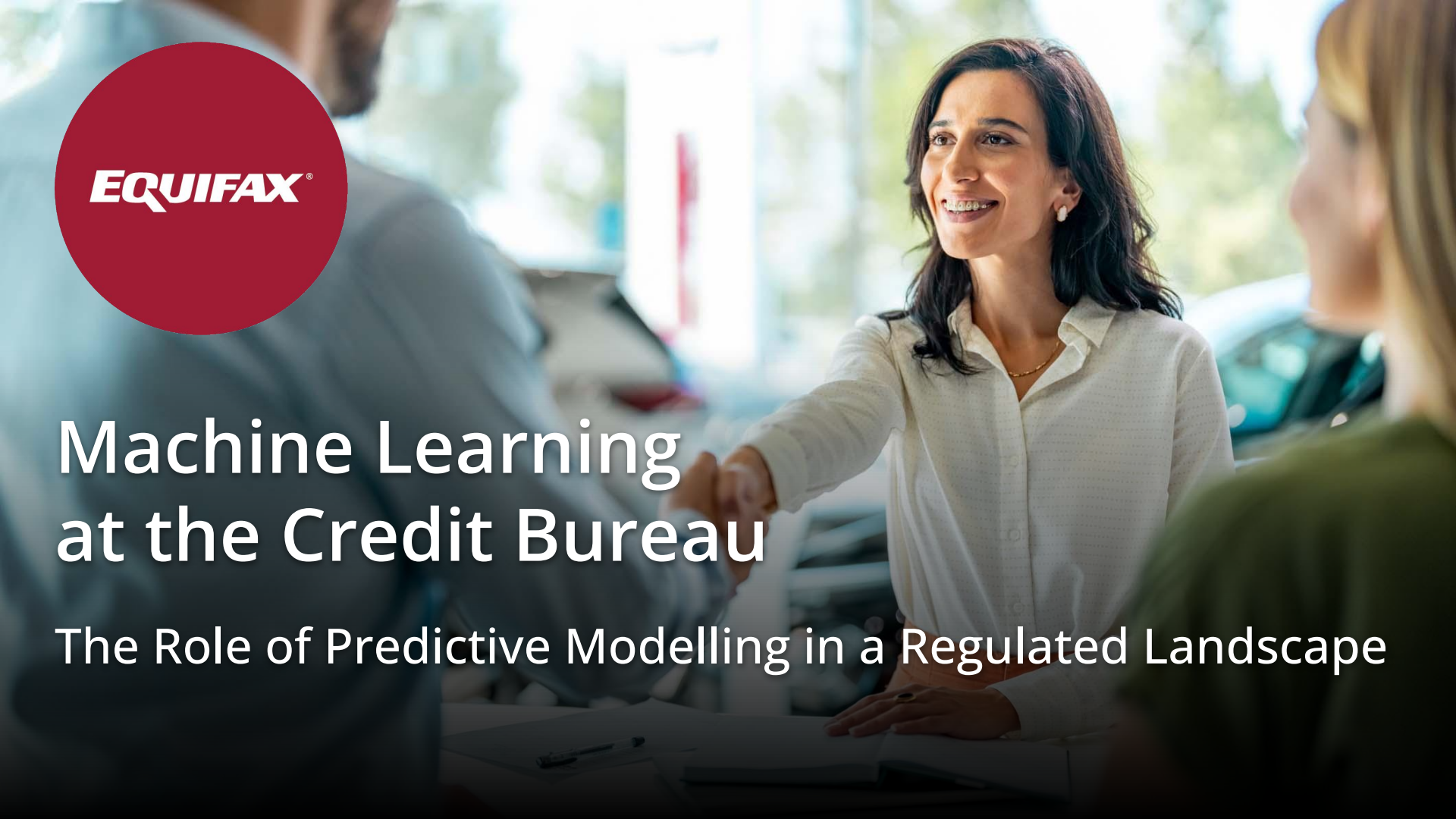


Machine Learning at the Credit Bureau

The Role of Predictive Modelling in a Regulated Landscape

Agenda...

From Credit Risk models to Affordability models

Affordability world tour!

