

Lukas, Moritz; Nöth, Markus

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## Commitment and Borrower Heterogeneity: Evidence from Revolving Consumer Credit

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# Commitment and Borrower Heterogeneity: Evidence from Revolving Consumer Credit

Moritz Lukas and Markus Nöth\*

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## Abstract

Based on a unique dataset, we analyze borrower heterogeneity in the debt response to interest rate decreases and credit limit increases in revolving consumer credit. Our key findings show that 1) the debt response of borrowers who commit to monthly minimum repayments is about four times as large as the response of uncommitted borrowers when interest rates decrease and 2) committed borrowers' reaction to credit limit increases is almost 30% stronger. These results are most likely to be caused by sophisticated impatient individuals choosing to commit and shed new light on the role of non-standard borrower preferences in consumer credit.

*JEL Classification:* D12, D14, D91, G02, G21

*Keywords:* Financial Intermediation, Behavioral Finance, Household Finance, Consumer Credit

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# 1 Introduction

Understanding the response of consumer debt to changes in credit supply is of prime importance for lenders since the interest income generated with consumer credit constitutes a substantial share of income for most universal banks. Lenders need reliable information regarding private borrowers' future credit demand and its dynamics in order to forecast debt volume and earnings, for pricing considerations, and to implement target-oriented measures to foster credit demand (Alan and Loranth; 2013; Gross and Souleles; 2002). Since different groups of borrowers might react differently to changes in credit supply, understanding the sources and consequences of borrower heterogeneity is of prime importance. Yet the empirical evidence on the drivers of credit demand in this segment is scarce and mixed. In this study, we show how the ability to distinguish between borrowers who commit to minimum debt repayments and borrowers who choose to remain uncommitted can substantially improve forecasts of retail borrowers' debt response to changes in interest rates and their marginal propensity to consume (MPC) out of liquidity.

Interest rate and credit limit changes constitute two forms of variation in credit supply which have been identified as central drivers of retail debt demand in previous theoretical and empirical studies. While the permanent income hypothesis (PIH) of Friedman (1957) suggests that the MPC out of credit limit increases equals zero and increases in consumers' credit limits only matter if liquidity constraints are binding, interest rate elasticities are typically difficult to predict on a conceptual level. Several studies empirically estimate the elasticity to interest rates in a borrowing context: Gross and Souleles (2002) and Alan and Loranth (2013) derive the effects of interest rate changes on US and UK credit card debt and conclude that the interest rate elasticity of consumption is significantly negative in the absence of binding liquidity and credit constraints. Alessie et al. (2005) find evidence of interest rate elastic demand for consumer loans in Italy. Attanasio et al. (2008) analyze a sample of US auto loans and find no evidence of interest rate elasticities which are significantly different from zero.<sup>1</sup> Gross and Souleles (2002) find that credit card borrowers' MPC out of credit limit increases is significantly different from zero. Importantly, the MPC increases with a borrower's utilization rate in the month before the credit limit increase. These findings are attributed to liquidity constraints which are currently binding as well as potentially binding in the future. Outside the borrowing domain, Parker (1999) reports a significantly positive MPC out of predictable after-tax income of US citizens. Souleles (1999) and Hsieh (2003) estimate a significantly positive MPC out of income tax refunds of US households. Agarwal et al. (2007) find that liquidity constrained

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<sup>1</sup>The latter two studies are based on loan take-up only and do not examine patterns of subsequent debt usage.

consumers increase spending more strongly than others in response to the 2001 US Federal income tax rebate. Jappelli and Pistaferri (2014) analyze the MPC out of a hypothetical unanticipated transitory reimbursement equal to a household's monthly earnings from Italian survey data and find that the MPC is significantly positive and unevenly distributed among households. They interpret their results as evidence of precautionary motives. Agarwal and Qian (2014) observe that spending is increased in the wake of a one-time unanticipated cash payout to Singaporean adults; the increase is strongest for liquidity constrained consumers. Jappelli and Padula (2016) show that a negative income shock reduces the propensity to consume.

Using a unique dataset on revolving credit take-up and usage of borrowers with high credit quality provided by a large retail lender in the German market, we provide an important extension to the empirical findings on the response of consumer debt to interest rate and credit limit changes by estimating both measures separately for borrowers who commit to monthly minimum repayments and for borrowers who choose full flexibility by remaining uncommitted. What renders our dataset with more than 1,600,000 account-month observations unique in the first place is the fact that the cooperating lender requires borrowers to actively choose in advance how to repay their outstanding debt: borrowers can either commit to monthly minimum repayments of outstanding debt or choose full flexibility, i.e., no minimum repayments. The lender does not influence borrowers' choice; most notably, commitment decisions are not rewarded with higher credit limits or lower interest rates. The endogenous self-selection of borrowers into the commitment device thus has the potential to reveal valuable insights regarding borrower heterogeneity. During our observation period from January 2008 to December 2012, borrowers in both groups experience decreases in the annual interest rate and credit limit increases. This enables us to jointly analyze the influence of both sorts of changes in credit supply. A further advantage of our dataset is the fact that all borrowers pay the same variable interest rate. Consequently, interest rates do not depend on an individual borrower's creditworthiness, the amount borrowed, or the available credit limit.<sup>2</sup>

Consistent with the bulk of previous research, we first confirm a significantly negative interest rate elasticity and a positive MPC in the cross-section. Debt rises in the wake of interest rate decreases compared to periods with no interest rate changes, and credit limit increases result in additional debt outstanding. These responses depend on borrowers' utilization rate right before the interest rate or credit limit change, with liquidity constrained borrowers reacting more strongly to interest rate decreases and credit limit increases. As the major contribution to these results, our

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<sup>2</sup>We hence avoid problems of endogeneity. See the related discussions in Attanasio et al. (2008) and Alan and Loranth (2013).

dataset reveals a substantial amount of heterogeneity not yet documented. Committed borrowers' debt response to interest rate changes is about four times as large as the reaction of uncommitted borrowers on average. Whereas both borrower groups exhibit a significantly positive MPC, the MPC of committed borrowers is almost 30% larger than the MPC of uncommitted borrowers in the cross-section.

Why could borrowers' commitment decisions reveal important information regarding their demand for debt? A large strand of research shows that many individuals tend to act inconsistently over time, exhibiting the tendency to be impatient in the short-run but patient in the long-run. Such time-inconsistent preferences affect individual consumption and borrowing decisions (Laibson; 1997, 1998; Phelps and Pollak; 1968). Since exponential discounting is not considered suitable to reflect this pattern of preferences, the concept of (quasi-)hyperbolic discounting has been suggested as an alternative perspective on intertemporal consumption decisions. Previous research indicates that some impatient individuals are aware of their inconsistent time preferences and form realistic beliefs regarding the extent of their future consumption and demand for debt; they thus exhibit a positive willingness to pay for commitment devices which might help avoid the potentially negative implications of inconsistent choices (these individuals are typically classified as sophisticated impatient). Other individuals are either unaware of their own impatience, thereby underestimating their future consumption and credit use (non-sophisticated impatient individuals), or simply not impatient and thus not in need of commitment (Ausubel; 1991; DellaVigna and Malmendier; 2004; Heidhues and Kőszegi; 2010; O'Donoghue and Rabin; 1999; Strotz; 1956). In line with these findings, we argue that sophisticated impatient individuals choose to commit to minimum repayments whereas patient and non-sophisticated impatient borrowers prefer to remain uncommitted and determine their repayments at their discretion each month. This causes a concentration of impatient borrowers in the committed group while the uncommitted group consists of both impatient and patient borrowers. Since previous research has shown that impatient borrowers tend to borrow more than patient borrowers (Meier and Sprenger; 2010), these differences in group composition are likely to ultimately translate into the observed differences in borrowers' debt demand and response.<sup>3</sup>

As for the group differences observed in our analyses, we can reject alternative explanations such as group differences unrelated to impatience and sophistication, committed borrowers breaking their commitment, and the non-usage of loan accounts. Furthermore, our results indicate that basic borrower impatience and sophistication drive the results rather than the disciplining effect of the

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<sup>3</sup>In a related context, the self-selection of borrowers into different maturities of debt and the subsequent loan usage are investigated in Hertzberg et al. (2015).

commitment device itself. Based on these insights on borrower heterogeneity and a simple means of identifying sophisticated impatient borrowers, lenders can target their measures to foster credit demand (such as interest rate discounts or credit limit increases) at those borrower groups which are most susceptible and thus increase cost efficiency and profitability.

This study is the first to empirically study borrower heterogeneity in the interest rate elasticity and the MPC out of liquidity based on the impatience and sophistication of retail borrowers. Comparable studies usually assume that individuals exhibit standard preferences and make their consumption and borrowing decisions within the framework of exponential discounting. While heterogeneity is typically attributed to credit constraints or average utilization rates, we add the notion of borrowers' impatience and distinguish between committed and uncommitted borrowers' debt responses based on borrowers' endogenous self-selection into an available commitment device. Our way of distinguishing different borrower types is not available in related studies. In addition to our findings on borrower heterogeneity, we provide evidence on the debt response of borrowers with relatively high amounts of debt and a high creditworthiness outside the domain of credit cards; in comparison to Gross and Souleles (2002) and Alan and Loranth (2013), the debt amounts in our dataset are substantially larger on average, and our dataset contains no subprime borrowers.

The remainder of this paper proceeds as follows. In Section 2, we discuss the theoretical foundations of our analysis. In Section 3, we provide the institutional details of the revolving loans studied here and the description of our dataset. Our empirical specification is discussed in Section 4. The main results are presented in Section 5. In Section 6, we show how lenders can use our insights to provide credit more efficiently and profitably. Section 7 concludes.

## 2 Borrower Impatience and Self-Commitment

The major contribution of our study is related to the research on consumers' impatience, sophistication, and self-commitment.

Earlier theoretical and empirical work by Phelps and Pollak (1968) and Laibson (1996, 1997, 1998) argues that some individuals are impatient in the short-run and exhibit time-inconsistent preferences to varying degrees. As a central framework to accommodate time-inconsistent preferences, the concept of quasi-hyperbolic discounting assumes a hyperbolic discount factor  $\beta$  ( $0 < \beta < 1$ ), which is distinct from the exponential discount factor  $\delta$ . In this setting, an individual's lifetime utility from the perspective of Period  $t$  can be written as

$$U_t(c_0, \dots, c_T) = E_t \left[ u(c_t) + \beta \sum_{i=1}^{T-t} \delta^i u(c_{t+i}) \right] \quad (1)$$

where  $c$  denotes consumption and  $u(c)$  represents utility derived from consumption. An alternative way to think about intertemporal choice is that an individual's current self (Period  $t$ ) is distinct from her future selves (Periods  $t+i$ ).<sup>4</sup> In this model, impatient individuals exhibit a  $\beta$  smaller than 1 while patient individuals (i.e., pure exponential discounters) have a  $\beta$  equal to 1. In the borrowing domain, more impatient individuals show the tendency of borrowing more than more patient individuals, particularly in the context of revolving credit (Meier and Sprenger; 2010). Intuitively, hyperbolic borrowers who currently borrow plan to repay their debt or to take on no additional debt in the subsequent period; when this period arrives, repayment and the intention not to increase debt are deferred to the subsequent period again, and the same reasoning applies to all future periods. In extreme cases, debt is never repaid.

