

# The impact of credit limit on credit card expenditure and risk of default or persistent debt

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# Introduction

- Credit cards offer customers the flexibility to substitute future consumption for current consumption and enable them to manage their income and expenditure shocks (FCA, 2018).
- **60.1 million** credit cards issued to UK residents by January 2019, with 337 million credit card transactions in January 2019 only, which **has risen by 7.3%** compared to January 2018 (UK Finance, 2019).
- Americans' credit card debt hit **\$1.0645 trillion** in April 2019 (Consumer Credit, 2019) while the total outstanding consumer credit lending in the UK was **£217 billion** at the end of April 2019 (UK Finance, 2019).



# Introduction

- Credit risk is the most **significant risk** to credit card lenders as borrowers may carry excessive balance over long period of time and may become unable to repay, particularly in times of an economic recession or personal catastrophic event (OCC, 2017).
- On the other hand, paid interest on credit card lending is a **source of significant value** to lenders.
- The **£12 billion** of **credit card spending** in the UK in July 2019 was 8.2 percent higher than in July 2018 and reached its highest level on record. The level of credit card borrowing grew by 3.8 percent in the year to July 2019. (UK Finance, 2019)



Critical decision:

→  
Extending  
**credit limit**

# Definitions

Financial Conduct Authority (FCA) published CP17/103\* in April 2017 and proposed new rules and guidance on the treatment of customers whose credit card debt persists over 18 to 36 months. In this consulting paper they identified four different arrears-based indicators of **potentially problematic credit card debts**:

- 1) Severe arrears:** Consumers whose debt amount is unlikely to be collected and have been charged-off.
- 2) Serious arrears:** Consumers who have missed three or more repayments.
- 3) Persistent debt:** Consumers that have an average credit limit utilisation of 90% or above over a calendar year are categorised as being in persistent debt. Alternative thresholds for defining persistent debt include a 50% or 75% utilisation rate.
- 4) Systematic minimum repayments:** The last arrears type are consumers that have made nine or more minimum repayments over the course of the year, while also incurring interest charges.



\* The Financial Conduct Authority (FCA), (2017).

*Credit card market study: consultation on persistent debt and earlier intervention remedies.* London: Consultation Paper.

# Definitions

The final rules and guidance on persistent credit card debt and earlier intervention have been published by FCA in the 'Policy Statement PS18/4' on February 2018, which has been in effect since 1<sup>st</sup> September 2018.

**Final definition of persistent debt:** Credit card holders who have been paying *more in interest, fees and charges than they have towards repaying their account balance for 18 months or more*, are classified as being in 'Persistent Debt'.

Firms need to identify customers in persistent debt, prompt them to change their repayment behaviour, put repayment plans in place where these prompts do not work, and intervene earlier to help customers showing signs of actual or possible financial difficulties (FCA, 2018).

- ❖ In our preliminary analysis, we have implemented different thresholds of credit utilisation over a calendar year to define the accounts in Persistent Debt.



# Motivation of this study

- ❖ The importance of accurate revenue prediction and lenders' interest in terms of profitability prediction
- ❖ The significance of optimal customer risk management
- ❖ The consequences of credit limit allocation strategy



# Objectives of this research

- ❖ To examine the impact of credit limit on credit card holders' purchasing amount, systematic minimum repayment behaviour, the risk of default and the risk of being in persistent debt
- ❖ To allow lenders to discover consumers' behaviour pattern and take required actions earlier
- ❖ To classify customers based on their credit behaviour and suggest policies of credit limit extension for each segment
- ❖ The first academic paper exploring systematic minimum repayment behaviour and forecasting the risk of persistent debt



## Report

Score is: 65

Rating: EXCELLENT

Summary

Excellent: 700 - 800  
Good: 501 - 700  
Fair: 351 - 500  
Uncertain: 301 - 350

Your Credit Score is: 765

Credit Rating: EXCELLENT

Report Summary

Tradeline Overview

|              |    |
|--------------|----|
| Total:       | 37 |
| Current:     | 32 |
| Overdue:     | 0  |
| Inst. Neg:   | 0  |
| Partial Neg: | 1  |

Account Status

|                   |            |
|-------------------|------------|
| Current Past Due: | 50         |
| Accts Paid:       | 1          |
| Account Balance:  | \$ 193,450 |
| Monthly Payment:  | \$1,842    |

