

# **Case Study: The Impact of Mobile Phone Usage on Borrowing Behavior and Indebtedness in Indonesia**

## **1. Introduction**

The rapid adoption of mobile phones and digital financial services has transformed financial behavior worldwide. In Indonesia, where mobile penetration is high, digital finance has become an essential tool for accessing credit, savings, and payments. However, increased access to financial services via mobile phones may influence borrowing behavior and lead to heightened indebtedness. This study aims to investigate the impact of mobile phone usage on borrowing behavior and indebtedness among individuals in Indonesia using survey data.

## **2. Research Objectives**

- To analyze the relationship between mobile phone ownership and borrowing behavior.
- To examine the role of digital financial services in shaping borrowing patterns.
- To assess the extent to which mobile phone usage influences financial decision-making and indebtedness.
- To explore demographic differences in financial behavior related to mobile technology adoption.

## **3. Data and Key Variables**

The study will utilize individual-level survey data incorporating demographic, financial access, and technology-related variables. Key variables include:

### **Demographic Variables:**

- Respondent\_Female (Respondent is female)
- Age (Respondent age)
- Education\_Level (Respondent education level)
- Income\_Quintile (Within-economy household income quintile)
- Employment\_Status (Respondent is in the workforce)
- Rural\_Residence (Respondent lives in a rural area)

### **Financial Access & Usage:**

- Has\_Account (Has an account)
- Has\_Financial\_Institution\_Account (Has an account at a financial institution)
- Has\_Mobile\_Money\_Account (Has a mobile money account)
- Mobile\_Access\_Account (Used a mobile phone or internet to access an account)

- Mobile\_Check\_Balance (Used a mobile phone or internet to check account balance)
- Has\_Credit\_Card (Has a credit card)
- Used\_Credit\_Card (Used a credit card)
- Used\_Credit\_Card\_Instore (Used a credit card in-store)
- Paid\_Credit\_Card\_Full (Paid credit card balances in full)
- Borrowed\_Mobile\_Money (Used a mobile money account to borrow money)
- Borrowed\_Financial\_Institution (Borrowed from a financial institution)
- Borrowed\_Medical\_Purpose (Borrowed for medical purposes)
- Borrowed\_Family\_Friends (Borrowed from family or friends)
- Borrowed\_Savings\_Club (Borrowed from an informal savings club)
- Borrowed (Borrowed in the past year)
- Main\_Source\_Emergency\_Funds (Main source of emergency funds in 30 days)
- Difficulty\_Emergency\_Funds (Difficulty of emergency funds in 30 days)

### **Technology & Digital Finance:**

- Owns\_Mobile\_Phone (Owns a mobile phone)
- Internet\_Access (Internet access)
- Made\_Digital\_Payment (Made or received a digital payment)
- Digital\_Merchant\_Payment (Made a digital merchant payment)

## **4. Methodology**

- **Descriptive Analysis:** Summarize borrowing behavior, indebtedness, and mobile phone usage trends by demographic groups.
- **Regression Analysis:** Use logistic and linear regression models to identify the impact of mobile phone usage on borrowing behavior and indebtedness, controlling for demographic and economic factors.
- **Instrumental Variable Approach:** To address endogeneity concerns, leverage exogenous variations in mobile phone access (e.g., network coverage expansions).
- **Robustness Checks:** Conduct sensitivity analysis, alternative model specifications, and sub-group analyses.

## **5. Expected Contributions**

- Provide empirical evidence on the link between mobile technology adoption and borrowing behavior in Indonesia.
- Inform policymakers and financial institutions about potential risks associated with digital financial inclusion.
- Contribute to the broader literature on financial access, digital finance, and economic well-being in developing economies.

## 6. Policy Implications

Findings from this study can guide policy decisions on digital financial literacy programs, consumer protection regulations, and the design of responsible lending practices in the mobile finance sector.

## 7. Data Analysis Result

### 7.1 Examines whether mobile ownership is related to borrowing behavior

```
tabulate owns_mobile_phone borrowed_binary, chi2
```

Owns a mobile phone	borrowed_binary		Total
	0	1	
yes	493	312	805
no	174	79	253
(dk)	1	0	1
(ref)	3	0	3
Total	671	391	1,062

```
Pearson chi2(3) = 7.0349  Pr = 0.071
```

This table examines whether **owning a mobile phone** is related to **borrowing behavior**.

