Statistical appendix to the report 'Helping customers pay their BNPL bill on time'

In short This statistical appendix provides details on the analyses and results of the experiment with SMS reminders. The information supplements the main report, which contains information on the background of the experiment, the experimental procedure, and the key findings. AFM and Riverty jointly designed the experiment and devised an analysis plan. Before the start of the experiment, we preregistered the formal hypotheses, a plan for the confirmatory analyses, and criteria for inclusion in the sample.

Formal Hypotheses

The outcome variable of interest was whether customers with an invoice that is due for payment pay their balance in full before he first late payment fee More specifically, in our hypotheses we use the "share before fees", which we calculated as follows:

$$\text{Share before fees} = \frac{\text{count of unique customers who completely pay the outstanding amount before the first fee}}{\text{count of unique customers with an invoice that is due for payment}}$$

Our main hypothesis was that the SMS messages would serve as an additional reminder on top of already existing communication in activating customers to pay their balance in full before they are subject to late payment fees. Hence, we expected that customers who are exposed to the SMS reminder regardless of the variant would have a higher propensity of paying before late payment fees compared to those who are not exposed to the SMS reminder. However, we also allowed for the possibility that the SMS would have the opposite effect. This leads to the following null and alternate hypotheses:

Hypothesis 1

H0: *Share before fees SMS reminder = Share before fees Control*
H1: *Share before fees SMS reminder ≠ Share before fees Control*

Hypothesis 2

H0: *Share before fees SMS reminder incl. consequences = Share before fees Control*
H1: *Share before fees SMS reminder incl. consequences ≠ Share before fees Control*

Hypothesis 3

H0: *Share before fees SMS reminder incl. paylink = Share before fees Control*
H1: *Share before fees SMS reminder inc. paylink ≠ Share before fees Control*

Power analysis

To determine the required sample size, we conducted a power analysis before the start of the experiment. See Table 1 for the input used for this power analysis. We based the estimated effect size of the SMS reminders (2 percentage points) on the effect of e-mail reminders that Riverty sends to its customers and on a survey of relevant literature. We based the baseline payment rate before fees on an analysis of historical payment data. Assuming a two-sided test with one control group and three treatment groups, the minimal sample size required to obtain 80% power with an α of 0.05 was 23,664 unique customer observations (4 x 5,916).

Table 1. Input for power analysis.

Variable	Input value
Baseline payment before fees	80.5%
Estimated effect of SMS reminders	2 percentage points
Significance level (α)	5%
Required statistical power (1-β)	80%

Test retailer

To obtain a sufficiently large sample within a reasonable time, we selected an online fashion retailer for the experiment. The customers who use Riverty at the selected fashion retailer differ from the customers who use Riverty at other retailers in various ways. In the twelve months leading up to the test period (June 2022 - May 2023), customers at the selected retailer were significantly younger, had higher average order amounts, were less likely to pay in full before the due date and were less likely to pay in full before incurring late fees. Tables 2 and 3 show this comparison in more detail.

Table 2. Comparison between the test retailer and the top 50 of other retailers offering Riverty in the year before the experiment (June 2022 - May 2023), for age and order amount. The top 50 were determined based on the number of orders. With t-tests for statistical significance.

Variable	Test retailer (*N* = 229,643) Mean (SD)	Top 50 retailers (*N* = 1,137,738) Mean (SD)	*t*(df)	*p*
Age	28.81 (9.44)	40.60 (13.83)	-727.28 (1367379)	<.001
Order amount	€137.05 (€131.31)	€97.56 (€101.88)	276.37 (1367379)	<.001

Table 3. Comparison between the test retailer and the top 50 of other retailers offering Riverty in the year before the experiment (June 2022 - May 2023), for share of customers who pay before due date and share of customers who pay before late fees. The top 50 were determined based on the number of orders. With z-tests for statistical significance

Variable	Test retailer (*N* = 229,643)	Top 50 retailers (*N* = 1,137,738)	*z*	*p*
Share of customers who pay before due date	33.87%	48.03%	-179.09	<.001
Share of customers who pay before late fees	81.19%	86.47%	-95.20	<.001

Test period

Based on past transaction rates we estimated that we would need approximately 1 to 1.5 month to obtain a sufficiently large sample. After starting the experiment on 1 June 2023, we monitored the number of customers who were eligible for the sample. On 30 June, AFM and Riverty jointly decided to close data collection. This decision was made purely based on the sample sizes in each group, without inspecting or analysing the data.

