Payment patterns

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Edinburgh, August 2011

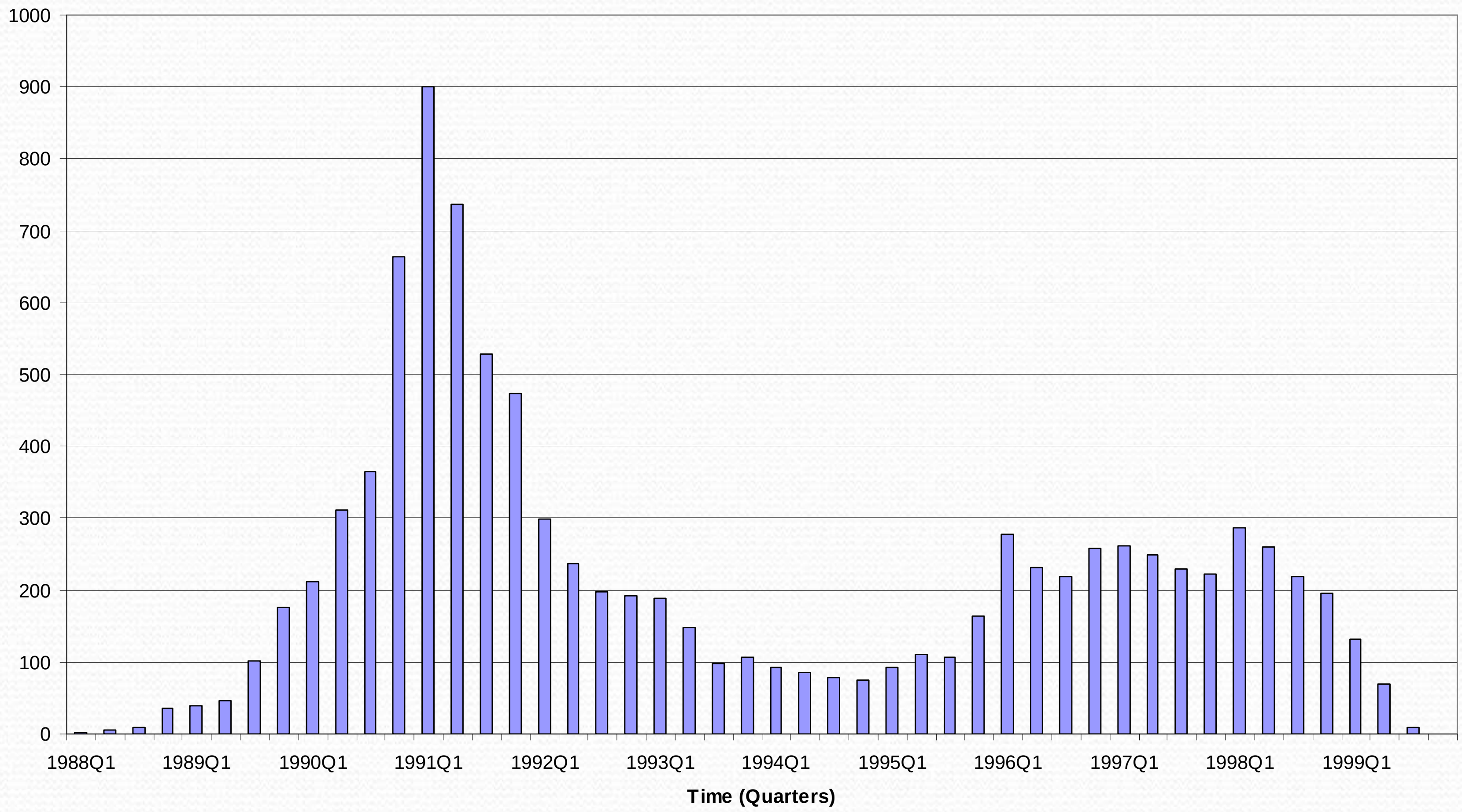
Agenda

- Data description
- Payment pattern
- Modelling repayment patterns using Markov chains:
  - Repayment sequence modelling
  - Modelling repayments each period
  - Results from modelling:
  - Repayment sequences
  - Repayments each period
- Summary

Data Desciption

- Data: ~10,000 cases from UK bank
- Product type – unsecured personal loans
- Loan start date: 1987 – 1998
- Default date: 1988 - 1999
- Payments: 1989-2004 (180 months)
- Default: 3 months in arrears