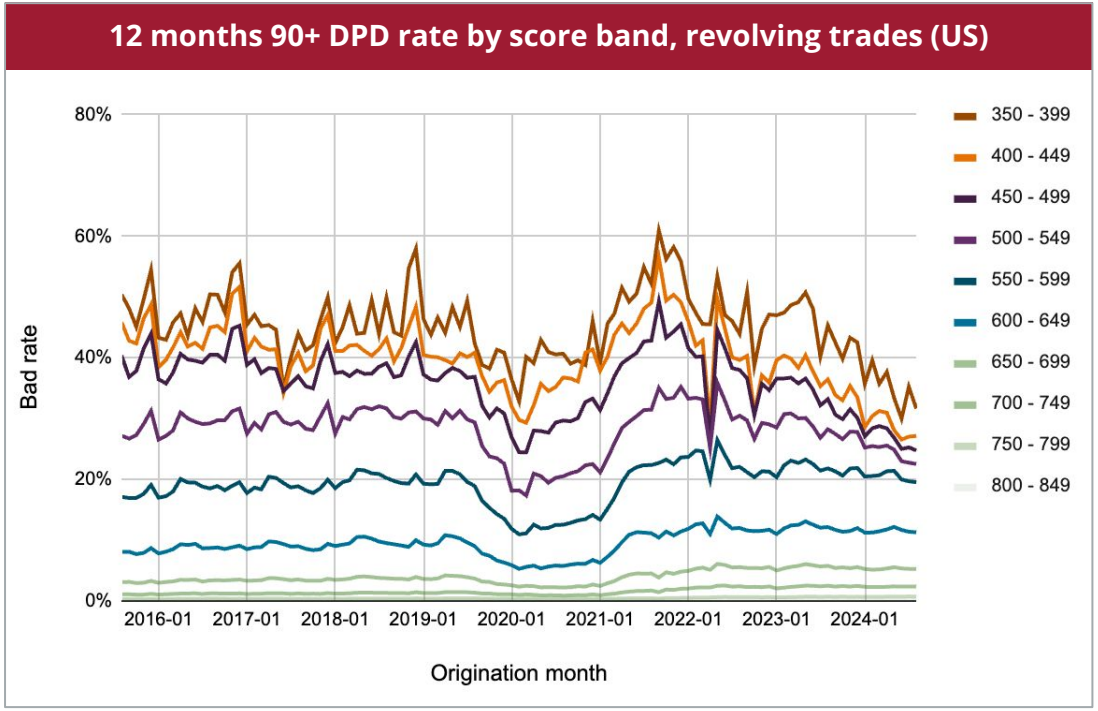
The firm must consider:

1. The risk that the customer will not make repayments under the agreement by their due dates (this is sometimes referred to as credit risk); and

2. The risk ***to the customer*** of not being able to make repayments under the agreement ... (referred to as 'affordability risk' in this section).

- FCA CONC (UK) 5.2A

All (credit) models are wrong…



Model

P(good) = f(score)