# Data

- Credit card data provided by a major Hong Kong bank
- Period: 2002 to 2007 (Recession 2002 to 2004)
- For accounts in the sample, we randomly pick one month during the 12 months sampling period and then observe the outcome in the next 12 months. This could reduce the impact of seasonality
- Sample in Good year: 100,000+; Sample in Bad year: 48,000+
- Time 't' refers to the point of observation



## List of behavioural variables

| Variable Name                        | Description  |
|--------------------------------------|--|
| <b>Credit Limit</b>                  | Maximum amount of credit that the bank has offered to the customer (considered at time 't')  |
| <b>Credit Utilisation</b>            | The proportion of the credit limit that the customer uses at time t. It is calculated as 'Billed Balance' divided by 'Credit Limit' (calculated at time 't') |
| <b>Amount Paid on Last Statement</b> | The amount paid by the customer from the total amount of the last statement (measured at time 't')   |
| <b>Months on Book</b>                | The number of months that a customer is with the bank (calculated up to time 't')  |
| <b>Minimum payment amount</b>        | Minimum amount of money that the customer must pay each month (considered at time 't')   |
| <b>Behavioural Score</b>             | A numeric score that summarises the bank's experience with the customer (measured at time 't')   |
| <b>Billed cash balance flag</b>      | A binary variable that is measured at time 't' and shows if the customers are using cash from their credit (1) or not (0)                                    |
| <b>Delinquency flag</b>              | A binary variable that shows if the customer is missing the minimum payment amount at time 't' or not. Non-delinquent accounts (0), Delinquent accounts (1)  |

## List of application variables (measured at the time of application)

| Variable Name           | Description   |
|-------------------------|---|
| <b>Occupation</b>       | Customers have been categorised in 5 different types of jobs and a group of missing values  |
| <b>Residential type</b> | Different groups of Residential Type are: rent private, rent public, mortgage, owned, living with parents, company housing and others |
| <b>Age</b>              | Card holder's age which is divided into 4 groups of 'Under 30', 'Between 30–49', 'Between 50–65' and 'Over 65'                        |
| <b>Annual income</b>    | Customers are grouped based on their total annual income into Very low, Low, Medium, Above Medium and High income, and missing values |

## List of response variables in our developed models

| Variable                               | Description  |
|--|--|
| <b>Y1=Total purchase amount</b>        | accumulated total amount of consumers' credit spending over the next twelve months (t+12)  |
| <b>Y2=Default flag</b>                 | A binary variable that shows whether the consumers have missed minimum payments for 3+ months over the next 12 months (t+12) or they are in Bankruptcy status and therefore are in default; 0 otherwise (0.63% of accounts are in default).  |
| <b>Y3=Persistent Debt flag</b>         | A binary variable that shows whether the consumers credit utilisation over the next 12 months (t+12) is in the defined thresholds of FCA for persistent debt and therefore they are in persistent debt; 0 otherwise (4.59% of accounts are in persistent debt when using >50% threshold) |
| <b>Y4=Systematic minimum repayment</b> | A Binary variable that shows whether the customers have only paid minimum payment for +9 months during the next 12 months (t+12); 0 otherwise (0.46% of accounts are in Systematic minimum repayments)   |

# Models

**Model 1:** Simple Linear Regression (OLS) on credit spending (Y1)

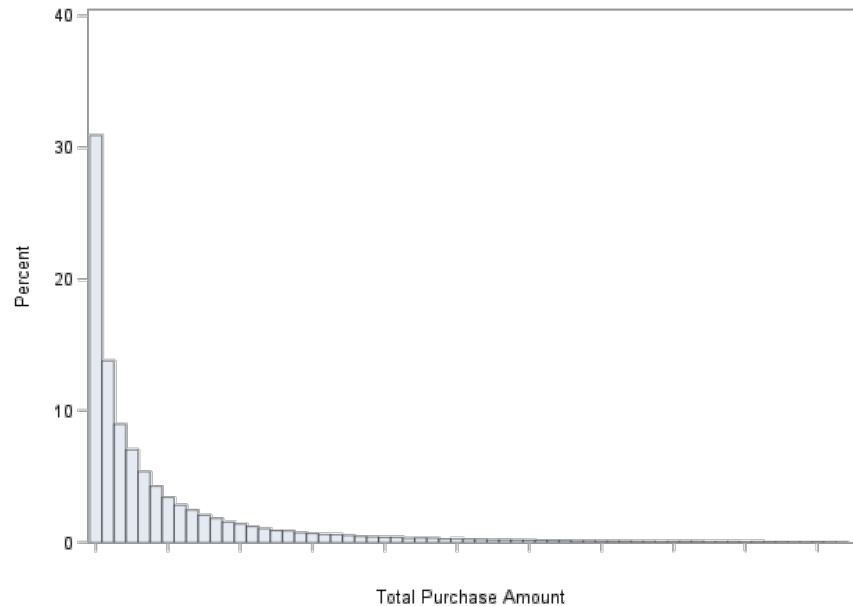
**Model 2:** Zero Adjusted Gamma Model (ZAGA) on credit spending (Y1)