Default Date

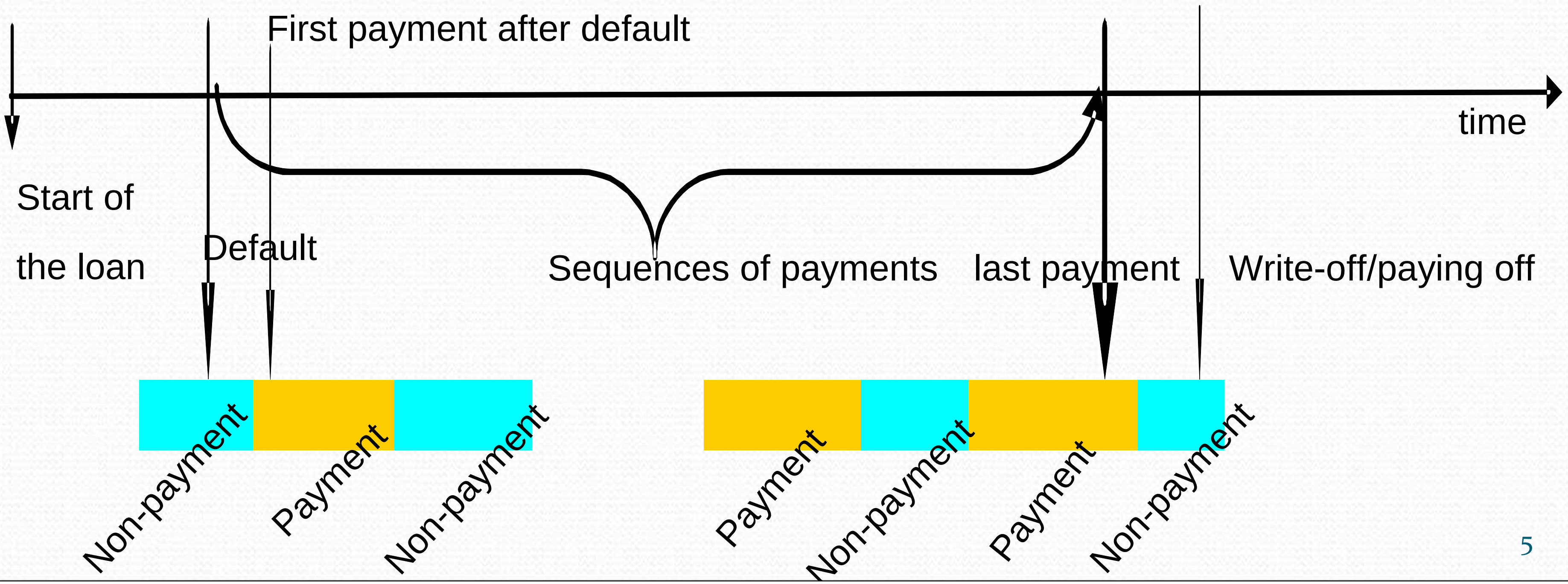


Payment Patterns

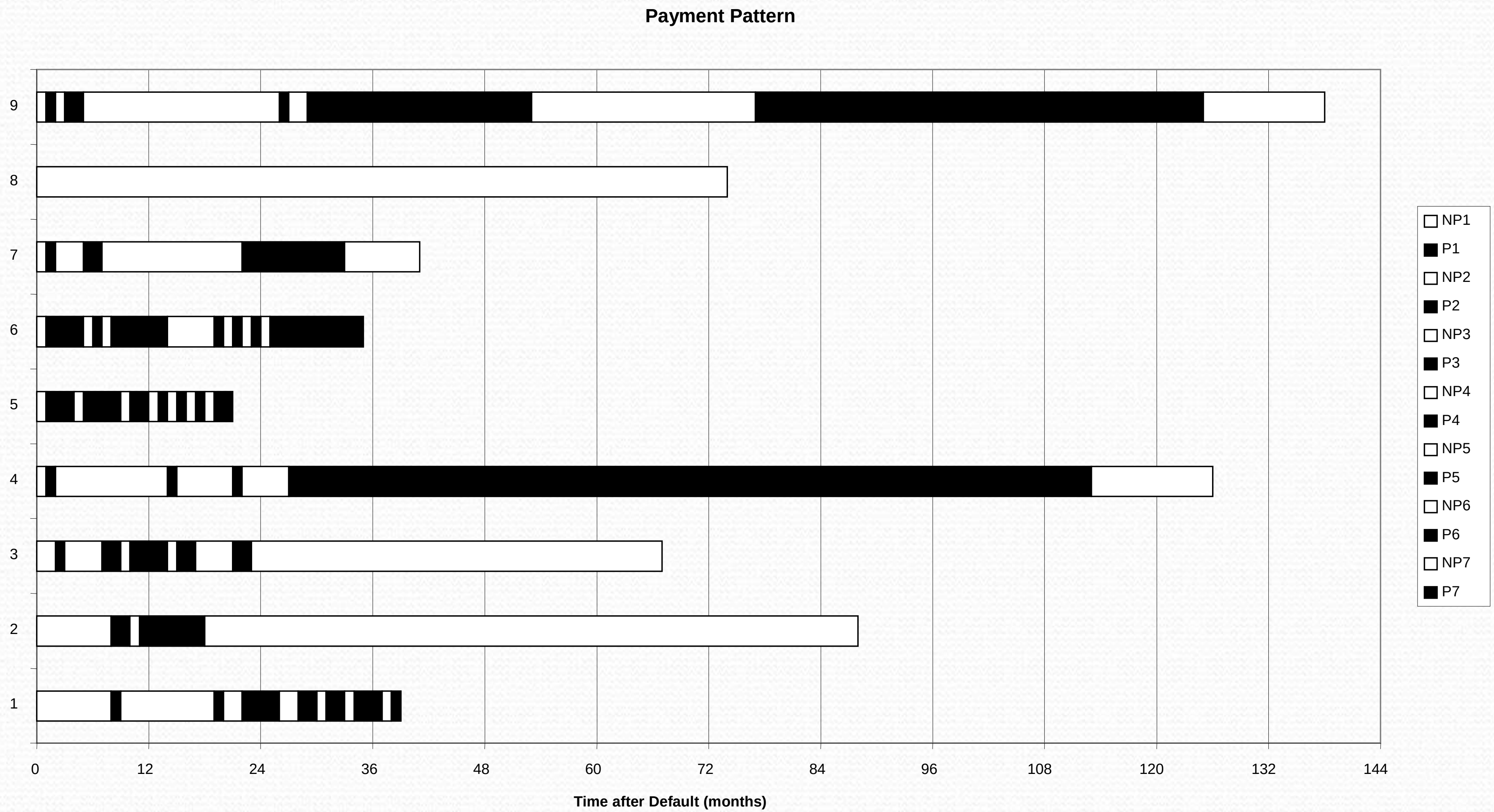