Reality

Seasonality

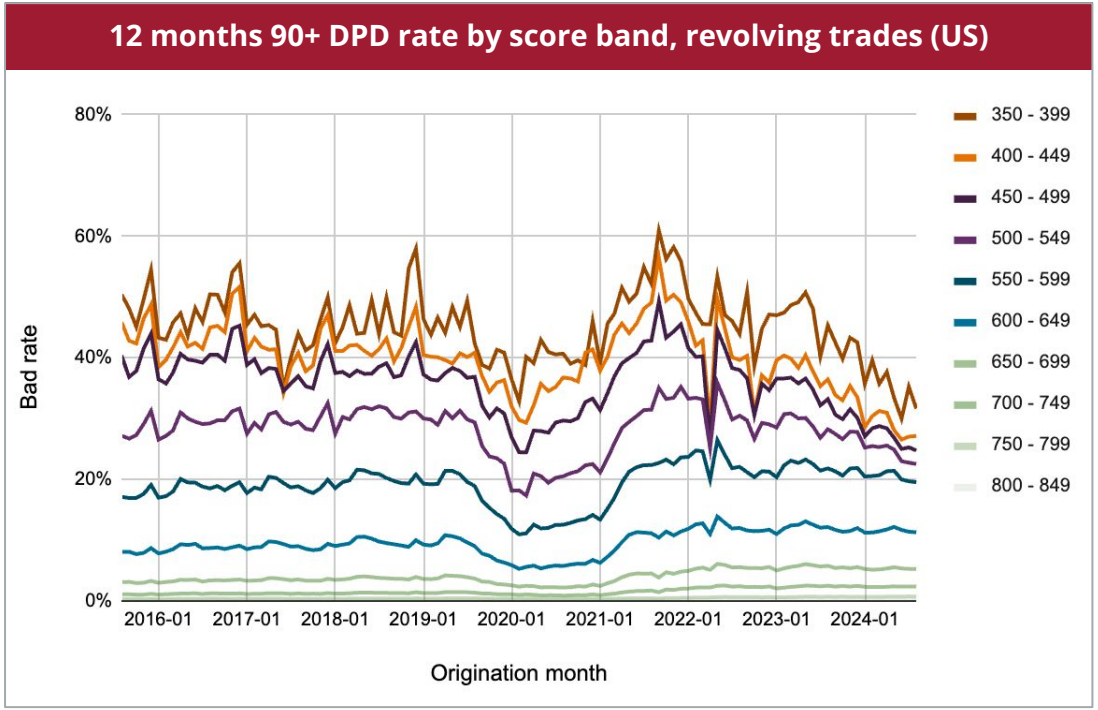
Drift

Interaction

All models are wrong.
Some models are useful.

- George Box

We *do* have an error model



Logistic regression

$$V_i = \beta \cdot X_i$$

$$Y_i = I[V_i + \varepsilon_i > 0]$$

$$P(Y_i=1) = \text{sigmoid}(\beta \cdot X_i)$$

Most credit risk models

$$V_i = f(X_i)$$

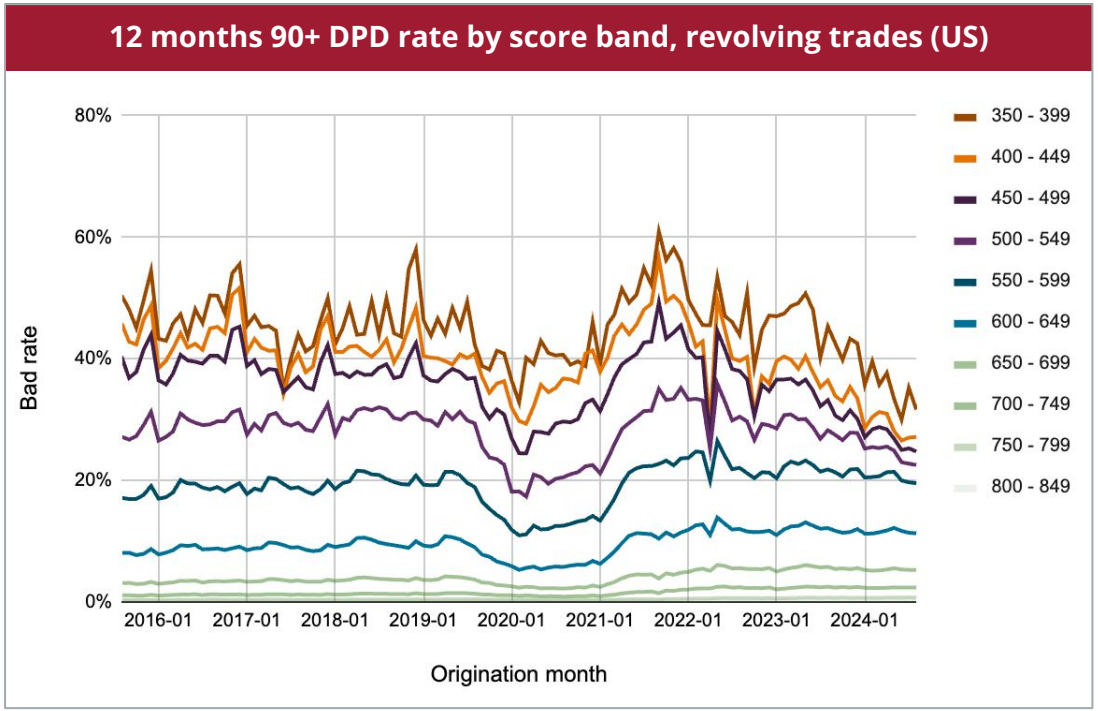
$$Y_i = I[V_i + \varepsilon_i > 0]$$

$$P(Y_i=1) = \text{sigmoid}(f(X_i))$$

$$\varepsilon_i \sim \text{IID Logistic}(0,1)$$

What's "wrong" with this model?