We have selected Zero Adjusted Gamma Model (ZAGA) to deal with zero observations and as the Gamma distribution is the best fit for non-zero Y1 values.

**Model 3:** Logistic Regression for predicting the risk of default (Y2)

**Model 4:** Logistic regression for predicting the risk of persistent debt (Y3)

**Model 5:** Logistic regression for predicting the risk of systematic minimum repayment behaviour (Y4)



# Preliminary findings

| After recession                 | Coefficient estimates                                   |                                      |   |   |
|---------------------------------|---|--------------------------------------|---|---|
| Model component                 | Model 1 (OLS regression for credit spending estimation) | Model 3 (Logistic model for default) | Model 4 (Logistic model for persistent debt with 50% threshold) | Model 5 (Logistic model for systematic repayment) |
| Intercept                       | — ***   | + ***                                | + ***   | + ***   |
| Credit Utilisation              | + ***   | + ***                                | + ***   | + ***   |
| Credit Limit                    | + ***   | + ***                                | + ***   | + ***   |
| Minimum Payment                 | + ***   | — ***                                | — ***   | — ***   |
| Amount Paid on Last Statement   | + ***   | +                                    | —   | — ***   |
| Months on Book                  | — ***   | +                                    | + ***   | + ***   |
| Processed Behavioural score     | + ***   | — ***                                | — ***   | — ***   |
| Cash Balance -YES               | — ***   | + ***                                | + ***   | + ***   |
| Cash Balance-NO                 | .   | .                                    | .   | .   |
| Delinquent                      | +   | + ***                                | — ***   | — ***   |
| Not-Delinquent                  | .   | .                                    | .   | .   |
| Residential-Rent private        | + ***   | + ***                                | + ***   | + ***   |
| Residential-Rent public         | +   | +                                    | —   | —   |
| Residential-Mortgage            | —   | —                                    | +   | —   |
| Residential-Owned               | — ***   | — ***                                | — **  | —   |
| Residential-Living with parents | —   | —                                    | — **  | + ***   |
| Residential-Company housing     | —   | —                                    | +   | —   |
| Residential-Unknown             | .   | .                                    | .   | .   |