Two types of sequences

- Sequences of non-payment (NP)

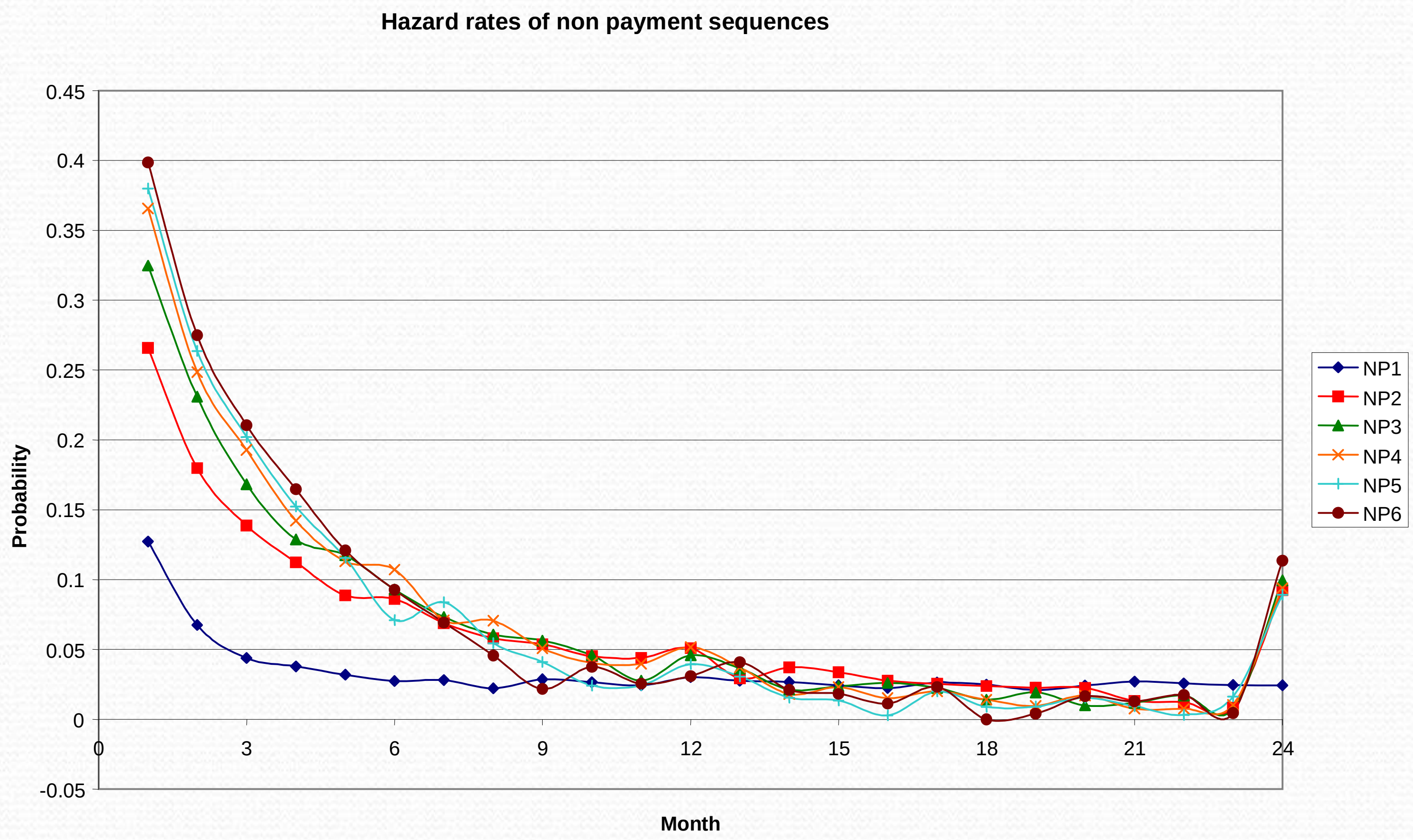
- Sequences of payment (P)