As argued by Strotz (1956), O'Donoghue and Rabin (1999), Loewenstein et al. (2003), and DellaVigna and Malmendier (2004), an individual's true hyperbolic discount factor,  $\beta$ , can deviate from her anticipated discount factor,  $\hat{\beta}$ . In this framework, a distinction is drawn between sophisticated impatient individuals for whom  $\beta = \hat{\beta} < 1$  (i.e., short-run impatience is correctly assessed) and non-sophisticated impatient individuals for whom  $\beta < \hat{\beta} = 1$  (i.e., short-run impatience is ignored).<sup>5</sup> For patient individuals (pure exponential discounters),  $\beta = \hat{\beta} = 1$ .<sup>6</sup> By this definition, only sophisticated impatient individuals are aware of their short-term impatience while non-sophisticated impatient individuals naively think of themselves as exponential discounters. Importantly, in a borrowing context, Heidhues and Köszegi (2010) and Ausubel (1991) show that non-sophisticated impatient borrowers underestimate their future credit use or underestimate the likelihood that they will borrow in the future while sophisticated impatient individuals make more accurate forecasts of their future demand for credit and are well aware of the extent of their future borrowing. Note that in line with the studies mentioned above, sophistication only relates to the degree to which a borrower is aware of her own impatience whereas the term does not necessarily mirror aspects like borrowing experience or debt literacy (some studies which are unrelated to the analysis of time preferences use the term to classify the general financial behavior of individuals; as an example, Calvet et al. (2009) use the term sophistication to describe how likely households are to commit

<sup>4</sup>Such models are sometimes referred to as *dual self models*, see Bryan et al. (2010).

<sup>5</sup>Non-sophisticated individuals are sometimes referred to as *naifs*, see O'Donoghue and Rabin (1999). Some studies add the notion of *partially non-sophisticated* individuals ( $\beta < \hat{\beta} < 1$ ), see the discussion in DellaVigna and Malmendier (2004) and Bryan et al. (2010).

<sup>6</sup>Non-sophisticated patient individuals do not exist since individuals with  $\beta = 1$  cannot exhibit a  $\hat{\beta}$  larger than 1.

**Table 1: Patience, Sophistication, and Commitment**

This table summarizes the relation between patience, sophistication, and self-commitment. *Impatient (patient)* is defined as  $\beta < 1$  ( $\beta = 1$ ); *Sophisticated (non-sophisticated)* implies that  $\beta = \hat{\beta}$  ( $\beta < \hat{\beta}$ ).

	Sophisticated	Non-sophisticated
<b>Impatient</b>	Commitment	No commitment (underestimating need)
<b>Patient</b>	No commitment (no need)	—

investment mistakes).

The research on commitment devices, pioneered by Strotz (1956), argues that only sophisticated impatient individuals are aware of the need to commit, i.e., to restrict the choices of future selves which might not be in the current self’s best interest, whereas completely non-sophisticated impatient individuals or patient individuals see no use in committing. While non-sophisticated impatient individuals underestimate the need to commit, patient individuals correctly anticipate that a commitment is not required. Consequently, the latter two groups will never choose an available commitment device while sophisticated impatient subjects choose the commitment device as they are aware that their future selves will not act in their current self’s best interest and they anticipate the potential negative consequences of not committing (Ashraf et al.; 2006; Beshears et al.; 2015; DellaVigna; 2009; DellaVigna and Malmendier; 2004; O’Donoghue and Rabin; 1999). As an example, in a borrowing context, such consequences are substantially higher interest payments in future periods if borrowers do not succeed in paying down debt on a regular basis.

Consequently, whenever a commitment device is available, the committed group will mostly be composed of impatient individuals while the uncommitted group will most likely be a mixture of impatient and patient individuals. Table 1 summarizes this reasoning. In the borrowing domain, these differences in group composition are very likely to translate into differences in the demand for credit (Meier and Sprenger; 2010), and potentially in the debt response to interest rate and credit limit changes.

### 3 Institutional Details and Data Description

This section discusses the central features of revolving credit for retail borrowers and shows how the self-selection of borrowers reveals their sophistication and impatience. We then present the main descriptive statistics of our dataset.



### 3.1 Revolving Consumer Credit

Revolving credit constitutes a pre-specified callable amount of credit with potentially infinite maturity, which can be partly or fully accessed by the borrower repeatedly when needed. Due to the possibility to use revolving credit as a liquidity reserve, borrowers might decide to open a loan account even in the absence of the current need for credit. Interest payments are made on the called loan amounts only, and the mere provision of a consumer line of credit is free of charge for the borrower.<sup>7</sup> The more borrowers reduce their debt, the lower their interest payments. Compared to fixed-rate installment loans, revolving credit is more flexible regarding the terms of repayment: each month, debt can be repaid fully or partly; alternatively, in a given month, borrowers can choose to make no repayment at all as there is usually no obligation to make regular repayments. Given the fixed credit limit, repayments increase and payouts reduce the available loan amount. Consumer revolving credit is typically uncollateralized and linked to the borrower's checking account.<sup>8</sup> With respect to legal handling, consumer revolving credit is treated as common installment credit.

While retail installment loans in Germany are usually offered with a fixed interest rate such that the refinancing risk is borne by the lender, the variable nature of the interest rate on revolving credit transfers this risk to borrowers. This risk transfer makes the provision of revolving credit attractive to lenders. At the data providing lender, all borrowers are charged the same interest rate in a given month, independent of their creditworthiness or their average utilization rate. As the interest rate is variable, it is occasionally adjusted by the lender to reflect changes in the reference rate.<sup>9</sup> All borrowers thus experience the same interest rate changes at the same time. Credit limit increases at the cooperating lender are exclusively initiated by borrowers; the lender usually grants limit increases based on a new evaluation of a borrower's creditworthiness. Although this renders limit changes endogenous, our analysis of the MPC is not compromised since we are interested in potential differences between committed and uncommitted borrowers. While we expect stronger reactions to requested limit changes than to automatic limit increases, our focus is on relative differences. In legal terms, a change in the credit limit constitutes a new loan contract which has to be signed by

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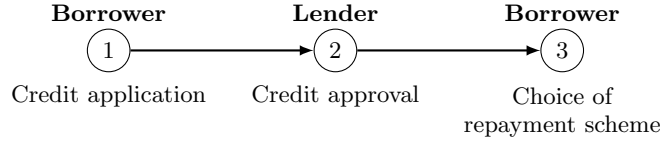
<sup>7</sup>Some providers charge provision fees which are paid on an ongoing basis even when the line of credit is not currently used.

<sup>8</sup>In our dataset, revolving credit constitutes a distinct account. Interest payments are typically made via a borrower's checking account (the reference account), which does not need to be held at the institution with which the loan is taken out. The type of credit considered here thus deviates from Norden and Weber (2010) where an *integrated account structure* is the object of analysis.

<sup>9</sup>The annual interest rate is tied to the key interest rate of the European Central Bank (ECB). If the ECB key interest rate declines, the bank is obliged to reduce the interest rate on its consumer revolving credit. In the case of ECB rate increases, the bank has the opportunity but not the obligation to raise the rate on revolving credit. Borrowers are informed about interest rate changes two weeks before the implementation. Here and in the following, we refer to the effective interest rate which is defined by German legislation and includes fees and debt discounts, if applicable.

**Figure 1: Loan Application and Approval Process**

This figure displays the loan application and approval process. A borrower approaches the lender and applies for a revolving credit account, including the desired credit limit. Based on the application, the lender potentially approves the loan. When the loan is granted, the borrower decides on the repayment scheme.



the borrower.

The above explanations illustrate why the type of revolving credit analyzed in this study shares many common features with US credit cards. Both constitute revolving credit with variable interest rates and discretionary repayments. Both products thus share the relatively high degree of flexibility in terms of usage and repayment in contrast to installment loans.

### 3.2 Committing to Minimum Repayments

At the lender, borrowers in revolving credit can either commit to a monthly minimum repayment or choose full flexibility. The former option makes borrowers repay a monthly minimum amount, for instance, €150, if they currently borrow while still allowing them to add additional repayments in each month at their discretion. In the latter scheme, borrowers do not commit to a minimum repayment and can decide on the amount of their repayments in each month at their discretion; each month, their repayment can range between zero and the full amount of debt outstanding. The lender does not influence the initial decision between the two schemes, which has to be made when the loan is granted; in particular, no rewards (such as a higher credit limit or a lower interest rate) are granted for choosing either option.<sup>10</sup> Figure 1 displays the loan application and approval process. Based on a loan application (including the requested credit limit) and external data from a credit registry, the lender evaluates the applicant's creditworthiness and makes a decision whether to grant a loan or not. If the application is successful, the loan contract terms such as the credit limit and the current interest rate (which is the same for all borrowers) are determined. Subsequently, borrowers choose their mode of repayment. Importantly, this happens *after* the credit approval (and before the loan is paid out), and borrowers are thus free to choose between the two repayment

<sup>10</sup>This can be considered a central design feature and is comparable to the commitment device described in Ashraf et al. (2006). Beshears et al. (2015) show that a compensation for choosing the commitment device can make non-sophisticated impatient and patient individuals choose the device. It is also important that there is no direct price of the commitment device since Laibson (2015) shows that such a price might prevent sophisticated impatient individuals from committing.

options, i.e., they can select themselves into the commitment device or the flexible scheme. When choosing the commitment device, the future monthly minimum repayment amount is determined at the borrower's discretion, i.e., independent of the credit limit or other criteria.

Borrowers who commit to monthly minimum repayments make their monthly debt repayments by direct debit on their reference accounts. A borrower who does not adhere to her minimum repayments in a given month (e.g., by paying less than the individually specified minimum repayment) does not face legal or economic penalties imposed by the lender.<sup>11</sup> Following Bryan et al. (2010), the monthly minimum repayments thus constitute a soft commitment device which primarily causes psychological costs if broken. There is however ample evidence that soft commitment devices are highly effective (such as the successful *Save More Tomorrow* savings plan described in Benartzi and Thaler (2007)). Moreover, since the direct debit agreement would need to be actively terminated by the borrower in order to skip a repayment in a given month, a borrower cannot break the commitment too easily or determine from month to month whether to adhere to it or not. As supporting evidence, we show that committed borrowers repay more than their chosen minimum payments require them to pay on average.

Borrowers have the possibility to terminate the commitment if they are currently committed or to commit at a later point in time if they have not committed themselves initially. As we show below, less than 1.5% of the borrowers contained in our dataset switch from being committed to being uncommitted or decide to commit later on. Thus, the empirical relevance of the switching option is very low. We exclude all switching borrowers from our main analyses and investigate their behavior in a separate analysis.