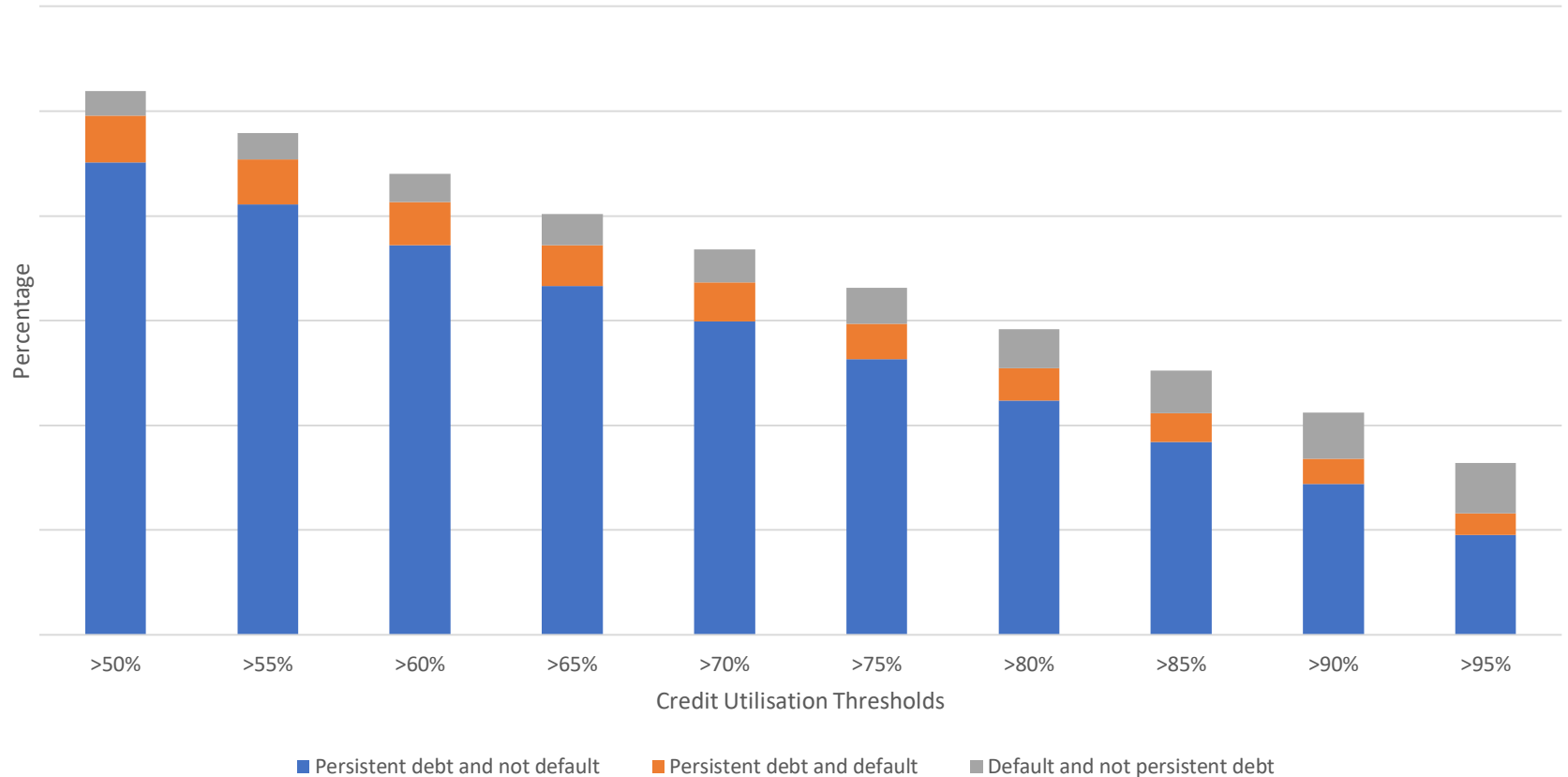
# Preliminary findings

| After recession            | Coefficient estimates                                   |                                      |   |   |
|----------------------------|---|--------------------------------------|---|---|
| Model component            | Model 1 (OLS regression for credit spending estimation) | Model 3 (Logistic model for default) | Model 4 (Logistic model for persistent debt with 50% threshold) | Model 5 (Logistic model for systematic repayment) |
| Occupation-G1              | +   | -                                    | -   | -   |
| Occupation-G2              | -   | ***                                  | ***   | -   |
| Occupation-G3              | + ***   | +                                    | +   | +***  |
| Occupation-G4              | + ***   | +                                    | +   | +   |
| Occupation-G5              | + ***   | +**                                  | +   | -   |
| Occupation-G6              | + ***   | +**                                  | +   | +   |
| Occupation-Unknown         | .   | .                                    | .   | .   |
| Age group 1-Under 30       | + ***   | +                                    | + ***   | -   |
| Age group 2- Between 30–49 | + ***   | +                                    | +   | +   |
| Age group 3- Between 50–65 | +   | +                                    | -   | +   |
| Age group 4- Over 65       | .   | .                                    | .   | .   |
| Income-Very low            | ***<br>-  | + ***                                | + ***   | +***  |
| Income- Low                | ***<br>-  | +                                    | + ***   | +***  |
| Income- Medium             | ***<br>-  | +                                    | +   | -   |
| Income- Above medium       | ***<br>-  | -                                    | +   | -   |
| Income- High               | + ***   | -                                    | **<br>-   | **<br>-   |
| Income- Unknown            | .   | .                                    | .   | .   |