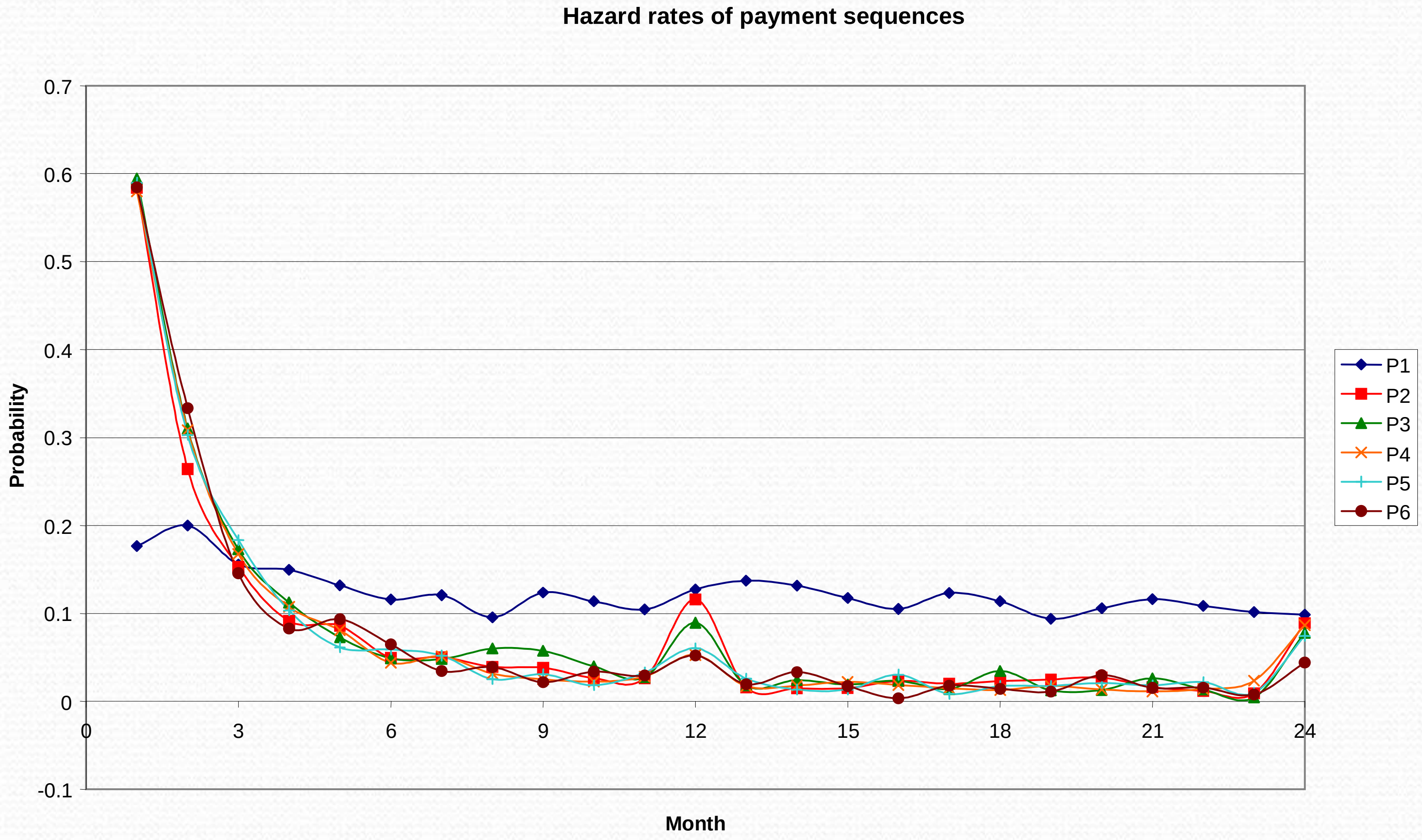
Payment Patterns –cont.