---

### 1. Understanding the Table

- The **rows** show whether a person **owns a mobile phone** (Yes, No, Don't Know (dk), or Refused (ref)).
- The **columns** show whether the person **borrowed money (1)** or **did not borrow (0)** in the past year.
- The **total number of respondents is 1,062**.
- Among those who own a mobile phone:
  - **493 people** did not borrow money.
  - **312 people** borrowed money.
- Among those who **do not** own a mobile phone:
  - **174 people** did not borrow.
  - **79 people** borrowed.
- Very few respondents answered "**don't know**" (**1 person**) or "**refused**" (**3 people**), so these categories are not very meaningful.

## 2. The Pearson chi<sup>2</sup> Test

The chi<sup>2</sup> test checks if there's a significant relationship between mobile phone ownership and borrowing.

- The **chi<sup>2</sup> value = 7.0349**
- The **p-value (Pr = 0.071)** is **above 0.05**, meaning the result is **not statistically significant**.
- A **p-value below 0.05** would indicate a strong statistical relationship, but since **0.071 is slightly above**, we **cannot confidently conclude that mobile phone ownership influences borrowing behavior**.

## 3. What This Means

- People **who own a mobile phone appear to borrow more often** than those who don't (312 vs. 79).
- However, since the **p-value is 0.071**, we **cannot be fully certain** that this difference is meaningful—it might be due to chance.
- If the p-value were lower (e.g., **below 0.05**), we could say that mobile phone ownership **has a statistically significant effect on borrowing behavior**.

## 4. Next Steps

- Since the relationship is **close to significance (p = 0.071)**, we should explore further using **regression analysis** to check if mobile phone ownership **still affects borrowing after controlling for income, education, and other factors**.
- A larger sample size or more detailed data may provide clearer evidence.

### 7.2 Examines whether internet access is related to borrowing behavior

. tabulate borrowed_binary internet_access, chi2				
borrowed_binary	Internet access			Total
	yes	no	(dk)	
0	335	335	1	671
1	224	167	0	391
Total	559	502	1	1,062

Pearson chi2(2) = 5.8478 Pr = 0.054

This table examines whether **internet access** is related to **borrowing behavior**.

---

## 1. Understanding the Table

- The rows show whether a person **borrowed money (1)** or **did not borrow (0)**.
- The columns show whether the person **has internet access (yes, no, or don't know)**.
- The **total number of respondents is 1,062**.
- Among those with internet access:
  - **335 people** did not borrow money.
  - **224 people** borrowed money.
- Among those without internet access:
  - **335 people** did not borrow.
  - **167 people** borrowed.
- Only 1 person answered "**don't know**" (dk), so this category is not very meaningful.

## 2. The Pearson chi<sup>2</sup> Test

- The **chi<sup>2</sup> value = 5.8478**
- The **p-value (Pr = 0.054)** is slightly above 0.05, meaning the result is **borderline significant**.
- A p-value below 0.05 typically means there is strong statistical evidence of a relationship, but since **0.054 is very close**, it suggests a weak or marginal relationship.

## 3. What This Means

- There **might** be a connection between internet access and borrowing behavior, but it's **not strongly significant**.
- People with internet access **appear slightly more likely** to borrow money, but we **can't be fully confident** that this pattern isn't due to chance.

## 4. Next Steps

- To confirm the relationship, we could analyze more data or use **regression analysis** to control for other factors like age, income, and employment.
- If the p-value had been below 0.05, we could confidently say that internet access **influences borrowing behavior**. But in this case, the effect is weak.

### 7.3 Examines correlation between internet access, mobile ownership and borrowing behavior

```
. /* Step 9: Correlation Matrix */
. pwcorr borrowed_binary owns_mobile_phone internet_access, sig
```

	borro~ry	owns_m~e	intern~s
borrowed_b~y	<b>1.0000</b>		
owns_mobil~e	-0.0783	<b>1.0000</b>	
internet_a~s	-0.0723	0.5208	<b>1.0000</b>
	0.0106	0.0185	0.0000

This table shows the **correlation** between three variables:

1. **Borrowing Behavior (borrowed\_binary)** – Whether a person borrowed money (1 = Yes, 0 = No).
  2. **Owes a Mobile Phone (owns\_mobile\_phone)** – Whether a person owns a mobile phone (1 = Yes, 0 = No).
  3. **Internet Access (internet\_access)** – Whether a person has internet access (1 = Yes, 0 = No).
- 

#### 1. Understanding the Table

- The values in the table represent **correlation coefficients (r values)** between the variables.
- The **closer r is to 1 or -1**, the stronger the relationship:
  - **Positive values** → as one variable increases, the other tends to increase.
  - **Negative values** → as one variable increases, the other tends to decrease.
  - **Values near 0** → weak or no relationship.
- Below each correlation coefficient is the **p-value**, which tells us if the correlation is statistically significant (**p < 0.05 is considered significant**).