We distinguish borrowers based on their self-selection into the commitment device offered by the lender. In line with our remarks in Section 2, we should observe that sophisticated impatient borrowers commit to monthly minimum repayments whereas non-sophisticated impatient borrowers and patient borrowers opt for the flexible repayment scheme and refrain from committing. Importantly, while the self-selection of sophisticated impatient borrowers into the commitment device is established in previous theoretical research, we use this well-documented result to empirically distinguish between different types of borrowers and then analyze the debt response of these borrower types. In their natural field experiment, Ashraf et al. (2006) find that impatient (hyperbolic) consumers are in fact more likely to choose a commitment device. This further supports our expectation that the

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<sup>11</sup>As a high creditworthiness is a precondition for obtaining a loan (in particular, permanent employment), only creditworthy borrowers should be contained in the sample. Subprime borrowers are not eligible for this type of credit. By this means, the creditworthiness requirements are at least as high as for common installment loans.

concentration of impatient consumers should be higher in the committed group.<sup>12</sup>

### 3.3 Data Description

Our dataset is provided by one of the 20 largest universal banks in the German market. The sample records all loan accounts opened between January 2008 and December 2012. Each account is traced on a monthly basis until the end of the observation period or until the loan account is closed (if the account is closed before December 2012), which enables us to study loan usage starting with the opening of the loan account for the five subsequent years (or less if the loan has been taken out after January 2008 or the account has been closed before December 2012).<sup>13</sup>

Three kinds of data are recorded for each loan account: First, the loan-specific details recorded during the opening of the loan account such as the credit limit or the start date of the loan contract. Second, the monthly updated loan usage such as the current debt, repayments, or interest payments. Importantly, borrowers' commitment decision is encoded as a dummy variable which is subject to monthly updates. Third, borrower-related data obtained during the loan application process or by external sources such as a borrower's marital status, zip code, occupation, income, or the number of further loans outstanding.

The key characteristics of the sample, expressed at the loan account level, are recorded in Table 2 in which a distinction is drawn between committed and uncommitted borrowers. In the full sample, 76,797 loan accounts are opened during the observation period with credit limits between €2,500 and €25,000. About 40% of borrowers choose the commitment scheme while 60% decide in favor of the flexibility option.<sup>14</sup> The average initial credit limit of the two groups is equal to €10,841 and €12,615, respectively. The average monthly debt, defined as the absolute loan amount outstanding in a given month, amounts to €7,051 and €6,370. While the monthly debt is higher for the committed group, the relation reverses if we condition on debt outstanding since the uncommitted group has more zero-usage periods but higher debt if it borrows (about 1,000 of the committed loan accounts and 4,000 of the uncommitted loan accounts do not take out any debt over the observation period;

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<sup>12</sup>Our analysis is also valid if we relax the assumption that all committed borrowers are sophisticated and impatient and all uncommitted borrowers are either non-sophisticated and impatient or patient and just assume that the share of sophisticated and impatient borrowers is higher in the committed group than in the uncommitted group. This is tantamount to the argument that the probability to choose the commitment device is higher for sophisticated and impatient borrowers than for all other borrowers.

<sup>13</sup>Since our dataset contains all loan accounts opened during the observation period, it should not exhibit a survivorship bias. As an example, such bias would matter if the dataset was restricted to all loan accounts still open in December 2012.

<sup>14</sup>The share of borrowers who choose the commitment device is quite stable over time. 1,026 borrowers do not commit initially but decide to commit later on. These borrowers are excluded from our analyses. We investigate this group of switching borrowers in Section 5.4. The maximum observed number of switches per loan account equals two; such borrowers usually terminate their commitment for a couple of months and then return to being committed.

**Table 2: Summary Statistics of Loan Accounts and Borrowers**

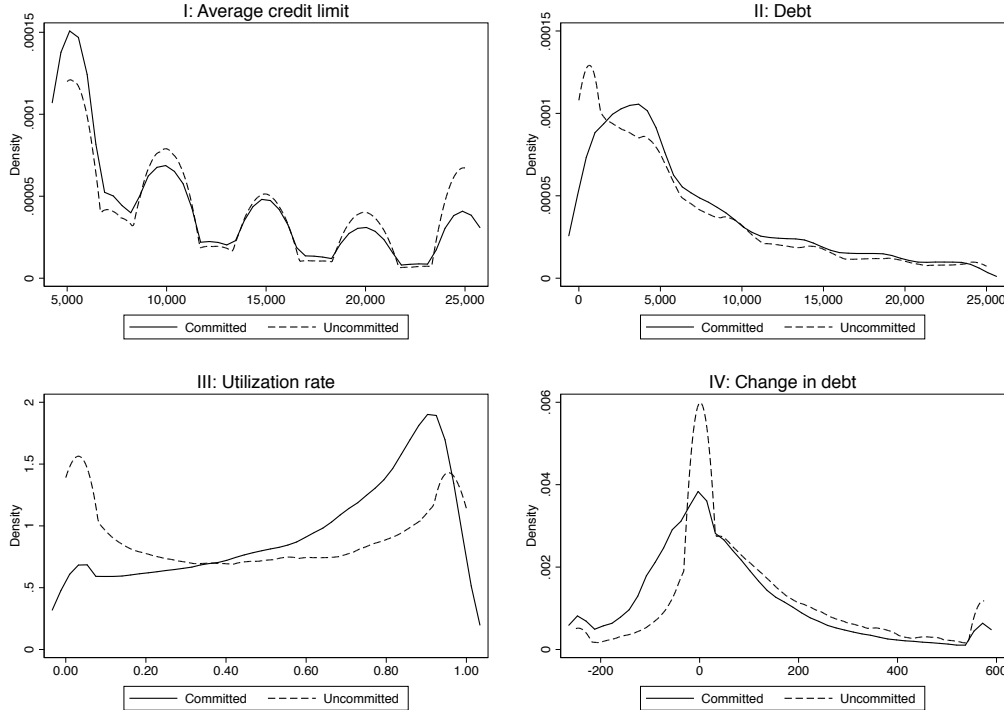
This table displays the summary statistics at the loan account level, grouped by the two repayment schemes available to borrowers. All loan details are based on monthly observations unless indicated otherwise. *Committed* includes all borrowers who are committed to monthly minimum repayments; *Uncommitted* denotes uncommitted borrowers; *Initial credit limit* is the credit limit when the loan is taken out, expressed in €; *Average credit limit* is the average credit limit, including subsequent limit changes, expressed in €; *Debt* is the average monthly debt outstanding, expressed in €; *Utilization rate* is the average monthly debt outstanding, expressed as fraction of the credit limit; *Interest rate p.a.* is the average annual interest rate, expressed in %; *Interest payment* is the average monthly interest payment, expressed in €; *Change in debt* is the monthly change in debt, expressed in €; *Minimum repayments* denotes the planned repayments to which sophisticated borrowers commit themselves, expressed in €; *Actual repayments* denotes the actual repayments, expressed in €; *Age* is a borrower’s age, expressed in years; *Male*, *Female*, *Couple*, and *Academic title* are dummy variables representing a borrower’s gender and education; *Monthly income, net of expenses* is the monthly income after the deduction of monthly expenses, expressed in €; *Length of customer relationship* expresses the duration of the bank-customer relationship when the loan is taken out, denoted in months; *Accounts* represents the number of accounts included in the sample; *Interest rate decreases* refers to the magnitude of decreases in the effective interest rate, denoted in percentage points; *Credit limit increases* represents the magnitude of credit limit increases, denoted in €.

	Committed		Uncommitted		Full sample	
	Mean	Median	Mean	Median	Mean	Median
<b>Account details</b>						
Initial credit limit	10,841	9,500	12,615	10,000	11,901	10,000
Average credit limit	11,618	10,000	13,115	10,000	12,512	10,000
Debt	7,051	4,866	6,370	4,357	6,644	4,599
Debt   debt > 0	8,030	5,814	8,488	6,200	8,283	6,000
Utilization rate	0.59	0.66	0.50	0.50	0.54	0.58
Utilization rate   utilization rate > 0	0.70	0.75	0.68	0.73	0.69	0.74
Interest rate p.a.	7.03	6.97	7.01	6.95	7.02	6.95
Interest payment	39	27	35	23	36	25
Interest payment   interest payment > 0	43	31	43	31	43	31
Change in debt	48	14	105	53	82	37
Minimum repayments	144	100			144	100
Actual repayments	237	147	253	61	246	107
<b>Borrower details</b>						
Age	44	44	43	43	44	43
Male	0.32	0.00	0.36	0.00	0.35	0.00
Female	0.24	0.00	0.19	0.00	0.21	0.00
Couple	0.44	0.00	0.45	0.00	0.45	0.00
Academic title	0.01	0.00	0.01	0.00	0.01	0.00
Monthly income, net of expenses	1,013	844	1,190	979	1,119	924
Length of customer relationship	44	33	45	34	45	33
Accounts	30,927		45,870		76,797	
Interest rate decreases	-0.40	-0.27	-0.40	-0.27	-0.40	-0.27
Account-month observations	31,905		38,450		70,355	
Credit limit increases	5,972	5,000	6,771	5,000	6,355	5,000
Account-month observations	6,307		5,825		12,132	

we address this observation in our analyses). In each month, the committed group increases debt less strongly than the uncommitted group (€ 48 versus € 105). The average monthly utilization rate, defined as monthly debt divided by the credit limit, is 59% and 50%, respectively. As a preliminary result, we note that committed borrowers borrow more than uncommitted borrowers on average, both in absolute and in relative terms. All group differences shown in Table 2 are statistically significant.

**Figure 2: Distributions of Credit Usage Variables**

Kernel density plots of variables related to credit usage on the loan account level. *Committed* refers to borrowers who commit to monthly minimum repayments; *Uncommitted* denotes borrowers choosing full flexibility. *Average credit limit* is the average credit limit, including subsequent limit changes, expressed in €; *Debt* is the average monthly debt outstanding, expressed in €; *Utilization rate* is the average monthly debt, expressed as fraction of the credit limit; *Change in debt* is the monthly change in debt, expressed in €.



In line with our remarks in Section 2, this is a first indication that borrowers in the committed group might in fact be more impatient on average. We interpret these observations as supporting evidence for the validity of our way to distinguish borrowers according to their sophistication and impatience.

Borrowers commit to monthly repayments of €144 on average if they commit (median: €100). The actual repayments of committed borrowers (€237) are substantially higher than the required minimum repayments, which indicates that borrowers more than just adhere to their repayment commitment. This observation underlines that the self-selection into minimum repayments represents borrowers' actual commitment which they try to fulfill. The repayments of uncommitted borrowers (€253) exceed the repayments of committed borrowers in the cross-section; the difference is significant at the 1% level.<sup>15</sup> This difference could be interpreted as further support of the higher average degree of impatience of the committed group.

<sup>15</sup>The relatively low median of the repayments of uncommitted borrowers can be explained by the relatively less frequent but higher repayments of that group.

Figure 2 plots the distribution of several variables related to the credit usage of committed and uncommitted borrowers: Panel I shows peaks at specific credit limits such as €5,000, €10,000, €15,000, or €20,000 for both groups. Panel II confirms that the uncommitted group includes relatively more account-month observations with no debt. Regarding utilization rates, committed borrowers are relatively more present in values close to full utilization than uncommitted borrowers (Panel III). Panel IV stresses uncommitted borrowers' comparatively higher relative frequency of months without a change in debt.

