

A good sketch is better than a long speech: evaluate delinquency risk through real-time video analysis

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Research background

- Limitations of Traditional Credit Assessment:
 - Relies on **historical data** (credit scores, digital footprints).
 - Not useful for first-time borrowers or those with minimal financial history.
 - Over 2.5 billion adults **lack bank accounts**.
 - Only 7% of adults in developing countries have **credit cards**.
 - **Limited credit access** exacerbates poverty and inequality.
- Emerging Alternative: Real-Time Video Analysis
 - Captures borrowers' micro-facial expressions during loan applications.
 - Offers new insights into financial stress and confidence.

Motivation

- Traditional Credit Evaluation Constraints:
 - Credit history may be missing, inaccurate, or outdated.
 - Conventional methods fail to assess **real-time financial situations**.
- Micro-Facial Expressions as a New Data Source:
 - Reveals unconscious emotional cues related to financial stress.
 - Can indicate borrowers' **ability** and **willingness** to repay loans.
 - Income adequacy channel & income uncertainty channel
- Advancements in Machine Learning and Fintech:
 - Real-time video processing enables large-scale **facial analysis**.
 - Fintech firms are seeking innovative credit assessment tools.

Contribution

- Existing Studies on Credit Assessment:
 - Traditional Methods: Rely on credit scores, digital footprints, and demographic data.
 - Behavioral Economics: Studies on borrower psychology and default risk.
- This Study:
 - Introduces **real-time video analysis** to predict loan delinquency.
 - Explores the **unconscious nature of micro-facial expressions**.
 - Provides empirical evidence using machine learning on fintech lending data.

Contribution

- Existing studies on video analysis and facial information
 - CEO's presentation and interview are informative to investors
 - Photos of borrowers/ managers/ analysts/ investors
- This paper:
 - The application of video analysis of individual borrowers in credit markets

Contribution

- Existing studies on alternative data
 - Useful to investors
 - Satellite image/customer transactions/ opinions/ mobile / real-time sales
 - These data can impact managerial insider trading behavior and disclosure decisions
- This paper:
 - New evidence on borrowers' alternative data to fintech lender

Hypothesis development

- Happiness is associated with financial well-being and lower uncertainty.
- Psychological basis: Positive affect is linked to better self-control and responsible financial decision-making.
- **H1:** The extent of borrowers' happiness facial expressions during the application process is negatively associated with future loan delinquency likelihood.

Hypothesis development

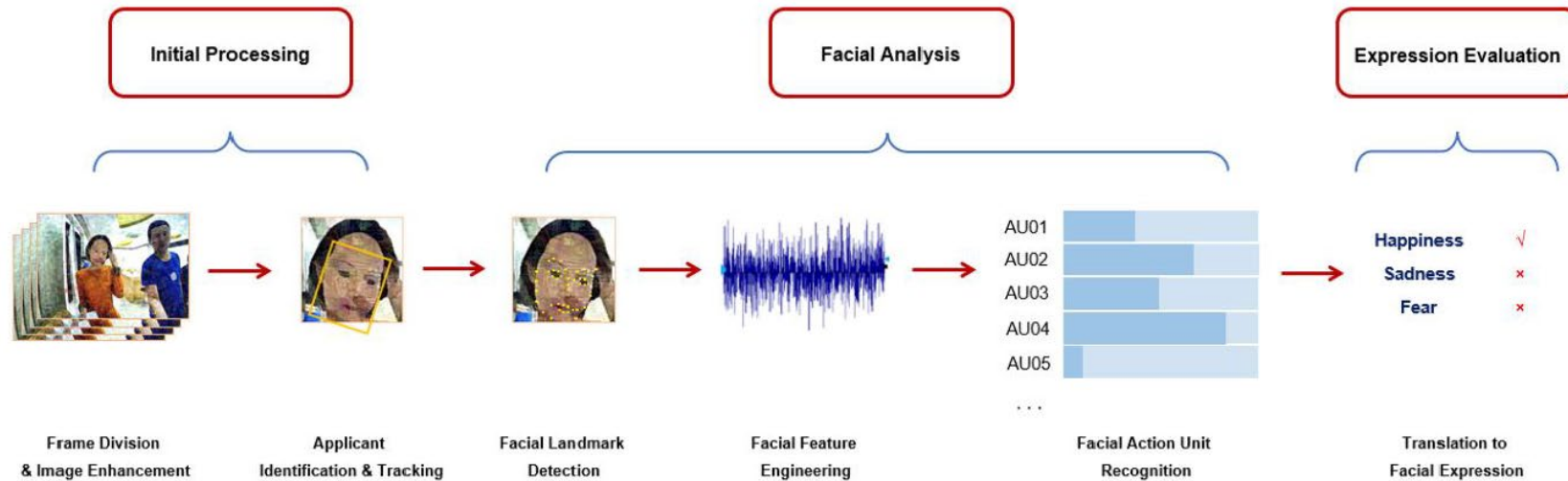
- Fear signals financial instability and higher income uncertainty. In capital markets, fear usually refers to the perceived volatility and risk of financial transactions
- Fearful borrowers face greater difficulty making timely loan repayments.
- **H2:** The extent of borrowers' **fear** facial expressions during the application process is positively associated with future loan delinquency likelihood.