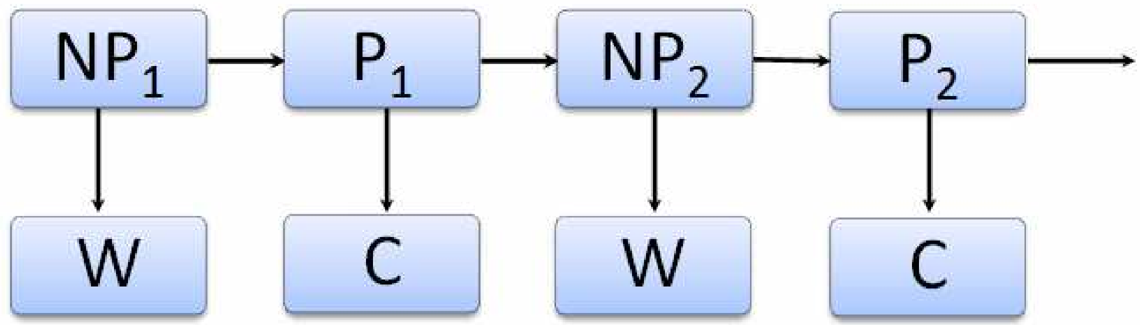
Length of Non-payment Sequences



Length of Payment Sequences



Repayment sequence modelling

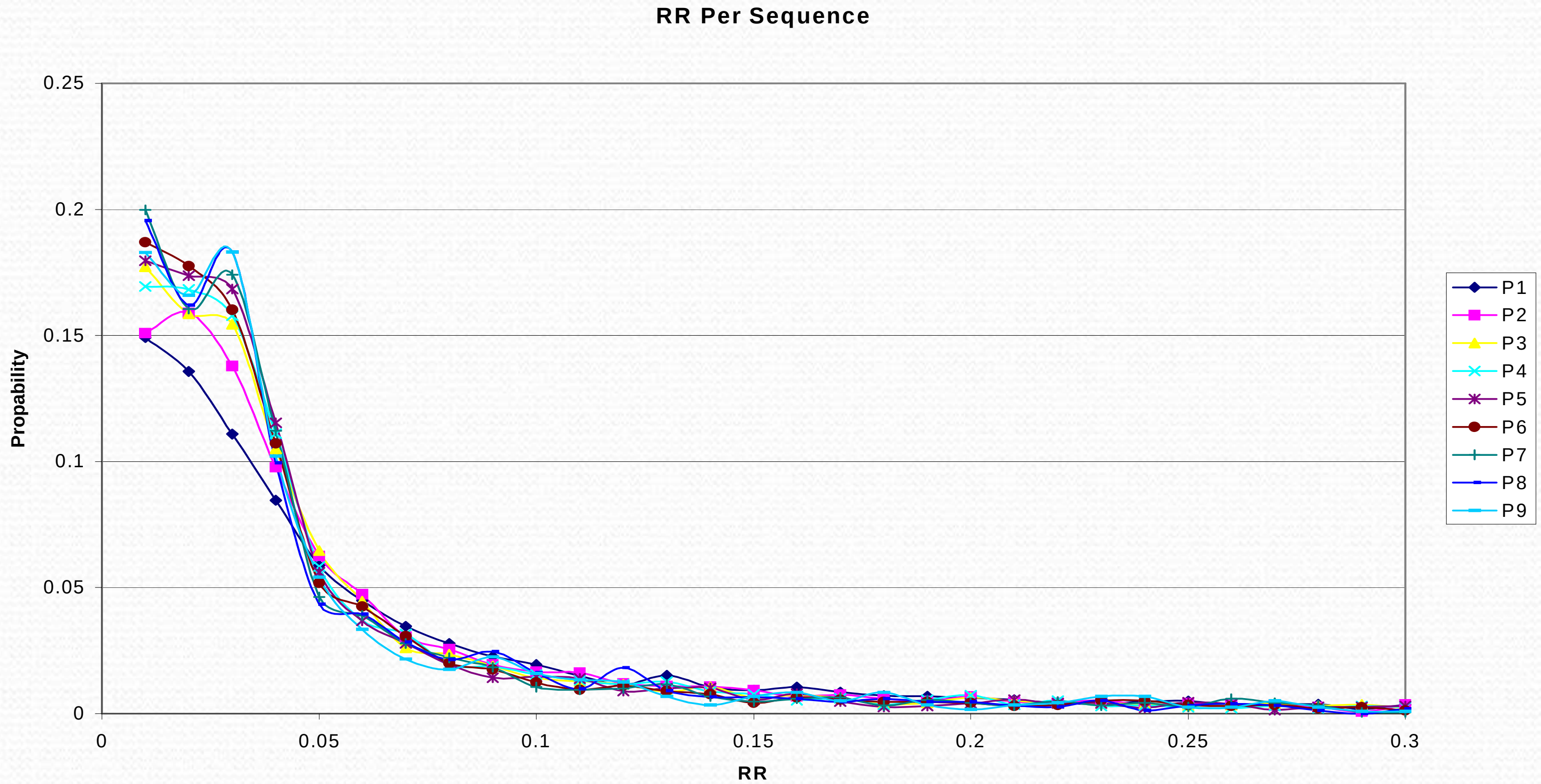


$P(P_j|NP_j)$ and $P(NP_{j+1}|P_j)$, $j=1,2\ldots$
and
$P(W|NP_j)= 1- P(P_j|NP_j)$;
$P(C|P_j)=1- P(NP_{j+1}|P_j)$,

	$P(W\|NP_j)$	$P(P_j\|\ NP_j)$	$P(C\|P_j)$	$P(NP_{j+1}\|P_j)$
NP1	0.273	0.727	0.043	0.957
NP2	0.163	0.837	0.042	0.958
NP3	0.138	0.862	0.044	0.956
NP4	0.113	0.887	0.051	0.949
NP5	0.122	0.878	0.049	0.951
NP6	0.105	0.895	0.049	0.951
NP7	0.097	0.903	0.053	0.947
NP8	0.089	0.911	0.059	0.941
NP9	0.104	0.896	0.069	0.931
NP10	0.117	0.883	0.065	0.935