The average annual interest rate, valid for both new and existing loans, equals 7.02%. The annual interest rate is increased by 27bp in September 2008 and decreased by 55bp, 53bp, and 27bp in January 2009, April 2009, and July 2010, respectively. Since the interest rate increase occurs very early in our observation period and hence only affects few accounts such that we cannot draw reliable inferences, we exclude it from further investigation and include it as a control variable in our estimations. In sum, over all 76,797 loan accounts, 70,355 interest rate decreases and 12,132 credit limit increases are observed. The latter are as high as €6,355 on average. The limit increases of uncommitted borrowers are about €800 higher than the limit increases of committed borrowers on average.

The average borrower is 44 years old and has been a client at the bank for 45 months when taking out the loan. 35% of borrowers are male. The average monthly disposable income, net of expenses, is €1,119. The monthly income of uncommitted borrowers is slightly higher than the income of committed borrowers.<sup>16</sup>

## 4 Empirical Specification

The specification of our multivariate estimations is based on Gross and Souleles (2002). To analyze the impact of interest rate decreases and credit limit increases on debt, we estimate a finite distributed lags model, assuming that the effects of both changes in credit supply on credit demand spread over a finite number of subsequent periods. We conduct a longitudinal, cross-sectional analysis based on account-month observations, which is represented in Equations (2) and (3), where the former represents the elasticity of debt to interest rate changes and the latter yields the MPC.

$$\Delta D_{i,t} = \alpha_i + \beta_{r,0}\Delta r_{i,t} + \beta_{r,1}\Delta r_{i,t-1} + \beta_{r,2}\Delta r_{i,t-2} + \dots + \gamma'X_{i,t} + \epsilon_{i,t} \quad (2)$$

---

<sup>16</sup>An analysis of borrowers' zip codes reveals that the borrowers contained in the dataset are spread quite evenly over the whole country. Further descriptive statistics are provided in the appendix. Ashraf et al. (2006) show that both the degree of impatience and the demand for a commitment device are not driven by demographic aspects. Slight differences between the two borrower groups should thus not influence the commitment decision.

$$\Delta D_{i,t} = \alpha_i + \beta_{L,0}\Delta L_{i,t} + \beta_{L,1}\Delta L_{i,t-1} + \beta_{L,2}\Delta L_{i,t-2} + \dots + \gamma'X_{i,t} + \epsilon_{i,t} \quad (3)$$

The dependent variable  $\Delta D_{i,t} = D_{i,t} - D_{i,t-1}$  denotes the change of debt outstanding of Borrower  $i$  from Month  $t - 1$  to Month  $t$ ,  $\Delta r_{i,t} = r_{i,t} - r_{i,t-1}$  represents the change of the annual interest rate between Month  $t - 1$  and Month  $t$ , and  $\Delta L_{i,t} = L_{i,t} - L_{i,t-1}$  reflects the change of the credit limit between the same months.  $\Delta D_{i,t}$  is influenced by the amount of new debt requested by a borrower in a given month and by the repayment of debt in the same month; it can be considered a result of the interplay of regular repayments of committed borrowers, unscheduled repayments, and new debt. A positive value of  $\Delta D_{i,t}$  implies that borrowers increase their monthly demand for credit compared to the previous month by taking on new debt; a negative value represents a decline in monthly loan demand. While  $\beta_{r,0}$  and  $\beta_{L,0}$  capture the immediate effect of a change in the interest rate or the credit limit on the current month's change in debt,  $\beta_{r,3}$  and  $\beta_{L,3}$  for instance capture the effect of a change in the interest rate or the credit limit which occurred three months ago on the change in debt in the current month. Adding up the lagged coefficients of the independent variables  $\Delta r_{i,t}$  and  $\Delta L_{i,t}$  yields the long-run multipliers of interest rate and credit limit changes. The aggregate effect of interest rate changes over a horizon of  $T$  months equals  $\sum_{k=0}^T \beta_{r,k}$ ; for credit limit changes, the long-run effect is equal to  $\sum_{k=0}^T \beta_{L,k}$ .

$X_{i,t}$  denotes a vector of control variables including the number of months passed since the opening of the loan account, month dummies and year dummies as well as the cumulative number of interest rate changes and credit limit increases experienced by each borrower in a given month. We also control for the average interest rate on overdraft facilities in the German market in each month since these might constitute an alternative source of liquidity for borrowers. To control for unobserved heterogeneity across borrowers, all regressions include loan account fixed effects. Regarding the choice of the lag length, we start with an initial lag length of twelve months and eliminate insignificant lags as long as the  $R^2$  does not decrease. Both for interest rate decreases and credit limit increases, conversion is achieved after six lags. We run separate regressions for committed and uncommitted borrowers.<sup>17</sup> The estimations are specified as OLS.

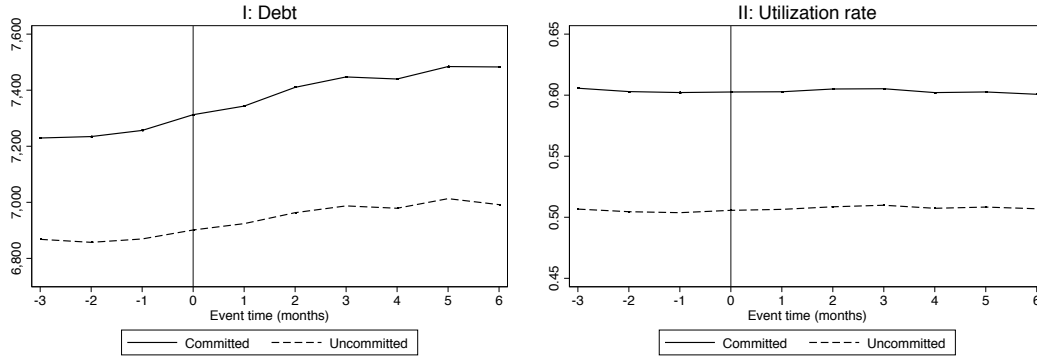
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<sup>17</sup>Our results are virtually unchanged if the estimations for committed and uncommitted borrowers are computed in one regression, using interaction terms. We estimate the influence of interest rate and credit limit changes on changes in debt in separate regressions; the inclusion of both influences in the same regression does not alter the results. As both, interest rate decreases and increases of the credit limit, might simultaneously influence the change in debt, we control for the respective other effect in our regressions.



**Figure 3: Interest Rate Decreases and Debt**

Debt (*Panel I*, expressed in €) and utilization rate (*Panel II*, expressed as fraction of the credit limit) in the three months preceding and the six months following an interest rate decrease. *Event time* ( $t$ ) denotes the time before ( $t < 0$ ), at ( $t = 0$ ), and after ( $t > 0$ ) an interest rate decrease, expressed in months; *Committed* refers to borrowers who commit to monthly minimum repayments; *Uncommitted* denotes borrowers choosing full flexibility for repayment. The figures include 70,355 interest rate decreases over the observation period 2008–2012.



## 5 Results

Both for interest rate decreases and credit limit increases, we first present a univariate analysis similar to an event study, followed by the multivariate estimation results.

### 5.1 Interest Rate Decreases and Debt

To start with a univariate description of the effect of interest rate decreases on borrowers' demand for debt, we interpret all interest rate decreases in our sample as events. The event time before and after interest rate reductions is defined on a monthly basis, with an observation period ranging from  $-3$  to  $+6$  months. All three interest rate decreases (70,355 observations) observed during the sample period obtain an event time of zero. Panel I of Figure 3 reveals that the committed group starts at higher levels of debt outstanding at event time  $-3$  than the uncommitted group on average. Up to event time zero, both lines exhibit parallel trends, i.e., the growth rates of debt are not significantly different between the two groups prior to an interest rate decrease on average. However, the growth rates start to fall apart after the interest rate decrease as the difference in debt between the two groups increases up to event time  $+6$ . This implies that committed borrowers increase debt more strongly than uncommitted borrowers over the six months subsequent to an interest rate reduction. Even though the impact on utilization rates seems moderate (as plotted in Panel II of Figure 3) and we cannot identify the same differences as with absolute debt levels, it should be noted that the univariate setting does not control for potential simultaneous credit limit increases which could

**Table 3: Long-Run Effects of Interest Rate Decreases on Changes in Debt Demand**

This table shows the long-run multipliers of the finite distributed lags model for interest rate decreases with  $n = 6$  lags. The dependent variable is the cumulative change in monthly debt, denoted in €.  $\sum \beta_{r,c}$  is the committed group's long-run multiplier of interest rate decreases over 6 months;  $\sum \beta_{r,u}$  is the uncommitted group's long-run multiplier of interest rate decreases over 6 months; *Low* denotes borrowers with a utilization rate of under 50% in month  $t - 7$ ; *Medium* includes borrowers with utilization rates between 50% and 90%; *High* represents borrowers with utilization rates above 90%. The cumulative number of interest rate changes and of credit limit increases, month and year dummies, the average interest rate on overdraft facilities in the German market, and the number of months passed since the loan account opening are included as control variables. All regressions include loan account fixed effects. Standard errors are clustered at the loan account level. \*, \*\*, and \*\*\* denote significance at the 10%, the 5%, and the 1% level, respectively.

$D/L_{init}$	$\Sigma \beta_{r,c}$	$\Sigma \beta_{r,u}$	$\Sigma \beta_{r,c} - \Sigma \beta_{r,u}$
High	-597***	-271***	-326***
Medium	-496***	-261***	-236***
Low	-230***	50	-280***
Total	-442***	-121***	-322***
Account-month obs.	731, 537	905, 817	1, 637, 354

bring down utilization rates.

The cumulative long-run effects of decreases in the monthly interest rate as specified in Equation (2),  $\sum_{k=0}^6 \beta_{r,k}$ , are recorded in Table 3 in which we draw the same triple split regarding borrowers' utilization rates in the very month preceding the farthest lag (since conversion is achieved after six lags, the farthest lag is Month  $t - 7$ ) as in Gross and Souleles (2002): the low utilization group contains all borrowers with a utilization rate of less than 50% in the month before the interest rate cut, the high utilization group includes all borrowers whose utilization rate exceeds 90%, and the remaining borrowers constitute the medium utilization group.<sup>18</sup> Whereas borrowers with high and medium utilization rates represent about 29% and 28% of the observations, respectively, borrowers with low utilization rates account for about 43% of the observations.