Errors are correlated over time



Slightly improved model

$$V_i = f(X_i) + g_{t(i)}$$

$$g_t \sim GP(\mu, K)$$

$$P(Y_i=1) = \text{sigmoid}(f(X_i) + g_{t(i)})$$

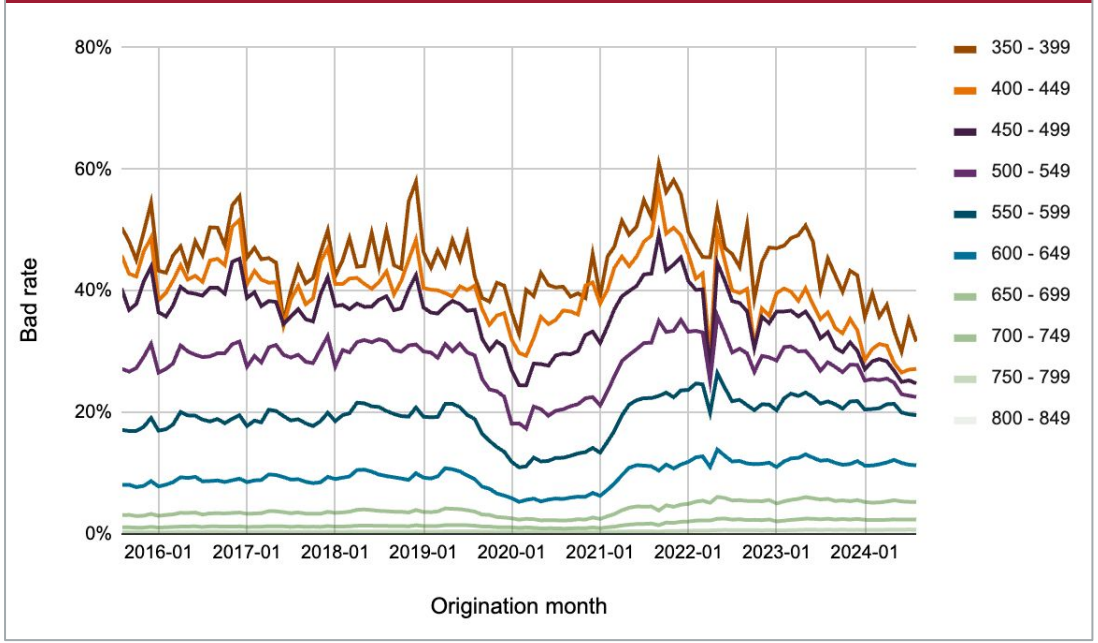
Individual term

+

Correlated random time effect

…but not completely unpredictable

12 months 90+ DPD rate by score band, revolving trades (US)



Improved model

$$V_i = f(X_i) + g(W_{t(i)})$$

$$P(Y_i=1) = \text{sigmoid}(f(X_i) + g(W_{t(i)}))$$

Individual term

+

Macroeconomic term

e.g. CPI, House Price Index, Unemployment, Bond Yields

So which model is *useful*?

Credit score

- Depends only on credit file information
- Consistently *ranks* risk
- Bad rates by score vary over time

Probability of Default (PD)

- Driven by macro indicators
- Predicts bad rates in absolute terms
- Suitable for scenario/stress testing

You were declined for credit because…

- It's December?
- Unemployment forecasts are up?

1. A creditor must disclose the principal reasons for denying an application or taking other adverse action.

2. The specific reasons disclosed … must relate to and accurately describe the factors actually considered or scored by a creditor.

- ECOA (USA) - Comment for 1002.9 - Notifications

Measuring macroeconomic sensitivity

Adding macros to the credit score

Selected indicators of macro sensitivity

- Number of past due accounts
- Third party collections
- Number of searches (24m)
- Number of revolving trades with balance
- Age of mortgage

Simple example: difference of two scores

Sensitivity score = Baseline score - Downturn score
W = 0 or 1

Sensitivity model

$$V_i = f(X_i) + g(W_{t(i)})h(X_i)$$

Individual term

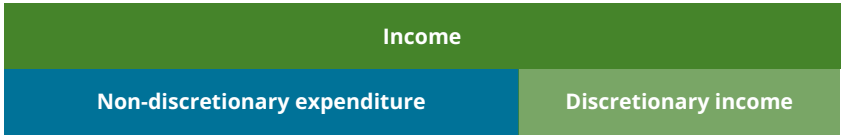
+

Macroeconomic interaction

Use cases

- Decision matrix
- Risk based pricing
- Limit management

Can affordability models be wrong?