2+

Recovery Rate in Each Payment Sequence

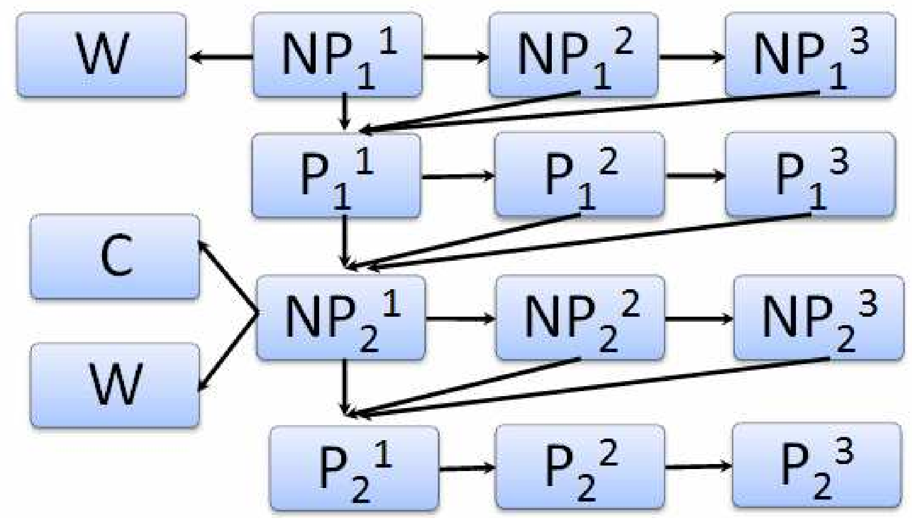


$$E(RR) = RR(1)\,p_1 + \frac{RR(2+)\,p_1 q_1 p}{1 - pq}$$

$P(P_1|NP_1)=p_1$; $P(P_i|NP_i)=p$; $i \geq 2$

$P(NP_2|P_1)=q_1$; $P(NP_{i+1}|P_i)=q$; $i \geq 2$

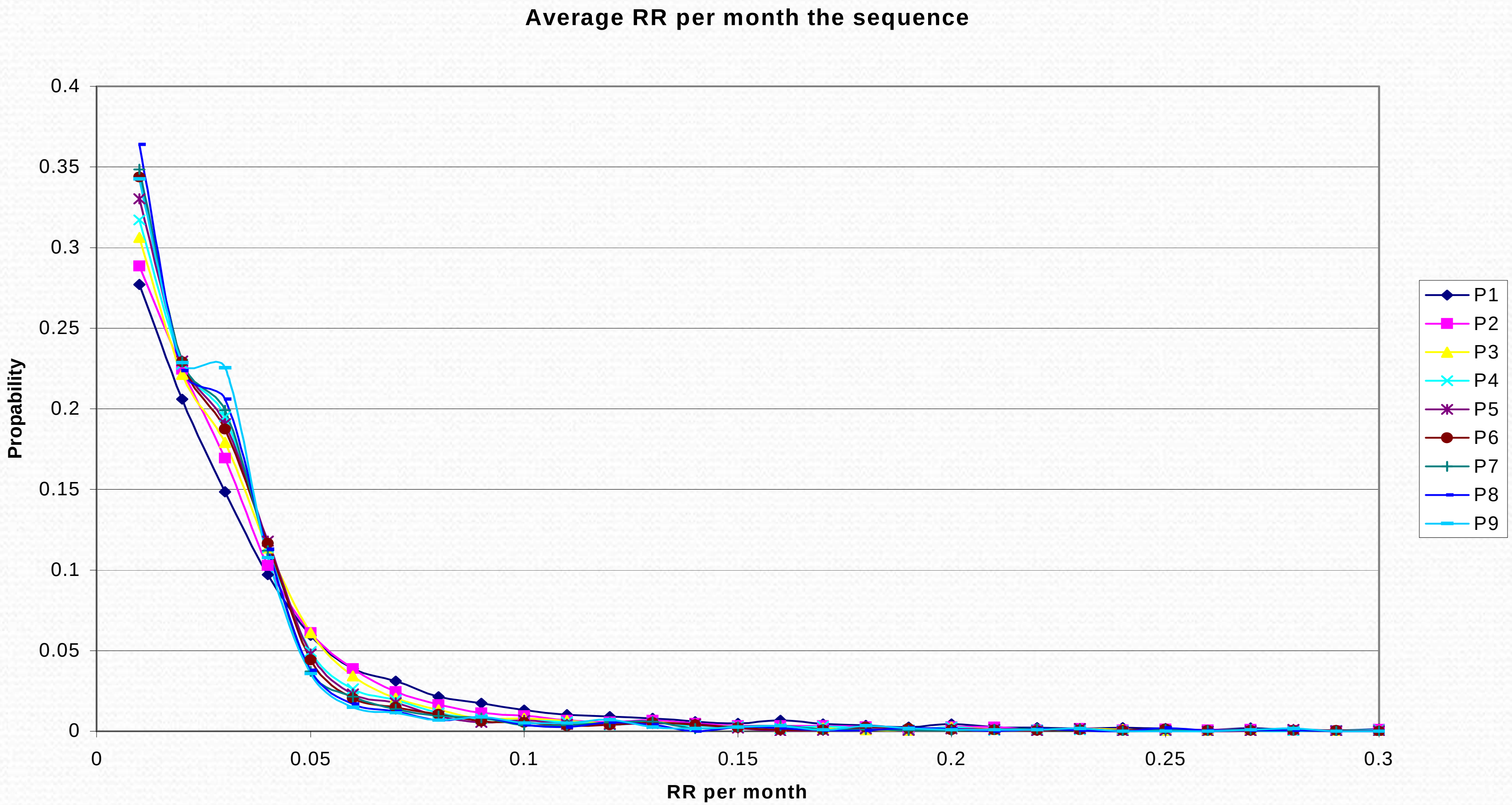
Payment sequence per month



$$E(RR) = \sum_{i=1}^{\infty} \prod_{j=1}^{i} (1 - P(W \mid NP_j^i)) \prod_{j=2}^{i} (1 - P(C \mid NP_j^i)) \sum_{k=1}^{\infty} RRM(i) \prod_{k=1}^{l-1} P(P_i^{k+1} \mid P_i^k)$$