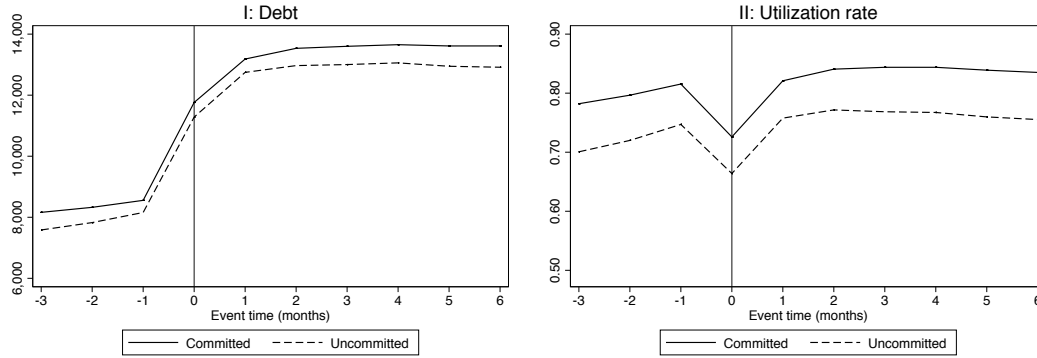
As displayed in Table 3, committed borrowers increase debt by €442 in response to an interest rate cut by 100bp compared to periods without interest rate reductions. In conjunction with Table 2, these findings imply that the committed group increases debt by about 6% after a 100bp decrease in the annual interest rate. Regarding the triple split by initial utilization rates, high utilization borrowers exhibit the strongest response to interest rate cuts on average (€597) while medium and low utilization borrowers increase debt by €496 and €230, respectively.<sup>19</sup> In the cross-section,

<sup>18</sup>For the individual, non-cumulative monthly lags, refer to the appendix.

<sup>19</sup>The fact that borrowers with high utilization rates before the intervention are able to substantially increase debt after interest rate decreases can be explained by 1) the average utilization rate of this group being below 100% and the average interest rate cut being equal to 40bp instead of 100bp and 2) credit limit increases granted to this group subsequent to interest rate decreases.

**Figure 4: Credit Limit Increases and Debt**

Debt (*Panel I*, expressed in €) and utilization rate (*Panel II*, expressed as fraction of the credit limit) in the three months preceding and the six months following an increase of the credit limit. *Event time* ( $t$ ) denotes the time before ( $t < 0$ ), at ( $t = 0$ ), and after ( $t > 0$ ) a credit limit increase, expressed in months; *Committed* refers to borrowers who commit to monthly minimum repayments; *Uncommitted* denotes borrowers choosing full flexibility for repayment. The figures include 12,132 credit limit increases over the observation period 2008–2012.



uncommitted borrowers increase debt by €121 or 2%; for all three utilization subgroups, the long-run multiplier of interest rate cuts is significantly lower than the multiplier of the committed group. While the high utilization group increases debt by €271, the medium utilization group's response is equal to €261, and the reaction of low utilization borrowers is insignificant. In total, the debt response of the committed group is almost four times as large as the reaction of the uncommitted group.

As an alternative frame of borrowers' debt response to interest rate changes, we compute the interest rate elasticity of debt. In combination with Table 2, the interest elasticities of the committed and the uncommitted group are equal to  $-1.1$  and  $-0.3$ , respectively. The substantial difference between the elasticities underlines that our results are not driven by group differences in debt outstanding, which could distort the results in absolute terms. Put differently, the stronger debt response of committed borrowers is not caused by the higher average debt level of this group of borrowers compared to the group of uncommitted borrowers.<sup>20</sup>

## 5.2 Credit Limit Increases and Debt

As with interest rate decreases, we begin with a univariate analysis and define credit limit increases as events, using the same event time windows as above. All 12,132 credit limit increases observed in the sample period are assigned an event time of zero. Figure 4 plots borrowers' debt and utilization

<sup>20</sup>The interest rate elasticity estimated in Gross and Souleles (2002) equals  $-1.3$ .

**Table 4: Long-Run Effects of Credit Limit Increases on Changes in Debt Demand**

This table displays the long-run multipliers of the finite distributed lags model for credit limit increases with  $n = 6$  lags. The dependent variable is the cumulative change in monthly debt, denoted in €.  $\sum \beta_{L,c}$  is the committed group's long-run multiplier of credit limit increases over 6 months;  $\sum \beta_{L,u}$  is the uncommitted group's long-run multiplier of credit limit increases over 6 months; *Low* denotes borrowers with a utilization rate of under 50% in month  $t-7$ ; *Medium* includes borrowers with utilization rates between 50% and 90%; *High* represents borrowers with utilization rates above 90%. The cumulative number of interest rate changes and of credit limit increases, month and year dummies, the average interest rate on overdraft facilities in the German market, and the number of months passed since the loan account opening are included as control variables. All regressions include loan account fixed effects. Standard errors are clustered at the loan account level. \*, \*\*, and \*\*\* denote significance at the 10%, the 5%, and the 1% level, respectively.

$D/L_{init}$	$\Sigma \beta_{L,c}$	$\Sigma \beta_{L,u}$	$\Sigma \beta_{L,c} - \Sigma \beta_{L,u}$
High	0.27***	0.23***	0.04***
Medium	0.22***	0.19***	0.04***
Low	0.12***	0.10***	0.02
Total	0.23***	0.18***	0.05***
Account-month obs.	731,537	905,817	1,637,354

rates around a credit limit increase for committed and uncommitted borrowers in the univariate setting. Panel I shows that debt rises for both borrower groups subsequent to credit limit increases. Up to event time zero, both lines exhibit parallel trends; the growth rates of debt are not significantly different between the two groups prior to a credit limit increase on average. Panel II demonstrates that in the very month of the limit increase, the utilization rate falls for both groups; in the subsequent periods however, borrowers ramp up debt, thereby bringing utilization rates back to the pre-increase levels.<sup>21</sup> Consistent with Table 2, the absolute level of debt outstanding and the utilization rate are higher for committed borrowers than for uncommitted borrowers on average. For both groups, the non-declining utilization rates subsequent to credit limit increases suggest that borrowers employ constant target utilization rates, which, according to Gross and Souleles (2002), are consistent with the use of debt buffers and the relevance of precautionary motives. As discussed in Section 3.3, the average credit limit increase of uncommitted borrowers exceeds the committed group's average increase by about €800; although the curves plotted in Figure 4 seem to run in parallel, the debt response to credit limit changes can be different for both groups since the underlying credit limit increases differ in size and the committed group might use the relatively lower limit increases to a greater extent.<sup>22</sup>

Table 4 contains the multivariate estimates of the cumulative long-run multipliers of credit limit

<sup>21</sup>Since we measure time in discrete steps, the decrease in the utilization rate at event time zero seems to start right after event time  $-1$  although it only occurs at event time zero.

<sup>22</sup>Note the higher debt levels and utilization rates in comparison to Figure 3 as borrowers whose utilization rate is close to 100% are more likely to request credit limit increases while interest rate decreases affect all borrowers alike.

changes from Equation (3),  $\sum_{k=0}^6 \beta_{L,k}$ . As previously described, we classify all borrowers into three groups based on their utilization rates in the month preceding the limit increase. Since all limit increases in our dataset are requested by borrowers, it is intuitive that only about 15% of all limit increases are requested by the low utilization group, about 28% by the medium group, and the largest fraction (57%) by the high utilization group. As the low and medium utilization borrowers are currently not credit constrained, these requests are presumably made for precautionary reasons.<sup>23</sup>

In the aggregate, the MPC out of credit limit increases is significantly different from zero. It equals 0.23 for committed and 0.18 for uncommitted borrowers. On average, the MPC increases monotonically with the initial utilization rate before the limit increase and is as high as 0.27 and 0.23 for the high utilization borrowers. This monotonic pattern of the MPC stresses the importance of borrowers' liquidity constraints. Intuitively, high utilization borrowers have the most binding liquidity constraints and would take out additional debt if their credit limits were higher. Since the low and the medium utilization groups also exhibit significantly positive MPC, precautionary motives are likely to be prevalent in these groups; these borrowers might not fully use their credit limits in order to have credit available as a buffer against future liquidity constraints.

Similar to interest rate changes, the findings differ between the committed and the uncommitted group. For high and medium initial utilization rates, the MPC is significantly higher for committed borrowers. Besides being statistically significant, these insights are economically important. As shown in Table 2, the median limit increase in our sample is as high as €5,000. In total, the committed group increases debt by €1,150 per €5,000 limit increase while the uncommitted group takes out €900 of additional debt only.<sup>24</sup> Put differently, the committed group exhibits a debt response to credit limit increases which is almost 30% larger on average. As before, these findings cannot be explained by differences in the debt levels of the two groups since the average difference between the debt balances is substantially smaller than 30%.

The fact that our estimates of the MPC are slightly higher than in Gross and Souleles (2002) can be attributed to the way in which limit increases are triggered. While 90% of the limit increases in their study are initiated by the lender and the MPC is significantly higher for the 10% of limit increases requested by borrowers, all credit limit increases in our dataset are initiated by borrowers. We are however interested in the comparison of the debt response of committed and uncommitted borrowers; although the MPC is higher on average than with automatic limit increases, we focus on the relative differences which should be independent of absolute levels. In addition, our results

<sup>23</sup>For the individual, non-cumulative monthly lags, refer to the appendix.

<sup>24</sup>These numbers are obtained by multiplying the MPC with the amount of the limit increase:  $0.23 \cdot 5,000 = 1,150$ ;  $0.18 \cdot 5,000 = 900$ .

**Table 5: Matched Loans**

This table displays the long-run multipliers of the finite distributed lags model for credit limit increases with  $n = 6$  lags. The dependent variable is the cumulative change in monthly debt, denoted in €. Each loan account of a committed borrower is matched with the most similar loan account of an uncommitted borrower (without replacement) based on the initial credit limit, income, age, gender, and duration of the client relationship.  $\sum \beta_{r/L,c}$  is the committed group's long-run multiplier of interest rate decreases or credit limit increases over 6 months;  $\sum \beta_{r/L,u}$  is the uncommitted group's long-run multiplier of interest rate decreases or credit limit increases over 6 months; *Low* denotes borrowers with a utilization rate of under 50% in month  $t - 7$ ; *Medium* includes borrowers with utilization rates between 50% and 90%; *High* represents borrowers with utilization rates above 90%. The cumulative number of interest rate changes and of credit limit increases, month and year dummies, the average interest rate on overdraft facilities in the German market, and the number of months passed since the loan account opening are included as control variables. All regressions include loan account fixed effects. Standard errors are clustered at the loan account level. \*, \*\*, and \*\*\* denote significance at the 10%, the 5%, and the 1% level, respectively.

$D/L_{init}$	$\Sigma \beta_{r,c}$	$\Sigma \beta_{r,u}$	$\Sigma \beta_{r,c} - \Sigma \beta_{r,u}$
High	-597***	-250***	-347***
Medium	-496***	-243***	-253***
Low	-230***	66	-296***
Total	-442***	-107***	-336***
Account-month obs.	731,537	602,159	1,333,696
$D/L_{init}$	$\Sigma \beta_{L,c}$	$\Sigma \beta_{L,u}$	$\Sigma \beta_{L,c} - \Sigma \beta_{L,u}$
High	0.27***	0.25***	0.03**
Medium	0.22***	0.21***	0.02
Low	0.12***	0.11***	0.01
Total	0.23***	0.19***	0.04***
Account-month obs.	731,537	602,159	1,333,696

regarding the debt response to exogenous interest rate decreases indicate that borrowers' reactions are comparable to the findings of previous studies and help us calibrate our analyses. Since we observe group differences with exogenous interest rate changes, group differences in the MPC seem plausible as well.

