation has had a significant impact on repayment behavior.

For Hypothesis 3, we turn our attention to the monthly dummy variables, representing potential seasonal fluctuations in repayment behavior. We observe a significant variation in the monthly coefficients, the most striking being associated with the month of June. The coefficients for the *Repayment ratio* and *Maximum payment* models for June are significantly higher compared to other months, suggesting a substantial surge in repayment activities during this period.

Furthermore, the coefficients reveal a less pronounced, yet still noteworthy decrease in the propensity for minimum payments in December. Unlike the 'June-effect', the 'December-effect' does not demonstrate a significant surge in repayment ratio or maximum payments, yet the decrease in minimum payments suggests a shift in repayment behaviors.

Moreover, we observe a comparatively poorer repayment performance, characterized by lower repayment ratio, maximum payment, and higher reliance on minimum payments, during the period of January through May.

This seasonality might indicate the influence of various factors such as holiday pay, tax refunds, bonuses, or other forms of irregular income that could play a role in shaping these repayment trends. In any case, it indicates that when borrowers have more disposable income or access to irregular income sources, they are more inclined to pay off their debts at a faster rate or in larger amounts.

5.4 Robustness tests

In order to ensure the reliability and robustness of our findings, we conducted robustness tests in Table 5.10 and 5.11.

In Table 5.10, we compare two different approaches to specifying the accounts in our dataset. Specifically, we compare the results from a regression with our prepared dataset with a restricted sample (Column 2 in Table 5.10) using our main model (Column 6 in Table 5.1). In the restricted sample, every unique account must have at least one observation both before and after the regulation. The accounts that do not appear both before and after, or were created after- or deleted before the regulation are no longer included. Nearly half of the unique accounts are removed using this restriction, however the amount of observations does not decline as much.

Table 5.10: This table shows the main sample (1) compared to an alternative sample (2), where the restricted sample includes only accounts with activity both before- and after the regulation.

	Dependent variable:	
	Repayment ratio	
	(1)	(2)
VARIABLES	Unrestricted	Restricted
Post regulation	0.0558***	0.0559***
	(0.0006)	(0.0006)
Constant	0.4541***	0.4565***
	(0.0009)	(0.0011)
Observations	22,567,695	17,040,353
R-squared	0.085	0.094
Number of accounts	701,488	352,399

*** p<0.01, ** p<0.05, * p<0.1

Note: Year-fixed effects, absolute value of closing balance and credit limit are included as control variables.

Robust standard errors in parentheses

The results indicate that the effect of the *Post regulation* dummy coefficient is nearly identical between the unrestricted sample (0.0558) and the restricted sample (0.0559).

The coefficients suggests that the presence of the restriction does not significantly impact the observed effect.

For the regressions in Table 5.10, the within R-squared is higher for the restricted sample (0.0935) compared to the unrestricted sample (0.0851). This suggests that the restricted sample model explains a slightly larger proportion of the within-group variation in the repayment ratio. This could be due to better control for unobserved heterogeneity among the accounts. Moreover, the between R-squared is higher for the restricted sample (0.4497) compared to the unrestricted sample (0.3661).

Additionally, the overall R-squared is higher for the restricted sample (0.3079) compared to the unrestricted sample (0.2914), suggesting that the restricted sample model has a slightly better overall explanation power.

The fixed effects model estimation results show that the choice of sample does not significantly affect the estimated coefficient of the post regulation dummy. The restricted sample model has a slightly better explanation power in terms of both within-group and between-group variations. However, the decision to use the restricted or unrestricted sample should be based on the trade-offs between precision and generalizability, in our case, generalizability is the preferred direction.

In Table 5.11, we compare the main model (Column 6 in Table 5.1) with a different restricted sample (Column 2 in Table 5.11). The restricted model removes the years 2020 - 2022 to examine the potential bias caused by the impact of COVID-19 on our main model's estimates. The *Post regulation* dummy coefficients from the main model (0.0558) and the new restricted model (0.0542) are almost identical. This suggests that the inclusion of the years 2020 to 2022 in our main model does not significantly bias our estimates. Based on these results, we can confidently include the years 2020 to 2022 in our main model without compromising the validity of our findings.