# Persistent Debt vs Default

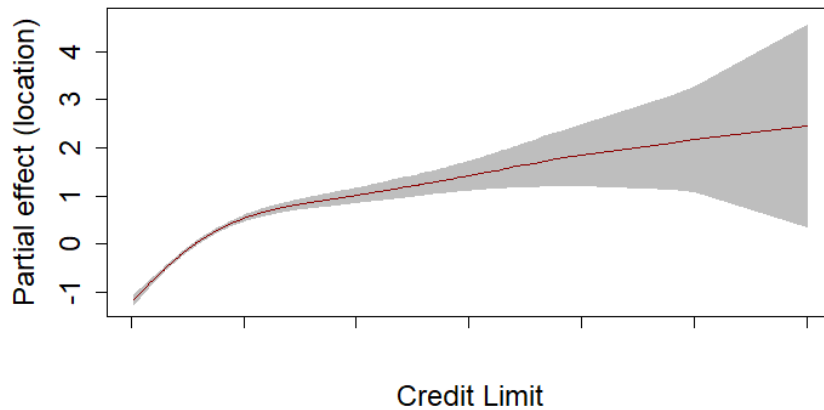
*Percentage of accounts in Persistent debt based on different thresholds of credit utilisation vs Percentage of accounts in default*

% of accounts in persistent debt vs in default

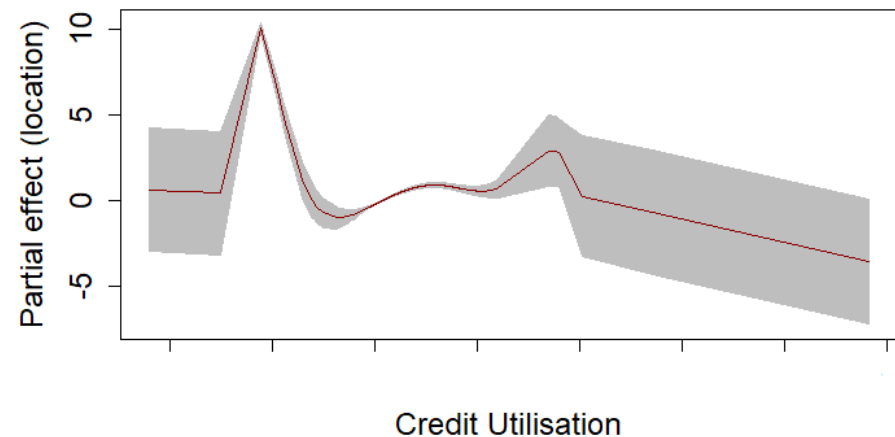


# Spline graphs

*Partial effects of credit limit and credit utilisation on the conditional mean of accumulated spending for the Zero Adjusted Gamma (ZAGA) model (Model2)*



Due to confidentiality, values on X axis are not shown



Used GAMLSS Package in R by  
(Stasinopoulos and Rigby,2007).

# Models Performance

- We have used 70% of the whole dataset as training and 30% out-of-sample observations to test the performance of our models.

- A ROC curve of 87%+ is obtained for our models which shows a high performance; we plan to further break down the performance according to different customer segments.



- 'Credit utilisation' strongly contributes to performance of these models.

# Key insights

- Both credit limit and credit utilisation have a positive significant impact on credit expenditure, risk of default and risk of persistent debt. Therefore, by increasing the credit limit, both profit and risk are expected to increase for the lender.



- Accurately quantifying profit and risk effects is important to understand the trade-off between both. Preliminary results show non-linearity should be taken into account here.
- Note that the impact of some of the predictors is different when predicting the risk of default than when predicting the risk of persistent debt. Moreover, by comparing the accounts in persistent debt vs in default, we realise that a fairly low percentage of persistent debt accounts are likely to be in default, too. This means that we cannot simply use the same model for predicting both types of risks.

# Future work

- ❑ In next steps of this study, we will include interaction effects of credit limit with other predictors in our models in order to develop credit limit extension strategies that consider different customer segments.
- ❑ We will implement the final definition of persistent debt to see how different definitions may lead to different classifications of customers in this dataset.
- ❑ We intend to verify how well our models work for different subgroups of accounts
- ❑ We will further analyse the systematic minimum repayment behaviour in our dataset and compare the results with other models
- ❑ We also aim to compare the consumers' credit behaviour during and after the recession by running our models on the 'bad year' dataset.

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Thank you for your attention

Any Questions?



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