### 5.3 Alternative Explanations

To strengthen the assertion that borrower impatience and sophistication drive the debt response to interest rate and credit limit changes, we address potential alternative explanations for the observed differences between the two borrower groups and discuss whether these approaches are capable of explaining our results.

**Group Differences Unrelated to Impatience and Sophistication** A potential objection to our results is that committed borrowers might differ from uncommitted borrowers in aspects which are not necessarily related to borrower impatience and sophistication. For instance, as shown

in Table 2, committed borrowers have lower initial credit limits and lower monthly income than uncommitted borrowers on average. As argued by Agarwal and Qian (2014), such factors could indicate a larger extent of current credit constraints. To rule out that such differences drive our results, we conduct a propensity score matching (Rosenbaum and Rubin; 1983) and match each committed borrower with an uncommitted borrower who is considered most similar, based on a propensity score. This procedure enables us to exclude about 15,000 uncommitted borrower accounts which are less comparable in this regard.<sup>25</sup> Our probit model matches borrowers based on the initial credit limit, income, age, gender, academic title, and length of the client relationship.<sup>26</sup> Importantly, after matching, committed and uncommitted borrowers do not significantly differ in terms of their credit limits and monthly income, two main drivers of financial constraints. Rerunning our main regressions for committed borrowers and their matched uncommitted counterparts, we find that the basic results for the full sample are quantitatively and qualitatively unchanged (Table 5). Although the MPC of committed and uncommitted borrowers with a medium and low utilization rate before the intervention is no longer significantly different, the group differences remain stable in the cross-section.

**Not Sticking to Minimum Repayments** A further concern is related to the soft nature of the commitment device (see Section 3.2). Since committed borrowers who do not meet their minimum repayments in a given month do not face legal or economic consequences, the soft commitment might be broken by some borrowers, thereby reducing the actual repayments of committed borrowers. To the extent that borrowers who break their commitment are more similar to uncommitted borrowers than to committed borrowers, this aspect could distort our evaluation of the role of impatience and sophistication. As demonstrated in Table 2, the actual repayments of committed borrowers (about €237) are substantially higher than the required minimum repayments (€144) on average. The numbers suggest that committed borrowers not only repay the minimum repayment but more than an additional 60% of the minimum repayment in each month on average. These observations lead us to conclude that committed borrowers adhere to their commitments in the cross-section. Consequently, breaking the soft commitment does not bias the results.

**Zero-Usage Accounts** Due to the possibility to use revolving credit as a liquidity reserve (see Section 3.1), loan accounts might be opened but never used (i.e., debt is never taken out after a

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<sup>25</sup>Further details are provided in the appendix. We run analyses with several alternative specifications of maximum tolerance levels and with alternative replacement specifications. The results are virtually unchanged.

<sup>26</sup>To ensure consistency with our empirical model, we do not match on outcome variables such as monthly debt or utilization rates.

**Table 6: Exclusion of Loan Accounts Never Used**

This table displays the long-run multipliers of the finite distributed lags model for credit limit increases with  $n = 6$  lags. Compared to our main analyses, 4,843 borrowers who never take out debt over the observation period are excluded. The dependent variable is the cumulative change in monthly debt, denoted in €.  $\sum \beta_{r/L,c}$  is the committed group's long-run multiplier of interest rate decreases or credit limit increases over 6 months;  $\sum \beta_{r/L,u}$  is the uncommitted group's long-run multiplier of interest rate decreases or credit limit increases over 6 months; *Low* denotes borrowers with a utilization rate of under 50% in month  $t - 7$ ; *Medium* includes borrowers with utilization rates between 50% and 90%; *High* represents borrowers with utilization rates above 90%;  $\sum \beta_{r,k}$  is the long-run multiplier of credit limit increases over 6 months. The cumulative number of interest rate changes and of credit limit increases, month and year dummies, the average interest rate on overdraft facilities in the German market, and the number of months passed since the loan account opening are included as control variables. All regressions include loan account fixed effects. Standard errors are clustered at the loan account level. \*, \*\*, and \*\*\* denote significance at the 10%, the 5%, and the 1% level, respectively.

$D/L_{init}$	$\Sigma \beta_{r,c}$	$\Sigma \beta_{r,u}$	$\Sigma \beta_{r,c} - \Sigma \beta_{r,u}$
High	-598***	-266***	-331***
Medium	-497***	-255***	-242***
Low	-238***	47	-285***
Total	-448***	-126***	-323***
Account-month obs.	719,929	862,663	1,582,592
$D/L_{init}$	$\Sigma \beta_{L,c}$	$\Sigma \beta_{L,u}$	$\Sigma \beta_{L,c} - \Sigma \beta_{L,u}$
High	0.27***	0.23***	0.04***
Medium	0.22***	0.19***	0.04***
Low	0.12***	0.10***	0.02
Total	0.23***	0.18***	0.05***
Account-month obs.	719,929	862,663	1,582,592

loan account has been opened). This is the case for almost 5,000 loan accounts in our dataset; such borrowers, according to Ausubel (1991), are likely to be fully unresponsive to interest rates. These borrowers might have correctly anticipated that they will not borrow and thus have chosen not to commit. About 1,000 of these accounts belong to the committed group, and almost 4,000 uncommitted accounts are never used. To ensure that these borrowers' unresponsiveness to interest rate and credit limit changes does not bias our results, we repeat our analysis when these borrowers are excluded. Table 6 shows that our main results are not substantially altered: uncommitted borrowers remain less responsive to interest rate changes, and their MPC is significantly lower than the MPC of committed borrowers. Consequently, our main results are not driven by zero-usage borrowers.<sup>27</sup>

<sup>27</sup>We perform two additional robustness tests and provide the detailed results in the appendix. First, about 430 out of 45,870 uncommitted borrowers use a regular money transfer order with constant amounts in order to repay their debt, thereby constructing their own commitment device. We recalculate the impact of interest rate and credit limit changes when these borrowers are excluded from the uncommitted group. Second, we use a minimum observation period of 24 months and exclude all loan accounts observed for less than 24 months from our main analyses. In both cases, we find that our results are virtually unchanged.



## 5.4 What Causes the Differences in Observed Behavior?

In this section, we briefly and indicatively address the question of causality. Our results from the previous sections suggest that borrower impatience and sophistication constitute distinct characteristics which steer borrowers' behavior independent of the effects of the commitment scheme on actual repayments. An alternative view is that the disciplining effect of the monthly minimum repayments causes the observed group differences in debt demand once borrowers have chosen to commit.

Our approach loosely follows Barzuza and Smith (2014). Excluded from the above analyses are 1,026 borrowers who choose no commitment when opening the loan account but commit later on. As discussed above, such decisions are not triggered or incentivized by the lender but independently made by borrowers. A potential reason for this decision is that borrowers do not use their credit account in the initial months but start to take out debt later on; the need to commit thus first arises several months after the opening of the account. If borrower impatience and sophistication drive the results, uncommitted borrowers who choose the commitment device at a later stage should show a behavior similar to committed borrowers even without being committed. If the commitment device drives the behavior, we should expect the behavior of this group of borrowers without commitment to resemble the behavior of uncommitted borrowers and to be more similar to committed borrowers as soon as they commit. Table 7 displays the variables related to borrowers' debt usage for the 1,026 borrowers who switch from being uncommitted to being committed *prior to switching* and for the 45,870 uncommitted borrowers who never switch. While the average credit limit of switchers prior to switching is lower than the limit of non-switchers, their debt and utilization rates are higher. In conjunction with Table 2, this indicates that prior to switching, uncommitted borrowers much more resemble the committed group that has lower average credit limits as well as higher debt and utilization rates than the uncommitted group.<sup>28</sup> In sum, this evidence is more consistent with the influence of borrower impatience and sophistication as basic characteristics rather than with a central role of the commitment scheme. These results suggest that lenders might identify sophisticated impatient borrowers by self-selection into alternative commitment devices other than minimum repayments.

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<sup>28</sup>Table 12 in the appendix displays the results of a probit regression among all 46,896 initially uncommitted borrowers in which the dependent variable is equal to 1 if an uncommitted borrower chooses to commit later on. The regression results confirm our findings from Table 7.

**Table 7: Debt Usage of Uncommitted Switchers and Non-Switchers**

This table displays the summary statistics at the loan account level, grouped by switchers and non-switchers. All loan details are based on monthly observations. *Switchers* include all borrowers who are not committed to monthly minimum repayments initially but decide to commit themselves at a later point in time (their monthly observations are only included for the months prior to switching); *Non-switchers* are uncommitted borrowers who remain uncommitted throughout the observation period; *Average credit limit* is the average credit limit, including subsequent limit changes, expressed in €; *Debt* is the average monthly debt outstanding, expressed in €; *Utilization rate* is the average monthly debt outstanding, expressed in % of the credit limit; *Accounts* represents the number of accounts included in the sample. For switchers, the numbers include months prior to committing only.

	Switchers		Non-switchers	
	Mean	Median	Mean	Median
Average credit limit	12,197	10,000	13,115	10,000
Debt	7,664	5,934	6,370	4,357
Utilization rate	0.63	0.77	0.50	0.50
Accounts	1,026		45,870	

## 6 Lender Interventions Using Borrowers' Commitment Decisions

To illustrate how lenders can benefit from the conclusions drawn in the previous sections, we discuss two examples of targeted lender interventions.<sup>29</sup> In order to realize the interventions described below, the distinction between sophisticated impatient borrowers on the one hand and non-sophisticated impatient and patient borrowers on the other hand is essential. As a precondition, a lender must develop a mechanism to identify both borrower groups. One such example is the self-selection of borrowers into commitment devices as implemented by the data providing lender.

**Borrower-Specific Interest Rate Discounts** Decreasing interest rates can result in additional interest income if borrowers take out additional debt in response to the lower cost of credit. Borrowers showing a weak or no response to interest rate decreases however reduce interest income as they pay relatively less interest on their debt outstanding than before the intervention. Lenders can thus optimize their interest income if interest rate changes are targeted towards borrowers who are most likely to significantly increase debt in the wake of interest rate reductions. This could be implemented via borrower-specific interest rates and temporary interest rate discounts to some borrower groups.