Table 5.11: This table shows the main sample (1) compared to an alternative sample (2), where the restricted sample does not include observations from the years 2020 - 2022.

	Dependent variable:	
	Repayment ratio	
	(1)	(2)
VARIABLES	Unrestricted	Restricted
Post regulation	0.0558***	0.0542***
	(0.0006)	(0.0006)
2016	0.0159***	0.0143***
	(0.0003)	(0.0003)
2017	0.0159***	0.0136***
	(0.0006)	(0.0006)
2018	0.0214***	0.0173***
	(0.0007)	(0.0007)
2019	0.0308***	0.0239***
	(0.0007)	(0.0007)
2020	0.0451***	
	(0.0007)	
2021	0.0569***	
	(0.0007)	
2022	0.0625***	
	(0.0007)	
Constant	0.4541***	0.4264***
	(0.0009)	(0.0010)
Observations	22,567,695	13,629,105
R-squared	0.085	0.062
Number of accounts	701,488	568,081

*** p<0.01, ** p<0.05, * p<0.1

Note: Absolute value of closing balance and credit limit are included as control variables.

Robust standard errors in parentheses

6 Discussion

6.1 Behavioral finance

Our analysis of the impacts of the 2017 Norwegian credit card regulation has provided insights into the interplay between behavioral finance theories and consumers' credit repayment behaviors.

Firstly, we identified a significant default effect, which resonates strongly with the findings of Johnson and Goldstein (2003). They underscored the influence of the default effect on decision-making, and our observations add weight to their conclusion. The introduction of the new regulation changed the default payment request from the minimum payment to the total outstanding balance. This shift resulted in an evident increase in the average repayment, indicating a substantial default effect at work. In addition, we noticed a considerable increase in the proportion of maximum payments and a greater decrease in the minimum payments, implying that individuals are more likely to conform to the newly presented default payment option.

Further, our data shows signs of an anchoring bias, the influential concept introduced by Tversky and Kahneman (1974). Later, Keys and Wang (2019) applied this concept to the realm of loan repayments, which parallels our context. Evidently, the shift from the minimum payment to the total outstanding credit on invoices seems to have established a new anchor. Consequently, individuals started repaying larger amounts, thereby pushing up the overall repayment ratio and lowering the overall debt. While it is plausible that this shift in the default payment amount could have influenced individuals' perceptions of 'appropriate' or 'best' repayment actions, our study does not directly measure these perceptions, and this remains an open question. Nevertheless, the anchoring effect is evident in our study, and it illustrates how even subtle changes in the presentation of payment options can have a profound impact on consumer repayment behaviors.

Interestingly, our analysis under Hypothesis 2 reveals a pattern indicating the presence of anchoring bias. We found that as the closing balance increases, the probability of

both minimum and maximum payments occurring decreases. This seemingly counter-intuitive behavior might be better understood through the lens of anchoring bias. In the case of credit card repayments, the anchoring bias might guide account holders' perception of what constitutes an acceptable repayment amount. As the closing balance or 'anchor' increases, it could influence the account holder's judgement of the minimum payment. The minimum payment itself is a fixed percentage of the total balance, meaning that the the minimum payment amount increases with the closing balance. However, influenced by the anchoring bias, account holders might perceive this higher minimum payment amount as increasingly inadequate compared to the larger closing balances. This could lead them to avoid this smaller alternative, decreasing the probability of making just a minimum payment despite being a higher amount. While these account holders tend to pay more than the minimum amount, they do not generally clear the entire higher closing balance, which explains the simultaneous decrease in the propensity for making a maximum payment when the closing balance increases.

The regulation seems to have harnessed the power of the 'nudge,' the concept introduced by Thaler and Sunstein (2009). They proposed how subtle shifts in choice architecture can 'nudge' people towards making decisions that are in their best long-term interest. In our context, the regulation nudged credit card users towards making larger repayments, thereby affirming the effectiveness of nudging in influencing financial decisions. Similarly, Navarro-Martinez et al. (2011) found that alterations to minimum payment requirements could significantly impact repayment decisions. Our work extends the discourse by examining the effect of a real-world regulatory change, and notably, our results align with the Norwegian government's intent to instill more responsible consumer behavior and raise awareness about the costs associated with credit usage.