Loan application procedures

- **Step 1: Loan Application Submission**
 - Borrowers apply via fintech terminals installed in retail stores.
 - They provide identification and necessary personal details.
- **Step 2: Video Recording During Application**
 - Borrowers' facial expressions and behaviors are captured.
 - Video recording is conducted with borrower consent.
 - The recording period typically lasts up to **5 minutes**.
- **Step 3: Credit Assessment and Approval Decision**
 - **Fintech firm evaluates borrower creditworthiness using internal credit scores.**
 - Borrowers receive approval or rejection within minutes.
 - Facial expression data is not used in the current assessment process.
- **Step 4: Loan Disbursement and Repayment**

Research design

- Data Source:
 - Proprietary dataset from a leading Chinese fintech firm.
 - 4,956 loan application video clips (2017-2019).
 - Applicants' facial expressions recorded during loan applications.
- Methodology:
 - **Step 1: Video Preprocessing**
 - Extracts **individual video frames** (10-30 frames per second).
 - Enhances image quality for accurate facial recognition.
 - Identifies and isolates borrower's face from background noise.
 - **Step 2: Facial Feature Detection**
 - Uses OpenFace 2.0 for detecting facial landmarks.
 - Tracks facial muscle movements (Facial Action Units - AUs).
 - Focuses on micro-expressions of **happiness and fear**.






• Step 3: Expression Classification

- Applies the Facial Action Coding System (FACS).
- Happiness: AU6 (cheek raiser) & AU12 (lip corner puller).
- Sad: AU1 (inner brow raiser), AU4 (brow lowerer), and AU15 (lip stretcher).
- Fear: AU1, 2, 4, 5, 7, 20, 26

• Step 4: Feature Extraction for Prediction

- Calculates percentage of video frames containing happiness or fear expressions.
- Distinguishes between macro and micro-expressions (lasting less than 0.5 seconds).

• Step 5: Empirical Validation

Emotion	AU Descriptions	AU Examples
Happiness	AU6, Cheek raiser	
	AU12, Lip corner puller	
Sadness	AU1, Inner brow raiser	
	AU4, Brow lowerer	
	AU15, Lip corner depressor	
Fear	AU1, Inner brow raiser	
	AU2, Outer brow raiser	
	AU4, Brow lowerer	
	AU5, Upper lid raiser	

Research design

$$\bullet \text{ Happiness} = \frac{\#happy - \#sad}{\#total \text{ frame}} \quad \text{Fear} = \frac{\#fear}{\#total \text{ frame}}$$

- Control variable:

- creditworthiness metric
 - Credit score
- borrower's personal characteristics
 - Age/Gender/History loans
- loan contract characteristics
 - Amount/Rate

- Logistic model

$$\text{Delinquency} = \alpha + \beta_{FE} \times \text{Facial Expression} + \beta_{Control} \times \text{Control Variables} + \beta_{FE} \text{Fixed Effects} + \epsilon,$$

Main results

	<i>Delinquency</i>				
	(1)	(2)	(3)	(4)	(5)
<i>Happiness</i>		−0.777*** (−5.861)		−0.797*** (−5.926)	−0.831*** (−6.406)
<i>Fear</i>		0.703*** (3.055)		0.624*** (2.597)	0.688*** (3.081)
<i>Score</i>	1.324*** (9.057)	1.281*** (8.818)	1.226*** (8.219)	1.190*** (8.041)	1.229*** (8.534)
<i>Age</i>			0.265* (1.754)	0.338** (2.436)	0.341** (2.193)
<i>Gender</i>			−0.068 (−0.572)	−0.082 (−0.742)	−0.037 (−0.329)
<i>History</i>			0.184* (1.774)	0.206** (1.995)	0.219** (2.074)
<i>Amount</i>			−0.327*** (−5.241)	−0.306*** (−5.273)	−0.314*** (−5.290)
<i>Rate</i>			0.053 (0.099)	0.144 (0.268)	0.050 (0.090)
Province Fixed Effect	No	No	No	No	Yes
Year Fixed Effect	No	No	No	No	Yes
Observations	4,956	4,956	4,956	4,956	4,956
Pseudo-R ²	0.023	0.036	0.032	0.045	0.066
AUC	0.605	0.627	0.626	0.647	0.670

Main result

- Out-of-sample:

	In-sample	Out-of-sample
	(1)	(2)
AUC _{Score}	0.605	0.604
Observations	4,956	4,956
AUC _{Score+Happiness+Fear}	0.627	0.625
Observations	4,956	4,956
AUC _{Score+ Controls}	0.626	0.620
Observations	4,956	4,956
AUC _{Score+Happiness+Fear+ Controls}	0.647	0.639
Observations	4,956	4,956
AUC _{Score+Happiness+Fear+ Controls + Fixed Effects}	0.670	0.641
Observations	4,956	4,956

Robustness and additional results

- Alternative delinquency definitions: Examines different measures of default severity (e.g., frequency, value).
- Alternative facial expression metrics: full length of video, post-, max.
- Subsample analyses: Tests consistency across different borrower groups (e.g., male vs. female).
- Time-period validation: Confirms stability of results across different loan application periods.
- Controlling exogenous factors about facial expression
- Other type of expressions: Anger, surprise, disgust
- Cross-province analyses

Conclusion

- This study adopts a machine-learning-based video analysis to evaluate borrowers' creditworthiness in the consumer credit market.
- The findings suggest that borrowers' micro-facial expressions during the loan application process identified in real-time video data are associated with their future delinquency likelihood.

Further discussion

- Multimodal behavioral analysis:
 - Combine facial expressions with **voice tone, speech patterns, and linguistic cues** from loan applicants.
- Facial Expressions and Corporate Financial Decision-Making
 - Apply facial expression analysis to **corporate executives**
 - Investigate whether CEOs/CFOs exhibiting micro-expressions of fear or stress predict **financial misreporting, stock price declines, or earnings surprises.**
- Facial Expressions and Policy Reaction
 - Apply facial expression analysis to authorities when disclosing policies