Written in a more formal way, the net effect of an interest rate decrease on a lender's interest income generated with Borrower  $i$  in a given Month  $t$  can be expressed as

$$\Delta D_{i,t} \cdot r_t + D_{i,t-1} \cdot (r_t - r_{t-1}) \quad (4)$$

<sup>29</sup>Using estimates of the MPC, Jappelli and Pistaferri (2014) demonstrate the benefits of targeted actions in the context of fiscal policy.

where  $\Delta D_{i,t}$ ,  $D_{i,t-1}$ ,  $r_t$ , and  $r_{t-1}$  denote additional debt taken out by Borrower  $i$  in response to the interest rate decrease, Borrower  $i$ 's amount of debt before the interest rate decrease, the interest rate after the decrease, and the interest rate before the decrease, respectively. In order for a lender to increase interest income, the net effect should be positive. Rearranging this equation yields the condition required for interest rate decreases to increase the interest income generated with Borrower  $i$ :

$$\frac{\Delta D_{i,t}}{D_{i,t-1}} > \frac{r_{t-1} - r_t}{r_t} \quad (5)$$

Regarding the three interest rate decreases observed in our data, the right-hand term of Equation (5) is equal to 0.07 for the first two of them and equal to 0.04 for the third. I.e., the new debt taken out by a borrower must exceed 7% or 4% of the debt outstanding before the intervention. In conjunction with Table 3, it is obvious that due to the relatively lower responsiveness of uncommitted borrowers, interest rate decreases will be more successful in fostering debt demand with committed borrowers. Since committed borrowers' debt response to interest rate decreases even in the group with the second largest response (borrowers with medium utilization rates before the decrease) is higher than the strongest reaction among uncommitted borrowers (borrowers with a high utilization rate), distinguishing borrowers based on sophistication and impatience in addition to their utilization rate adds value when implementing targeted interest rate decreases. By this means, lenders might implement interest rate decreases without having to give up interest income when there are some borrowers who exhibit a low or no responsiveness to such measures.<sup>30</sup>

**Targeted Credit Limit Increases** Depending on the specific contractual details, providing revolving credit could require lenders to hold regulatory capital in proportion to the credit limits granted. The mere provision of revolving credit is thus costly to a lender, and no provision fees are usually charged to borrowers to compensate the lender for these costs. Consequently, it is in the lender's interest to provide revolving credit to those borrowers who are most likely to make use of the additional liquidity and generate additional interest income as long as the probability of default does not increase. Following this reasoning, credit limit increases should be offered and granted to those borrowers who are most responsive, i.e., most likely to use the additional liquidity extensively, in

<sup>30</sup>A potential challenge to such interventions is the possibility that interest rate discounts reduce the effectiveness of the commitment device in revealing borrower impatience and sophistication since lower interest rates offered to committed borrowers might attract non-sophisticated impatient and patient borrowers to the commitment device. Recall that the commitment decision reveals impatience and sophistication since committing is not rewarded by the lender. The informational content of the commitment decision could be reduced when lenders publicly communicate interest rate discounts granted to some borrower groups.

order to achieve an optimal income-cost relation from the lender’s perspective. As shown in Table 4, committed borrowers with a high utilization rate before the limit increase have the highest MPC. To provide credit most efficiently, this subgroup of committed borrowers should thus be targeted with the highest priority when increases of the credit limit are intended and the provision of credit is costly.

Adding a risk management perspective further strengthens the value of revealing borrower heterogeneity. Some lenders might refrain from increasing the credit limits of high utilization borrowers since these could be most likely to default and not repay their debt. The medium and low utilization borrower groups might thus constitute more attractive targets to extend further credit to as long as the probability of default does not increase. For this reason, as Table 4 reveals, it might be reasonable to first focus on the medium borrowers of the committed group.

## 7 Conclusion

We analyze to what extent the impatience of borrowers is a determinant of heterogeneity in their reactions to interest rate decreases and credit limit increases. Previous empirical evidence has shown that borrowers’ interest rate elasticity and MPC are substantially driven by liquidity constraints. We contribute to this research by investigating the role of borrower impatience and sophistication in consumers’ credit demand subsequent to interest rate cuts and credit limit increases.

At the heart of our analysis is the distinction between borrowers who choose to commit to minimum monthly repayments and borrowers who prefer full flexibility. The self-selection of borrowers into the commitment device is not influenced by the lender. Our unique dataset with more than 1,600,000 account-month observations allows us to study the debt dynamics of both groups separately, as about 40% of borrowers choose to commit and 60% prefer to remain more flexible. Based on previous research, we classify the former group as sophisticated impatient borrowers and the latter group as either non-sophisticated impatient or patient borrowers.

We obtain two main results. First, in the aggregate, we confirm previous results on the impact of interest rate and credit limit changes on debt. The observed interest rate elasticities are significantly negative, and the MPC out of credit limit increases is significantly positive. The size of the effect of interest rate reductions and credit limit increases on debt depends on the average utilization rate right before the change in credit supply. Second, the reactions shown by committed borrowers are significantly stronger than the reactions of uncommitted borrowers for both changes in credit supply. Committed borrowers’ debt response to interest rate decreases is about four times as large

as the reaction of uncommitted borrowers, and their MPC is almost 30% higher. Whereas previous research has offered liquidity constraints and measures of creditworthiness as potential explanations, we document that the degree of impatience significantly determines borrowers' reactions to interest rate and credit limit changes. Group differences unrelated to impatience and sophistication, the violation of the commitment, and inactive borrowers cannot explain these observations. We also find that basic borrower impatience and sophistication seem to drive the results rather than the disciplining effect of the commitment device.

Our conclusions are not confined to the German credit market but should apply to most forms of revolving credit, for instance, US or UK credit cards; they have important implications for lenders who could use the self-selection of borrowers into different repayment schemes to target interventions more accurately at borrowers with the highest degree of responsiveness to these measures, thereby fostering the efficiency and profitability of credit supply.

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## Appendix

### Further Descriptive Statistics

This section presents further descriptive statistics. Figure 5 contains the distribution of monthly minimum repayments chosen by committed borrowers. The amount of monthly repayments chosen by a committed borrower when the loan is taken out can be adjusted in later months, i.e., borrowers can increase and decrease the amount of regular repayments. The smallest amount of monthly minimum repayments chosen during the observation period (January 2008 to December 2012) equals € 50.

**Figure 5: Distribution of Monthly Minimum Repayments**

Distribution of monthly minimum repayments chosen by committed borrowers, denoted in €. The payments are aggregated into bins of € 25.

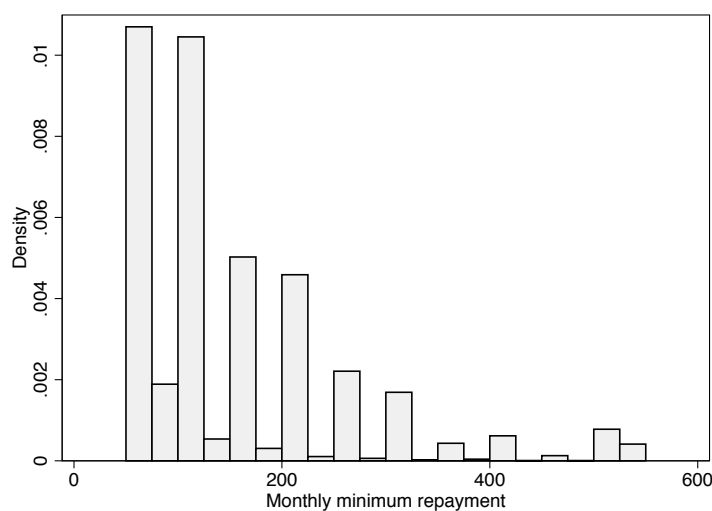


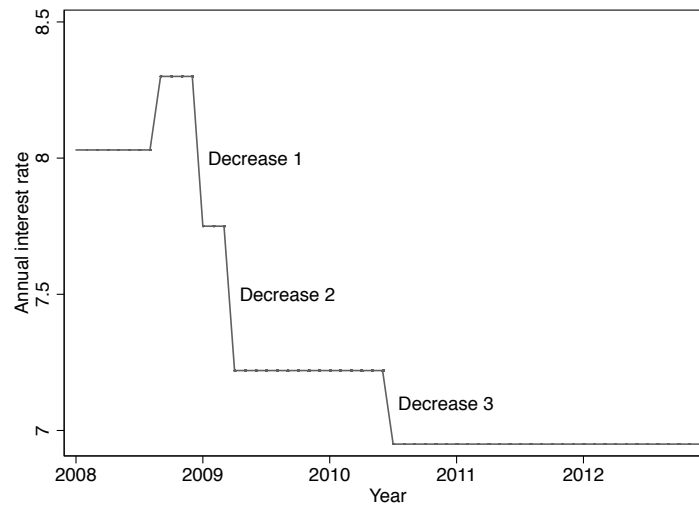
Figure 6 displays the development of the annual effective interest rate on revolving credit during the observation period. As noted in Section 3, we omit the only interest rate increase in September 2008 (27bp) since the number of observations is very low at this early stage of our observation period. The three interest rate decreases reduce the interest rate by 55bp, 53bp, and 27bp, respectively.

Figure 7 records the number of loan accounts which are opened in each month of the observation period. As shown in Table 2, 76,797 accounts are opened during the observation period.

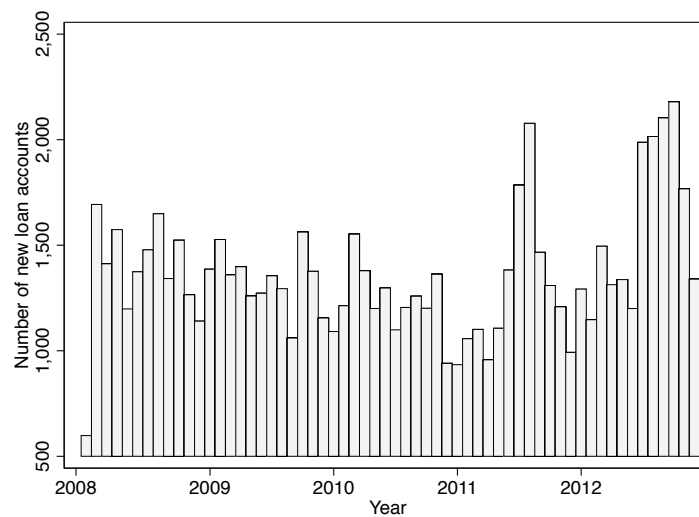


**Figure 6: Development of Interest Rate on Revolving Credit**

Development of the interest rate charged on consumer revolving credit at the cooperating lender during the observation period 2008–2012, denoted in %.

**Figure 7: Opening of Loan Accounts**

Number of loan accounts in revolving credit opened at the cooperating lender over the observation period 2008–2012.



## Cumulative and Marginal Coefficients

This section displays the individual marginal and cumulative lagged coefficients with respect to interest rate decreases and credit limit increases. In Tables 8 and 9, the left-hand panel shows the cumulative coefficients for each lag, and the right-hand panel records the marginal coefficients for each lag.

**Table 8: Cumulative and Marginal Sensitivities to Interest Rate Decreases**

This table displays the cumulative and the marginal lagged coefficients of interest rate decreases with  $n = 6$  lags (left-hand column of each group) and the corresponding p-values (right-hand column). The dependent variable is the change in monthly debt outstanding, denoted in €.  $\sum \beta_{r,c}$  denotes the committed group's cumulative coefficients;  $\sum \beta_{r,u}$  denotes the uncommitted group's cumulative coefficients;  $\beta_{r,c}$  denotes the committed group's marginal coefficients;  $\beta_{r,u}$  denotes the uncommitted group's marginal coefficients.