Our study reveals that the impact of the regulation varies across different groups, pointing towards heterogeneity in responses to the regulation. Although the regulation appears to have increased repayments on average, the magnitude of this effect is notably different between the groups. This may suggest that individual or group-specific factors, such as income level, financial literacy, or personal beliefs about debt, could

potentially moderate the effect of regulatory changes. These findings align with the diverse body of literature recognizing individual differences in susceptibility to behavioral biases (DellaVigna, 2009).

Our research underscores the importance of behavioral biases in policy design and contributes to the broader understanding of unsecured debt levels in Norway. The findings from our research can provide a solid foundation for further research in the fascinating and impactful field of behavioral finance.

6.2 Liquidity constraints

An interesting finding emerged when considering the impact of liquidity on repayment behavior. Hypothesis 3 suggests that seasonal liquidity changes would influence repayment behaviors, and our findings lend support to this hypothesis. Specifically, we observed unique 'June-' and 'December-effects'. The observed seasonal trends in repayment behavior could be explained by specific economic factors within the Norwegian context. Notably, June marks the period where Norwegians receive their holiday pay - a legally mandated bonus equivalent to 10.2% of the previous year's income. This additional income, coupled with the anticipation of summer holidays, might motivate individuals to repay more of their outstanding credit debt, hence the prominent 'June-effect'. In a similar vein, the 'December-effect' could be influenced by the reduction of tax liability to half in November and December for many Norwegians, freeing up more income for discretionary spending or debt repayment in December. However, it appears the effect is not as pronounced as in June, potentially due to countervailing pressures of increased holiday spending.

Furthermore, the comparatively poorer repayment performance in January through May could be indicative of liquidity constraints post-Christmas spending season, as consumers may face financial strain due to increased expenditures over the festive period. This pattern further underlines the potential influence of liquidity factors on repayment behavior. Overall, these findings emphasize the importance of considering local economic practices and seasonal spending habits when analyzing consumer credit

behavior.

Regarding the relationship between closing balances, repayment ratios, and liquidity constraints, our study underscores an interesting pattern. As expected, a higher closing balance typically translates into a lower repayment ratio, likely reflecting the presence of liquidity constraints. It suggests that when consumers face larger outstanding balances, their capacity to repay may be limited, leading to smaller repayment ratios. This observation is consistent with previous studies highlighting the role of liquidity constraints in shaping repayment decisions (Gross and Souleles, 2002). In relation, our results also indicate that, given more available money, consumers tend to repay more regardless of the repayment option in the invoice. This may be attributed to an increase in the ability to repay larger amounts when financial resources are more abundant. It can also be seen as a manifestation of rational behavior, as repaying more when one has a surplus can help to reduce future interest costs. This aligns with classical economic theory, which assumes that individuals will make optimal decisions given their constraints (Samuelson, 1948). However, the implications of the 2017 regulation suggest that while this rational behavior might hold true on average, the framing of choices can significantly influence the decisions individuals make.

7 Conclusion

This investigation into the impact of the 2017 Norwegian credit card regulation on consumer repayment behaviors has unveiled significant effects of behavioral finance principles and liquidity changes on credit card repayments. The regulatory change, requiring financial institutions to specify the total outstanding credit as the default amount for payment instead of the minimum requirement, demonstrated its ability to influence repayment decisions.

In response to the regulation, credit card users exhibited a shift in behavior, as reflected by the 5.58-point rise in the average repayment ratio. This suggests that the total outstanding credit on invoices has become a new anchor, altering consumers' repayment behaviors. This shift in behavior was also apparent in the reduced proportion of minimum payments, down by more than 52%, and the increased proportion of maximum payments, up nearly 27%.[1]

Furthermore, the regulation's success in 'nudging' users towards larger repayments indicates its efficacy in promoting responsible use of credit. However, the effects of the regulation varied significantly among different consumer groups, highlighting the potential moderating role of individual-specific factors. We observed that repayment behavior changes were more pronounced in account holders who initially repaid a lower proportion of their debt, borrowers with a lower credit limit, and individuals in the middle age groups (30-59).