#### 2. Key Findings

Variable Pair	Correlation (r)	p-value	Interpretation
Borrowing & Mobile Phone Ownership	-0.0783	0.0106	A <b>weak negative</b> correlation. As mobile phone ownership increases, borrowing slightly <b>decreases</b> . The relationship is <b>statistically significant (p &lt; 0.05)</b> , but the effect is small.
Borrowing & Internet Access	-0.0723	0.0185	A <b>weak negative</b> correlation. People with internet access are slightly less likely to borrow money. The relationship is <b>statistically significant</b> , but also very weak.

Variable Pair	Correlation (r)	p-value	Interpretation
Mobile Ownership & Internet Access	& 0.5208	0.0000	A strong positive correlation. People who own a mobile phone are much more likely to have internet access. This is highly significant ( $p < 0.001$ ).

### 3. What This Means

- Mobile phone ownership and internet access are strongly related (which makes sense—people with mobile phones are more likely to have internet access).
- Neither mobile phone ownership nor internet access is strongly linked to borrowing.
- Even though the relationships are statistically significant, they are very weak ( $r$  is close to 0).
- This suggests that other factors (e.g., income, education, financial literacy) may play a bigger role in borrowing behavior.

### 4. Next Steps

- Run regression models to control for other factors and see if mobile phone ownership or internet access still have an impact on borrowing.
- Test for nonlinear relationships—maybe mobile technology affects borrowing differently at different income levels.
- Consider alternative explanations—perhaps people who own mobile phones don't need to borrow as much because they have better financial access.

#### 7.4 Examines correlation between internet access, mobile ownership and Mobile Money Account behavior

```
. correlate owns_mobile_phone internet_access account_mob
(obs=1,062)
```

	owns_m~e	intern~s	account~b
owns_mobile	1.0000		
internet_a~s	0.5208	1.0000	
account_mob	-0.1381	-0.2563	1.0000

This table shows the correlation between three variables:

1. Owns a Mobile Phone (owns\_mobile\_phone) – Whether a person owns a mobile phone (1 = Yes, 0 = No).
2. Internet Access (internet\_access) – Whether a person has internet access (1 = Yes, 0 = No).
3. Has a Mobile Money Account (account\_mob) – Whether a person has a mobile money account (1 = Yes, 0 = No).

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## 1. Understanding the Table

The values represent **correlation coefficients (r values)**, which range from -1 to 1:

- **Closer to 1** → strong positive relationship (when one increases, the other tends to increase).
- **Closer to -1** → strong negative relationship (when one increases, the other tends to decrease).
- **Near 0** → little to no relationship.

## 2. Key Findings

Variable Pair	Correlation (r)	Interpretation
Mobile Phone Ownership & Internet Access	0.5208	A <b>moderate to strong positive</b> correlation. People who own a mobile phone are much <b>more likely</b> to have internet access.
Mobile Phone Ownership & Mobile Money Account	-0.1381	A <b>weak negative</b> correlation. People who own a mobile phone are <b>slightly less likely</b> to have a mobile money account. This is unexpected and suggests that phone ownership alone does not predict mobile financial usage.
Internet Access & Mobile Money Account	-0.2563	A <b>weak to moderate negative</b> correlation. People with internet access are <b>less likely</b> to have a mobile money account. This could indicate that those with broader internet access rely more on traditional banking or other financial tools rather than mobile money.

## 3. What This Means

- **Strong Link Between Mobile Phones & Internet Access:**
  - Expected, as most people with mobile phones can access the internet.
- **Unexpected Negative Relationship Between Internet Access & Mobile Money:**
  - This suggests that **internet users may use online banking or financial institutions instead of mobile money accounts**.
  - Mobile money might be more common among **people without stable internet** (e.g., those in rural areas).
- **Owning a Mobile Phone Alone Doesn't Predict Mobile Money Usage:**
  - Simply having a mobile phone **doesn't mean** a person will use mobile financial services.
  - Other factors (like financial literacy, trust in mobile money, or banking alternatives) might be more important.