<i>Cumulative</i>	$\Sigma \beta_{r,c}$	p-value	$\Sigma \beta_{r,u}$	p-value	<i>Marginal</i>	$\beta_{r,c}$	p-value	$\beta_{r,u}$	p-value
$\Delta r_{i,t}$	-75	0.000	-26	0.028	$\Delta r_{i,t}$	-75	0.000	-26	0.028
$\Delta r_{i,t-1}$	-141	0.000	-45	0.006	$\Delta r_{i,t-1}$	-66	0.000	-20	0.066
$\Delta r_{i,t-2}$	-153	0.000	-43	0.035	$\Delta r_{i,t-2}$	-12	0.261	2	0.819
$\Delta r_{i,t-3}$	-187	0.000	-43	0.046	$\Delta r_{i,t-3}$	-34	0.001	0	0.977
$\Delta r_{i,t-4}$	-217	0.000	-21	0.373	$\Delta r_{i,t-4}$	-30	0.001	22	0.011
$\Delta r_{i,t-5}$	-362	0.000	-85	0.001	$\Delta r_{i,t-5}$	-145	0.000	-64	0.000
$\Delta r_{i,t-6}$	-442	0.000	-121	0.000	$\Delta r_{i,t-6}$	-80	0.000	-35	0.000

**Table 9: Cumulative and Marginal Sensitivities to Credit Limit Increases**

This table displays the cumulative and the marginal lagged coefficients of credit limit increases with  $n = 6$  lags (left-hand column of each group) and the corresponding p-values (right-hand column). The dependent variable is the change in monthly debt outstanding, denoted in €.  $\sum \beta_{L,c}$  denotes the committed group's coefficients;  $\sum \beta_{L,u}$  denotes the uncommitted group's coefficients;  $\beta_{L,c}$  denotes the committed group's marginal coefficients;  $\beta_{L,u}$  denotes the uncommitted group's marginal coefficients.

<i>Cumulative</i>	$\Sigma \beta_{L,c}$	p-value	$\Sigma \beta_{L,u}$	p-value	<i>Marginal</i>	$\beta_{L,c}$	p-value	$\beta_{L,u}$	p-value
$\Delta L_{i,t}$	0.11	0.000	0.08	0.000	$\Delta L_{i,t}$	0.11	0.000	0.08	0.000
$\Delta L_{i,t-1}$	0.18	0.000	0.13	0.000	$\Delta L_{i,t-1}$	0.06	0.000	0.05	0.000
$\Delta L_{i,t-2}$	0.20	0.000	0.15	0.000	$\Delta L_{i,t-2}$	0.02	0.000	0.02	0.000
$\Delta L_{i,t-3}$	0.22	0.000	0.16	0.000	$\Delta L_{i,t-3}$	0.01	0.000	0.01	0.000
$\Delta L_{i,t-4}$	0.22	0.000	0.17	0.000	$\Delta L_{i,t-4}$	0.01	0.000	0.01	0.000
$\Delta L_{i,t-5}$	0.23	0.000	0.17	0.000	$\Delta L_{i,t-5}$	0.01	0.000	0.00	0.000
$\Delta L_{i,t-6}$	0.23	0.000	0.18	0.000	$\Delta L_{i,t-6}$	0.00	0.288	0.00	0.002

## Propensity Score Matching

To examine whether the group differences between committed and uncommitted borrowers are due to variables which are not necessarily related to borrower impatience and sophistication, we match each loan of a committed borrower with the most similar loan of an uncommitted borrower. This procedure eliminates about 15,000 loan accounts of uncommitted borrowers since the number of accounts included in the sample is about 46,000 for uncommitted and about 31,000 for committed borrowers. We classify committed borrowers as the treatment group ( $T_i = 1$ , where  $i$  denotes an individual borrower) and uncommitted borrowers as the control group ( $T_i = 0$ ). The matching is performed based on a propensity score (Rosenbaum and Rubin; 1983; Saunders and Steffen; 2011).

$$P(x_i) = \text{Prob}(T_i = 1|x_i) \quad (6)$$

Our probit specification equals

$$C = \beta_0 + \beta_1 \text{limit} + \beta_2 \text{income} + \beta_3 \text{age} + \beta_4 \text{male} + \beta_5 \text{female} + \beta_6 \text{academic} + \beta_7 \text{length} \quad (7)$$

where  $C$  denotes a dummy variable indicating the selection of the commitment device, *limit* is the initial credit limit when a loan account is opened, *income* is a borrower's monthly income, *age* is a borrower's age, *male* (*female*) is a dummy variable indicating a male (female) borrower, *academic* is a dummy variable indicating a borrower with an academic degree, and *length* denotes the length of the client relationship when a borrower opens a loan account.

Based on the results from the probit regression, we calculate the propensity score which can be interpreted as the likelihood that a borrower chooses to commit to monthly minimum repayments.

In our main specification, we choose one-to-one matching without replacement since we are interested in eliminating those accounts of uncommitted borrowers which differ significantly from the accounts of committed borrowers regarding the independent variables used in Equation (7). This implies that no loan account is used more than once.

## Robustness Checks

This section presents the detailed results of the additional robustness checks discussed in Section 5. In Table 10, we omit all uncommitted borrowers who construct their own commitment device from the analysis since these borrowers might exhibit some degree of sophistication. Compared to our main analyses, the number of account-month observations of uncommitted borrowers is reduced.

**Table 10: Exclusion of Self-Constructed Commitment**

This table displays the long-run multipliers of the finite distributed lags model for credit limit increases with  $n = 6$  lags. The dependent variable is the cumulative change in monthly debt, denoted in €. 429 borrowers using a money transfer order to repay their debt have been excluded from the uncommitted group.  $\sum \beta_{r/L,c}$  is the committed group's long-run multiplier of interest rate decreases or credit limit increases over 6 months;  $\sum \beta_{r/L,u}$  is the uncommitted group's long-run multiplier of interest rate decreases or credit limit increases over 6 months; *Low* denotes borrowers with a utilization rate of under 50% in month  $t - 7$ ; *Medium* includes borrowers with utilization rates between 50% and 90%; *High* represents borrowers with utilization rates above 90%. The cumulative number of interest rate changes and of credit limit increases, month and year dummies, the average interest rate on overdraft facilities in the German market, and the number of months passed since the loan account opening are included as control variables. All regressions include loan account fixed effects. Standard errors are clustered at the loan account level. \*, \*\*, and \*\*\* denote significance at the 10%, the 5%, and the 1% level, respectively.

$D/L_{init}$	$\Sigma \beta_{r,c}$	$\Sigma \beta_{r,u}$	$\Sigma \beta_{r,c} - \Sigma \beta_{r,u}$
High	-597***	-271***	-325***
Medium	-496***	-253***	-243***
Low	-230***	48	-278***
Total	-442***	-119***	-324***
Account-month obs.	731,537	893,064	1,624,601
$D/L_{init}$	$\Sigma \beta_{L,c}$	$\Sigma \beta_{L,u}$	$\Sigma \beta_{L,c} - \Sigma \beta_{L,u}$
High	0.27***	0.23***	0.04***
Medium	0.22***	0.19***	0.03**
Low	0.12***	0.10***	0.02
Total	0.23***	0.18***	0.06***
Account-month obs.	731,537	893,064	1,624,601

In Table 11, we set the minimum observation period for all loan accounts equal to 24 months. Consequently, we exclude all loan accounts with an observation period of less than 24 months. The number of account-month observations of committed and uncommitted borrowers is reduced compared to our main analyses.

**Table 11: Minimum Observation Period**

This table displays the long-run multipliers of the finite distributed lags model for credit limit increases with  $n = 6$  lags. The dependent variable is the cumulative change in monthly debt, denoted in €. All loan accounts with an observation period of less than 24 months are excluded from the analysis.  $\sum \beta_{r/L,c}$  is the committed group's long-run multiplier of interest rate decreases or credit limit increases over 6 months;  $\sum \beta_{r/L,u}$  is the uncommitted group's long-run multiplier of interest rate decreases or credit limit increases over 6 months; *Low* denotes borrowers with a utilization rate of under 50% in month  $t - 7$ ; *Medium* includes borrowers with utilization rates between 50% and 90%; *High* represents borrowers with utilization rates above 90%. The cumulative number of interest rate changes and of credit limit increases, month and year dummies, the average interest rate on overdraft facilities in the German market, and the number of months passed since the loan account opening are included as control variables. All regressions include loan account fixed effects. Standard errors are clustered at the loan account level. \*, \*\*, and \*\*\* denote significance at the 10%, the 5%, and the 1% level, respectively.

$D/L_{init}$	$\Sigma \beta_{r,c}$	$\Sigma \beta_{r,u}$	$\Sigma \beta_{r,c} - \Sigma \beta_{r,u}$
High	-597***	-247***	-351***
Medium	-499***	-245***	-254***
Low	-238***	71**	-309***
Total	-448***	-118***	-331***
Account-month obs.	678,562	810,277	1,488,839
$D/L_{init}$	$\Sigma \beta_{L,c}$	$\Sigma \beta_{L,u}$	$\Sigma \beta_{L,c} - \Sigma \beta_{L,u}$
High	0.27***	0.24***	0.04***
Medium	0.23***	0.19***	0.03**
Low	0.12***	0.10***	0.02
Total	0.23***	0.18***	0.05***
Account-month obs.	678,562	810,277	1,488,839

## Switching from No Commitment to Commitment

Table 12 displays the results of a probit regression among all initially uncommitted borrowers where the dependent variable is equal to 1 if an initially uncommitted borrower decides to commit at a later point in time. As described in Section 5, 1,026 borrowers fall into this category. Since we use logarithms of the three main independent variables *average credit limit*, *debt*, and *utilization rate*, the number of accounts included in the regression is lower in Columns 2 and 3 as the average debt and the average utilization rate may be equal to zero.

**Table 12: Switching Propensity of Uncommitted Borrowers**

This table contains the marginal effects of a probit regression among uncommitted borrowers and borrowers who are initially uncommitted and then choose to commit. The dependent variable is equal to 1 if a switch is observed. *Average credit limit* is the average credit limit of a loan account, including subsequent limit changes, expressed in €; *Debt* is the average monthly debt outstanding, expressed in €; *Utilization rate* is the average monthly debt outstanding, expressed in % of the credit limit; *Age* is a borrower's age, expressed in years; *Male* and *Female* are dummy variables representing a borrower's gender; *Monthly income of borrower* is a borrower's monthly income after the deduction of monthly expenses, expressed in €; *Month* and *Year* denote the month and the year in which a loan is taken out; *Accounts* represents the number of accounts included in the sample. \*, \*\*, and \*\*\* denote significance at the 10%, the 5%, and the 1% level, respectively.

	(1)	(2)	(3)
Average credit limit (log) (€)	-0.153*** (-6.30)		
Debt (log) (€)		0.200*** (12.74)	
Utilization rate (log) (%)			0.452*** (16.26)
Age	-0.005*** (-3.58)	-0.005*** (-3.24)	-0.004** (-2.36)
Male	-0.037 (-1.16)	0.020 (0.56)	0.013 (0.35)
Female	0.107*** (2.90)	0.205*** (4.93)	0.151*** (3.56)
Constant	-0.030 (-0.12)	-3.226*** (-18.74)	-1.227*** (-12.25)
Month	Yes	Yes	Yes
Year	Yes	Yes	Yes
Accounts	46,896	43,021	43,021
Pseudo $R^2$	0.11	0.18	0.21