Our study also revealed a correlation between increasing closing balances and decreasing repayment ratios across all categories, suggesting the presence of liquidity constraints. The 'June-effect' and 'December-effect' further emphasized the impact of liquidity on repayment behaviors, revealing a clear seasonal influence.

[1]The change is calculated from the *Post regulation* coefficients and constants in Table 5.8. Calculation of minimum decrease is |-0.1288| / 0.2458 = 52% and calculation of maximum increase is 0.0846 / 0.3135 = 27%. These percentage changes are estimated assuming all other model variables are set to zero.

In essence, this research provides robust evidence supporting the meaningful impact of regulatory measures and seasonal liquidity changes on credit card repayment behaviors. The 2017 Norwegian credit card regulation has successfully nudged consumers towards improved repayment behaviors, serving its objective of promoting responsible credit use effectively.

7.1 Limitations and directions for further research

Our research was designed with a focus on "typical" credit card repayment behavior, leading to the exclusion of about half the dataset's observations. This approach, while enhancing the clarity of our study, has its limitations. By discarding these outliers, we may have ignored certain insightful aspects of repayment patterns. For instance, atypical credit card usage such as reward-focused spending or emergency funds utilization may be regular practice for some consumer segments. Examining the repayment behaviors of those outliers excluded from our study could reveal new patterns and nuances of consumer credit card usage.

Our study primarily employed a fixed effects model, which is ideal for handling unobserved time-invariant elements. However, this methodology may overlook individual-specific time-variant factors not directly observable in our data, despite the incorporation of year and month dummy variables. Such factors could include changes in personal financial situations, shifts in individual attitudes towards debt, variations in financial literacy, changes in income level, or alterations in other socioeconomic circumstances, which might influence repayment behaviors over time. A focus on these factors could provide a better understanding of the dynamics affecting repayment behaviors over time.

We identified the unique 'June-' and 'December effects', but we did not delve deeply into the specific factors causing this seasonal pattern. Additional data or specialized research is necessary to accurately pinpoint the cause of this effect. A more detailed study could enhance our understanding of seasonal influences on repayment behaviors. An in-depth analysis of the effects of broader macroeconomic changes on credit card

repayment behaviors would also provide valuable insights.

The assumption that changes in credit card repayment behaviors are directly attributable to the new regulations is another potential limitation. Other macroeconomic factors like inflation rates, unemployment rates, or changes in the wider financial environment could also have influenced these behaviors. Additionally, other factors such as digitization and the transition to electronic invoices can be assumed to affect repayment.

Future research can broaden its scope by investigating other behavioral finance principles and how they impact repayment behaviors. Exploring additional cognitive biases in the context of credit use and repayment decisions could offer additional insight.

In conclusion, despite certain limitations, our investigation into the impact of the 2017 Norwegian credit card regulation underscores the complex interplay of factors shaping repayment behaviors. This research both enriches current understanding and shows potential for further studies in behavioral finance and consumer credit behavior.

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Appendix

A Statistical tests

A.1 The Hausman test

Table A.1 presents the results from the Hausman test. The test is used to determine whether we should use a fixed effect or random effect model. We observe that the chi-squared value is very high and the p-value is 0, which means the random effect model is biased and inconsistent. We use the fixed effect model as our preferred model based on these results.