$\sum_{j=1}^{\infty} RRM(i) \prod_{R=1}^{j-1} P(P_i^{k+1} \mid P_i^k)$ - the average recovery rate in payment sequence i

Recovery rate per month in each sequence



Modelling RR

The following variables were considered as targets and modelled for the **first** and the second **sequence** of payment:

- Recovery rate during a payment sequence
- Recovery rate per month during a payment sequence

Variables used

Using univariate analysis we identified the following variables which were the strongest predictors of the RR values:

- Age at application
- Application score
- Default amount
- Actual amount customers borrow
- The term of the loan

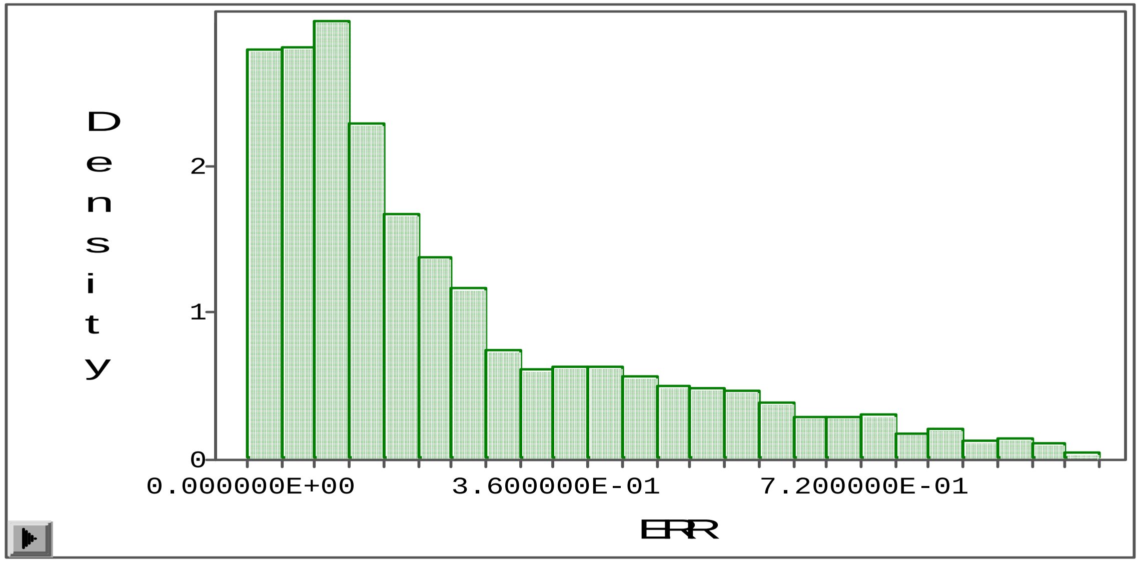
Results

- The younger the applicant was, the higher RR
- The lower the application score, the higher RR
- The higher the amount at default, the higher RR
- The higher the amount customers borrow, the higher RR
- The longer the term of the loan, the lower the RR

Results – cont.

Method	Target variable	R^2	Target variable	R^2
Log normal	Recovery rate in the first sequence	0.0652	Average recovery rate per month in the first sequence	0.0427
Linear		0.0633		0.0325
WOE		**0.0928**		**0.1149**
Log normal	Recovery rate in the second sequence	0.0225	Average recovery rate per month in the second sequence	0.0377
Linear		0.0243		0.0218
WOE		**0. 0516**		**0.0990**

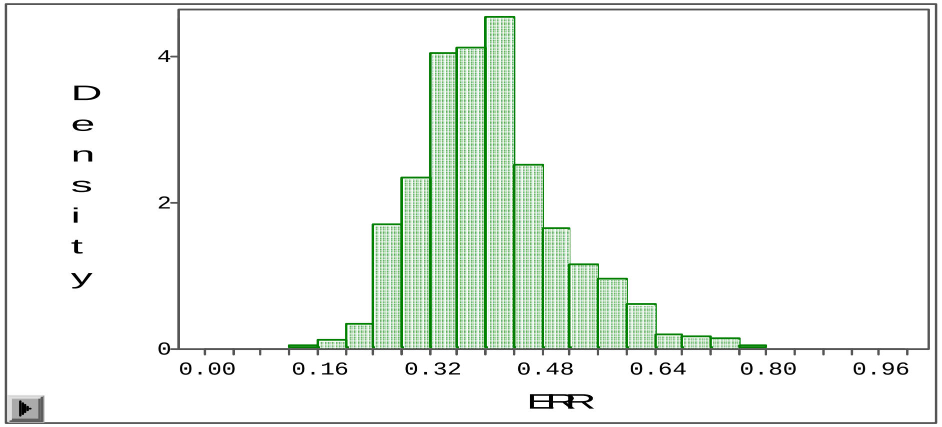
Results from sequence modelling (without characteristics)



Moments			
N	4669.0000	Sum Wgts	4669.0000
Mean	0.4839	Sum	2259.1898
Std Dev	0.7757	Variance	0.6018
Skewness	4.0192	Kurtosis	35.0364
USS	3902.2495	CSS	2809.0949
CV	160.3205	Std Mean	0.0114

$$\text{E(RR)}=\sum_{\text{i}=1}^{\infty}\text{RR(i)}P(P_i \mid NP_i)\prod_{j<i}P(P_j \mid NP_j)$$