Sample and randomisation checks

All 47,709 unique customers who selected Riverty at checkout in the period between 1 June 2023 and 30 June 2023 were eligible for inclusion in the sample. If customers made more than one purchase with Riverty at the retailer in this period, they were only eligible for

inclusion in the sample once, with their first purchase. All customers who returned their order in full were excluded from the data. This led to a sample of 34,365 customers. Tables 4 and 5 provide an overview of the sample.

Tables 4 and 5 also show also shows a series of randomisation checks. We tested for differences between the four groups with respect to customers' age, order amount, and past payment behavior (number of past orders, number of previous arrears, and paying before the day of the intervention). Whereas we have no reason to think that randomisation did not work as intended, we do see a small but significant difference in the number of previous arrears between the four groups. Because of this difference, we decided to include the number of previous arrears as an additional covariate in the regression analyses that we conducted as robustness checks of our main results (see Tables 7 and 8).

Table 4. Comparison of descriptive variables between the four groups, with F-test for statistical significance.

Variable	Control group (N = 8,553)	Reminder (N = 8,601)	Reminder incl. consequence (N = 8,611)	Reminder incl. paylink (N = 8,600)	F (df, df)	p
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Age	29.31 (9.03)	29.11 (8.90)	29.08 (8.78)	29.27 (9.16)	1.395 (3, 34362)	.242
Order amount	€154.67 (€142.00)	€153.75 (€140.55)	€155.45 (€143.21)	€154.28 (€141.65)	0.218 (3, 34362)	.884
Past orders	11.13 (14.05)	11.07 (15.06)	11.14 (14.46)	10.83 (14.11)	0.842 (3, 34362)	.471
Number of previous arrears	0.48 (0.96)	0.47(0.97)	0.50 (1.01)	0.46(0.94)	2.771 (3, 34362)	.040

Table 5. Comparison of share of customers who pay before the day of the intervention between the four groups, with X^2-test for statistical significance.

Variable	Control group (N = 8,553)	Reminder (N = 8,601)	Reminder incl. consequence (N = 8,611)	Reminder incl. paylink (N = 8,600)	X^2	p
Share of customers who pay before day of intervention	37.47%	38.74%	38.45%	38.63%	3.649	.302

Effect of SMS reminders on payment before late fees

To test our preregistered hypotheses, we examined whether customers in each of the three reminder groups were more or less likely to pay their balance in full before the first late payment fee compared to customers in the *control group* who received no SMS reminder.

The share of customers who paid their balance in full before late fees was significantly higher in the *reminder group* (84.85%) compared to the *control group* (81.48%), z = 5.90, p < .001.

The share of customers who paid their balance in full before late fees was significantly higher in the *reminder incl. consequence group* (84.78%) compared to the *control group* (81.48%), z = 5.77, p < .001.

The share of customers who paid their balance in full before late fees was significantly higher in the *reminder incl. paylink group* (85.65%) compared to the *control group* (81.48%), z = 7.37, p < .001.

Difference between SMS reminders

We tested whether the share of customers who paid their balance in full before the first late payment fee differed between the three reminder groups.[1]

The share of customers who paid their balance in full before late fees was not significantly different in the *reminder incl. consequence group* (84.78%) compared to the *reminder group* (84.85%), z = -0.13, p = .898.

This means we find no evidence that mentioning consequences of late payment in the SMS had an additional effect on the likelihood of paying before late fees.

The share of customers who paid their balance in full before late fees was not significantly different in the *reminder incl. paylink group* (85.65%) compared to the *reminder group* (84.85%), z = 1.48, p = .139. This means we find no evidence that the payment link in the SMS had an additional effect on the likelihood of paying before late fees.

The share of customers who paid their balance in full before late fees was not significantly different in the *reminder incl. paylink group* (85.65%) compared to the *reminder incl. consequence group* (84.78%), z = 1.61, p = .108. This means we find no evidence that the SMS with the payment link was more or less effective in encouraging payment before fees than the SMS mentioning the consequences of late payment.

Table 6 shows the results of logistic regression analysis of payment in full before late fees (0 = not paid in full; 1 = paid in full) on group dummy variables. The results indicate that our key findings are robust across different methods of analysis.