Discretionary income := income - non-discretionary expenditure

The firm must:

1. Consider the risk that the customer will not make repayments under the agreement by their due dates (this is sometimes referred to as credit risk); and

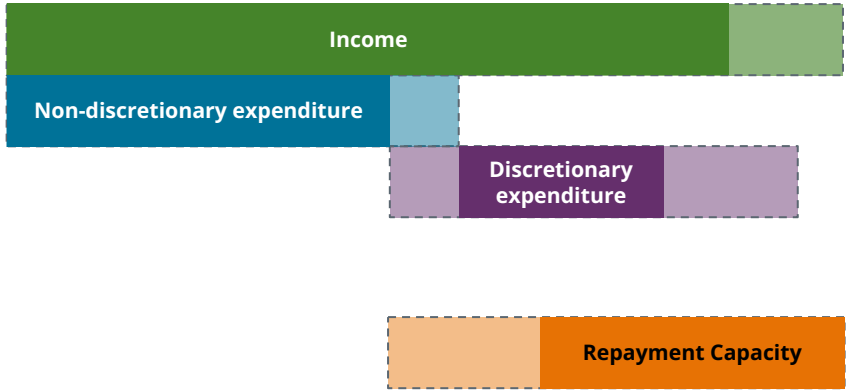
2. Consider the risk ***to the customer*** of not being able to make repayments under the agreement … (referred to as 'affordability risk' in this section).

3. Take reasonable steps to determine the amount, or make a reasonable estimate, of the customer's *current income*.

4. Take reasonable steps to determine the amount, or make a reasonable estimate, of the customer's *current non-discretionary expenditure*.

- FCA CONC (UK) 5.2A

Making affordability a statistical model



The firm must:

consider the customer's ability to make repayments under the agreement:
...
(3) without the customer having to borrow to meet the repayments;
(4) without failing to make any other payment the customer has a contractual or statutory obligation to make; and
(5) without the repayments having a ***significant adverse impact*** on the customer's financial situation.

- FCA CONC (UK) 5.2A

Repayment Capacity := The maximum incremental repayment a consumer can take on without adverse impact

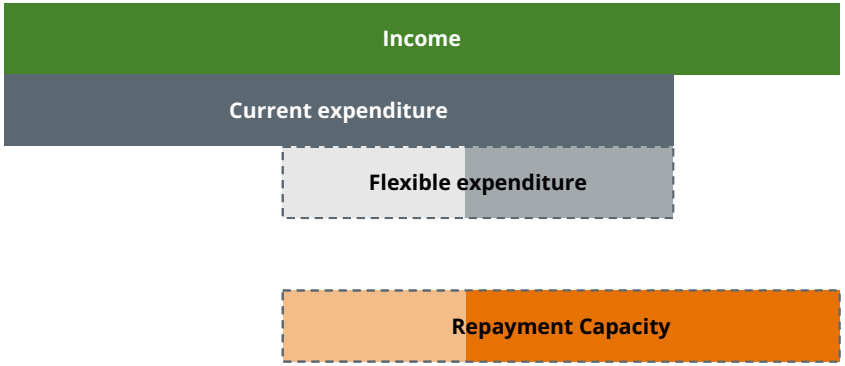
$$Y = I[\text{Capacity} \geq \text{Repayment}]$$

$$\text{Capacity} = \text{Capacity estimate} + \varepsilon$$

Some signs of adverse impact

- Missed payments on any account
- High cost borrowing
- Increasing revolving balance/interest
- New collections/judgment/insolvency
- Indebtedness score

Australia - full income & expenditure review



Verified income & expenditure
⇒ Little scope for error?

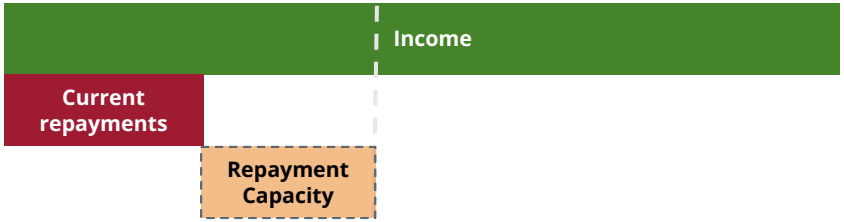
Capacity estimate =
Income
- current expenditure
+ *flexible expenditure estimate*

1 Information about the consumer's ***current outgoings***, and reasonably foreseeable changes to those outgoings, will help you to determine:
(a) how much of the consumer's income is likely to be available for meeting new financial obligations; and
(b) if there is a shortfall, whether the consumer is likely to be ***able and willing*** to ***reduce some expenditure*** to meet the new financial obligations.

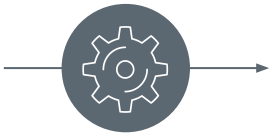
2 We recognise that there are different kinds of outgoings, and that ***some are likely to be more important than others for the consumer you are dealing with***. You are likely to need enough information to determine how much of the consumer's income is, and will continue to be, needed for outgoings the consumer is unable or unwilling to reduce or forego.