Results from sequence modelling (with characteristics)



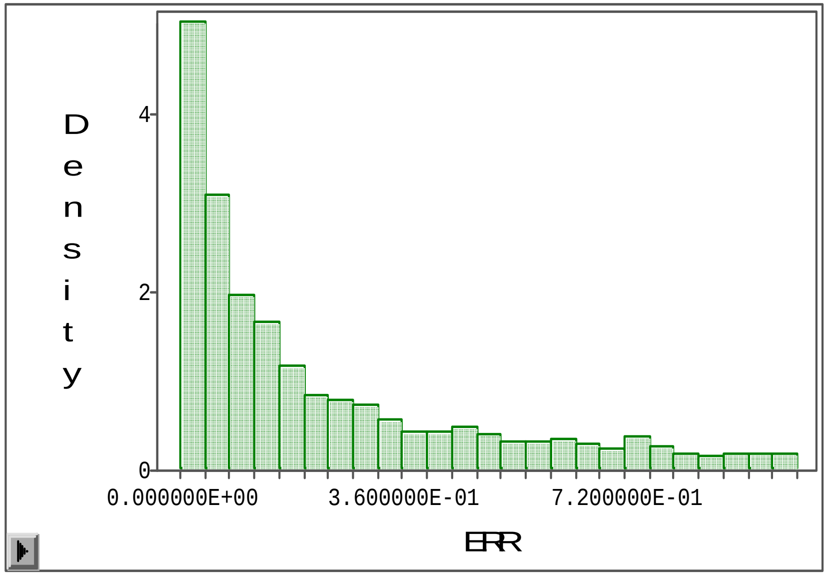
Moments

N	2009.0000	Sum Wgts	2009.0000
Mean	0.4064	Sum	816.5548
Std Dev	0.1024	Variance	0.0105
Skewness	0.6347	Kurtosis	0.6905
USS	352.9416	CSS	21.0542
CV	25.1931	Std Mean	0.0023

$$E(RR,x) = RR(1,x)\,p_1(x) + RR(2,x)\,\frac{p_1(x)q_1(x)p(x)}{1 - p(x)q(x)}$$

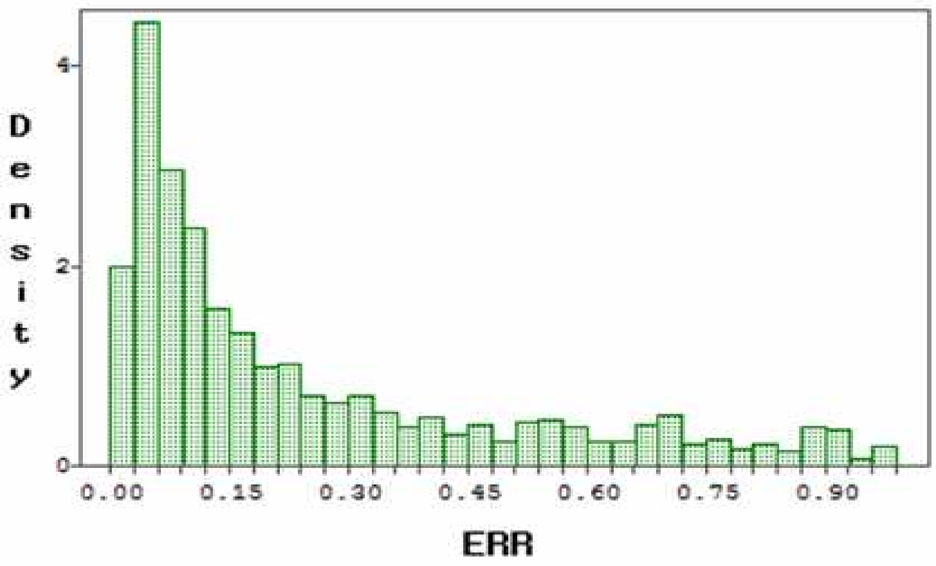
$$E(RR,x) = RR(1,x)*0.727 + RR(2,x)\,\frac{0.727*0.957*0.883}{1 - 0.883*0.946}$$

Results from modelling RR per month during a payment sequence (without characteristics)



Moments			
N	3783.0000	Sum Wgts	3783.0000
Mean	0.5855	Sum	2215.1181
Std Dev	1.3066	Variance	1.7071
Skewness	7.6018	Kurtosis	86.0319
USS	7753.3564	CSS	6456.3043
CV	223.1365	Std Mean	0.0212

Results from modelling RR per month during a payment sequence (with characteristics)



Moments			
N	1602.0000	Sum Wgts	1602.0000
Mean	0.5640	Sum	903.5087
Std Dev	0.7148	Variance	0.5110
Skewness	2.0178	Kurtosis	4.7956
USS	1327.6410	CSS	818.0730
CV	126.7449	Std Mean	0.0179

E(RR)=length(P1)*FARR*0.727 + lenghtP(2+)*SARR*0.727*0.95*0.85

Summary

- The payment patterns allow to predict the expected recovery rate of the loan after default
- Payment patterns models can be useful for not only predicting loss given default but also in the collection process (predicting income from defaulted loans).

Questions?

Thank you.

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