---

1   All of the following analyses are exploratory. We preregistered no hypotheses for these analyses.

Table 6. Results of logistic regression analysis of payment in full before late fees (0 = not paid in full; 1 = paid in full) on group dummy variables. Log likelihood = -14,966.

Variable	Estimate	Standard error	z	p	OR (95% CI)
Reminder	0.241	0.041	5.891	<.001	1.27 (1.17-1.38)
Reminder incl. consequence	0.236	0.041	5.757	<.001	1.27 (1.17-1.37)
Reminder incl. paylink	0.305	0.041	7.355	<.001	1.36 (1.25-1.47)
Constant	1.482	0.028	53.224	<.001	4.40 (4.17-4.65)

Effect of customer characteristics

Table 7 shows the results of a second regression analysis, this time including several customer characteristics as covariates. We draw two conclusions from this analysis. First, the effect of the SMS reminders is virtually unaffected after including covariates, as we would expect with randomly assigned groups. Second, independent of the effect of the SMS reminders, each of the four covariates is significantly associated with the likelihood of paying in full before the first late payment fee.

Table 7. Results of logistic regression analysis of payment in full before first late payment fee (0 = not paid in full; 1 = paid in full) on group dummy variables. Log likelihood = -14,809.

Variable	Estimate	Standard error	z	p	OR (95% CI)
Reminder	0.244	0.041	5.919	<.001	1.28 (1.18-1.38)
Reminder incl. consequence	0.246	0.041	5.985	<.001	1.28 (1.18-1.39)
Reminder incl. paylink	0.305	0.042	7.306	<.001	1.36 (1.25-1.47)
Age	0.005	0.002	3.094	.002	1.01 (1.00-1.01)
Order amount	-0.00	0.000	-2.352	.019	1.00 (1.00-1.00)
Returning customer (vs. new)	0.564	0.042	13.343	<.001	1.76 (1.62-1.91)
Number of previous arrears	-0.199	0.014	-14.708	<.001	0.82 (0.80-0.84)
Constant	0.981	0.069	14.139	<.001	2.67 (2.33-3.06)

Payment before or on due date

The SMS messages were sent one day before the due date. To understand the immediate effect of the SMS messages, we ran additional analyses with payment before or on due date as the dependent variable.[2] We tested whether customers in each of the three *Reminder groups* were more or less likely to pay their balance in full before or on the due date compared to customers in the *control group* who received no SMS reminder.

The share of customers who paid their balance in full before due date was significantly higher in the *reminder group* (54.94%) compared to the *control group* (45.57%), $z = 12.27$, $p < .001$.

The share of customers who paid their balance in full before or on due date was significantly higher in the *reminder incl. consequence group* (54.77%) compared to the *control group* (45.57%), $z = 12.05$, $p < .001$.

The share of customers who paid their balance in full before or on due date was significantly higher in the *reminder incl. paylink group* (55.15%) compared to the *control group* (45.57%), $z = 12.55$, $p < .001$.

We tested whether the share of customers who paid their balance in full before or on the due date differed between the three different reminder groups.

The share of customers who paid their balance in full before or on due date was not significantly different in the *reminder incl. consequence group* (54.77%) compared to the *reminder group* (54.94%), $z = -0.22$, $p = .823$. This means we find no evidence that mentioning consequences of late payment in the SMS had an additional effect on the likelihood of paying before or on due date.

The share of customers who paid their balance in full before or on due date was not significantly different in the *reminder incl. paylink group* (55.15%) compared to the *reminder group* (54.94%), $z = 0.28$, $p = .782$. This means we find no evidence that the payment link in the SMS had an additional effect on the likelihood of paying before or on due date.

The share of customers who paid their balance in full before or on due date was not significantly different in the *reminder incl. paylink group* (55.15%) compared to the *reminder incl. consequence group* (54.77%), $z = 0.50$, $p = .616$. This means we find no evidence that the SMS with the payment link was more or less effective in encouraging payment before or on due date than the SMS mentioning the consequences of late payment.

Incidence of second late payment fee

Whereas our predictions were focused on the payment before the first late payment fee, we also examined whether the effects persisted when looking at incidence of the second late payment fee. Hence, we tested whether customers in each of the three reminder groups were more or less likely receive the second late payment fee[3] compared to customers in the *control group* who received no SMS reminder.

The share of customers who were charged the second late payment fee was significantly lower in the *reminder group* (6.29%) compared to the *control group* (7.53%), $z = -3.20$, $p = .001$.