- ASIC Regulatory Guide 209

USA - Debt to Income (sometimes)



Income/proxies
Repayments
Expenditure proxies
Indebtedness indicators



Capacity estimate

1

... the creditor must consider the consumer's ***monthly debt-to-income ratio***, or the consumer's ***monthly residual income***, in accordance with the requirements in [...].

[...] does not prescribe a specific monthly debt-to-income ratio with which creditors must comply.

- Comment for Reg Z 1026.43 Minimum Standards for Transactions Secured by a Dwelling

2

Section 1026.51(a) requires a card issuer to consider a consumer's ability to make the required minimum periodic payments under the terms of an account based on the consumer's ***income or assets*** and ***current obligations***. The card issuer may also consider consumer reports, credit scores, and other factors, consistent with Regulation B (...).

- Comment for Reg Z 1026.51 Ability To Pay (credit cards)

Affordability without income?

Loan amounts
Mortgage payments
Revolving limits

Scheduled payments
Revolving balance
Actual payments

Available credit

Utilization
Delinquency
Collections
Inquiries

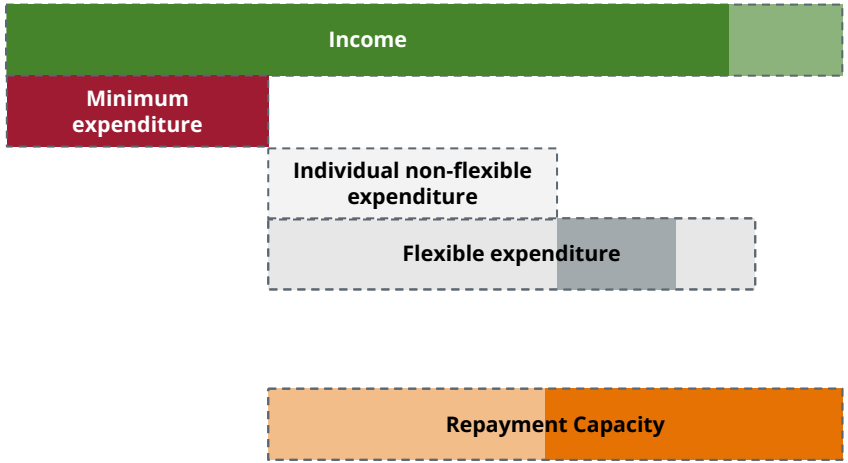
Challenges

- Reliance on existing income checks
- Double counting income vs expenditure
- Feedback effects
- Missing information
- Affordability/risk distinction

We can build a well-calibrated, explainable repayment capacity model without income, that adds ranking power to an industry standard credit score.

- A Parametric Machine Learning Approach to Affordability (Turner and Miller CSCC 2025)

UK - income verification, expenditure statistics



Capacity estimate =
Income estimate
- minimum expenditure
- *individual non-flexible expenditure estimate*

1. An estimate of the customer's income may include a minimum amount or a range, provided that any assumptions on which the estimate is based are reasonable in the circumstances.

   - CONC 5.2A.16

2. For the purpose of considering the customer's non-discretionary expenditure ..., the firm may take into account statistical data unless it knows or has reasonable cause to suspect that the customer's non-discretionary expenditure is significantly higher than that described in the data or that the data are unlikely to be reasonably representative of the customer's situation.

   - CONC 5.2A.19

A couple of additional challenges

This looks a little like a … *risk* model

- Risk team

Measure your outcomes

Indicators of financial distress
Reject reference
Control for income shock

1

The typical information we would normally expect to see about this type of complaint includes:

- application form completed by the customer and any pre contract documents
- credit file results obtained at the time of approving the lending
- details of income information obtained, and any documents used to verify income such as payslips or bank statements
- any income and expenditure checks completed at the time of the application
- a statement of account including payment history and the current position

- UK Financial Ombudsman guidance to businesses

Predictive Modelling in a Regulated Landscape

- **Statistical frameworks are still important**
  - Explaining a black box is not the end goal of xAI
- **Model assumptions are important**
  - ...and should be appropriate to the task
  - credit scoring/stress testing/affordability assessment
- **Model targets depend on the environment**
  - Knowns vs unknowns and regulatory requirements
- **The goal is to make better lending decisions**
  - We have the tools. Measure your outcomes!

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