Table A.1: Hausman test

Chisquared	**DF**	**P-value**	**Conclusion**
5290.2	12	0.0000	Inconsistent

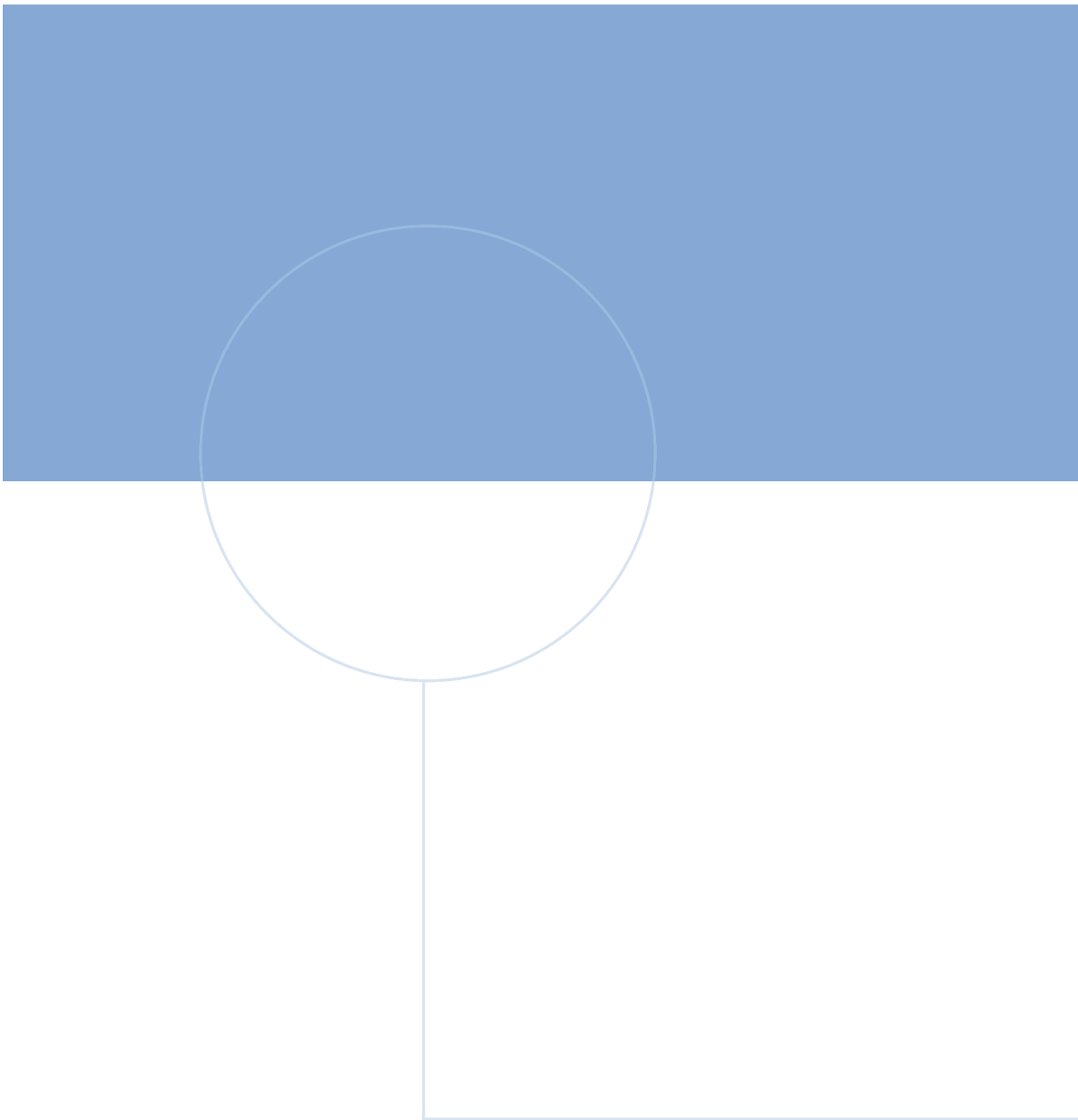
A.2 Breusch-Pagan test

Table A.2 presents the results of the Breusch-Pagan test. This test is conducted to determine whether there is homogeneity or heterogeneity among the account holders in our sample. It examines the variance in the residuals within the simple Pooled OLS model.

Based on the results in Table A.2, we observe that the test statistic is 26,052.67 and the p-value is 0.0000. This indicates that we reject the null hypothesis of constant variance in the residuals and conclude that there is heteroskedasticity among the account holders in our sample.

Table A.2: Breusch-Pagan test (column 1, Table 5.1)

Chisquared	**DF**	**P-value**	**Conclusion**
26052.67	1	0.0000	Heteroskedasticity



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