The share of customers who were charged the second late payment fee was significantly lower in the *reminder incl. consequence group* (6.49%) compared to the *control group* (7.53%), $z = -2.67$, $p = .007$.

---

2   Note that in Table 2 of the main report, we chose to report the share of customers who did not pay before or on the due date. This is 100 minus the share of customers who pay before or on the due date.

3   Note that not all customers who failed to pay before the second late payment fee were in fact charged the second late payment fee. This can be due to customers requesting to put their payment on hold.

The share of customers who were charged the second late payment fee was significantly lower in the *reminder incl. paylink group* (6.55%) compared to the *control group* (7.53%), $z = -2.51$, $p = .012$.

We tested whether the share of customers who were charged the second late payment fee differed between the three different reminder groups.

The share of customers who paid their balance in full before or on due date was not significantly different in the *reminder incl. consequence group* (6.49%) compared to the *reminder group* (6.29%), $z = 0.54$, $p = .592$. This means we find no evidence that mentioning consequences of late payment in the SMS had an additional effect on the likelihood of receiving the second late payment fee.

The share of customers who paid their balance in full before or on due date was not significantly different in the *reminder incl. paylink group* (6.55%) compared to the *reminder group* (6.29%), $z = 0.70$, $p = .487$. This means we find no evidence that the payment link in the SMS had an additional effect on the likelihood of receiving the second late payment fee.

The share of customers who paid their balance in full before or on due date was not significantly different in the *reminder incl. paylink group* (6.55%) compared to the *reminder incl. consequence group* (6.49%), $z = 0.16$, $p = .873$. This means we find no evidence that the SMS with the payment link was more or less effective in encouraging payment before receiving the second late payment fee than the SMS mentioning the consequences of late payment.

Heterogeneous treatment effects

Table 8 shows the results of a third regression analysis, including interaction terms between group dummy variables and customer characteristics as covariates. The interaction terms indicate no clear evidence that the effect of SMS reminders differed across customer age, customer status (returning vs. new customer), and the number of previous arrears. The effect of the *reminder incl. consequence* (as compared to the *Control group*) was significantly smaller for customers with higher order amounts. The effect of the *reminder incl. paylink* (as compared to the *control group*) did not significantly differ across order amounts.

Table 8. Results of logistic regression analysis of payment in full before first latepayment fee (0 = not paid in full; 1 = paid in full) on group dummy variables, covariates, and interaction effects. Log likelihood = -14,799.

Variable	Estimate	Standard error	z	p	OR (95% CI)
Reminder	0.034	0.178	0.194	.846	1.04 (0.73-1.47)
Reminder incl. consequence	0.089	0.180	0.491	.623	1.09 (0.77-1.56)
Reminder incl. paylink	0.239	0.184	1.302	.193	1.27 (0.89-1.82)
Age	0.001	0.003	0.443	.658	1.00 (1.00-1.01)
Order amount	-0.000	0.000	-0.764	.445	1.00 (1.00-1.00)
Returning customer (vs. new)	0.560	0.079	7.065	<.001	1.75 (1.50-2.04)
Number of previous arrears	-0.199	0.014	-14.723	<.001	0.82 (0.80-0.84)
Reminder × Age	0.002	0.005	0.449	.653	1.00 (0.99-1.01)
Reminder incl. cons. × Age	0.007	0.005	1.517	.129	1.01 (1.00-1.02)
Reminder incl. paylink × Age	0.007	0.005	1.542	.123	1.01 (1.00-1.02)
Reminder × Order amount	0.000	0.000	0.888	.375	1.00 (1.00-1.00)
Reminder incl. cons. × Order amount	-0.001	0.000	-2.120	.034	1.00 (1.00-1.00)
Reminder incl. paylink × Order amount	0.000	0.000	0.006	.995	1.00 (1.00-1.00)
Reminder × Returning customer (vs. new)	0.129	0.113	1.137	.255	1.14 (0.91-1.42)
Reminder incl. cons. × Returning customer (vs. new)	0.052	0.114	0.451	.652	1.05 (0.84-1.32)
Reminder incl. paylink × Returning customer (vs. new)	-0.171	0.119	-1.442	.149	0.84 (0.67-1.06)
Constant	1.085	0.122	8.915	<.001	2.96 (2.33-3.75)