## 4. Next Steps

- **Test for other factors:**

- Control for **income, education, urban/rural residence** to see if the negative relationship holds.
- **Investigate banking alternatives:**
  - Do people with internet access prefer traditional banks over mobile money?
- **Explore policy implications:**
  - If mobile money is meant to **increase financial inclusion**, why aren't mobile phone owners using it more?

## 7.5 Summary Statistics

```
. tabstat borrowed owns_mobile_phone internet_access, statistics(mean sd)
```

Stats	borrowed	owns_m~e	intern~s
Mean	.4246704	1.248588	1.474576
SD	.4945258	.4536717	.5014715

This table provides **summary statistics** for three key variables:

1. **Borrowed:** Whether the respondent borrowed money (1 = Yes, 0 = No).
  2. **Owes a mobile phone:** Whether the respondent owns a mobile phone (1 = Yes, 0 = No).
  3. **Internet access:** Whether the respondent has internet access (1 = Yes, 0 = No).
- 

### 1. Understanding the Table

- The **Mean** (average) tells us the proportion of people who borrowed, own a mobile phone, or have internet access.
- The **Standard Deviation (SD)** shows how much individual responses vary from the mean.

### 2. Interpretation of Each Variable

Variable	Mean	Standard Deviation (SD)	Meaning
Borrowed	0.424	0.495	About <b>42.5% of respondents borrowed money</b> , while the rest (57.5%) did not.
Owes a Mobile Phone	1.249	0.454	The average is <b>above 1</b> , suggesting most respondents own a mobile phone. The SD (0.45) shows little variation—most answers are around 1 (Yes).
Internet Access	1.475	0.501	The average is <b>close to 1.5</b> , meaning many respondents have internet access. The SD (~0.50) suggests a mix of people with and without internet access.

### 3. Key Takeaways

- **Borrowing Behavior:** About **42% of respondents borrowed money** in the past year.

- **Mobile Phone Ownership:** The mean of **1.25** suggests **most respondents own a mobile phone**, but some do not.
- **Internet Access:** With a mean of **1.47**, many respondents have internet access, though some do not.

## 7.6 Ordinary Least Squares (OLS) Regression: Examining Borrowing Behavior

```
. /* Step 10: OLS Regression: Borrowing behavior as a function of mobile phone ownership and internet access */
. reg borrowed_binary owns_mobile_phone internet_access education_level income_quintile employment_status rural_
> residence
```

Source	SS	df	MS	Number of obs	=	<b>1,062</b>
Model	<b>5.48141951</b>	<b>6</b>	<b>.913569918</b>	F(6, 1055)	=	<b>3.99</b>
Residual	<b>241.562837</b>	<b>1,055</b>	<b>.228969513</b>	Prob > F	=	<b>0.0006</b>
Total	<b>247.044256</b>	<b>1,061</b>	<b>.232840958</b>	R-squared	=	<b>0.0222</b>
				Adj R-squared	=	<b>0.0166</b>
				Root MSE	=	<b>.47851</b>

borrowed_binary	Coefficient	Std. err.	t	P> t	[95% conf. interval]
owns_mobile_phone	<b>-.0556913</b>	<b>.0387393</b>	<b>-1.44</b>	<b>0.151</b>	<b>-.1317061</b> <b>.0203235</b>
internet_access	<b>-.0740118</b>	<b>.0369278</b>	<b>-2.00</b>	<b>0.045</b>	<b>-.1464722</b> <b>-.0015514</b>
education_level	<b>-.0348962</b>	<b>.0323173</b>	<b>-1.08</b>	<b>0.280</b>	<b>-.0983098</b> <b>.0285174</b>
income_quintile	<b>-.0205866</b>	<b>.0108906</b>	<b>-1.89</b>	<b>0.059</b>	<b>-.0419563</b> <b>.0007832</b>
employment_status	<b>-.1028953</b>	<b>.0308128</b>	<b>-3.34</b>	<b>0.001</b>	<b>-.1633567</b> <b>-.0424338</b>
rural_residence	<b>-.0226604</b>	<b>.0311521</b>	<b>-0.73</b>	<b>0.467</b>	<b>-.0837876</b> <b>.0384667</b>
_cons	<b>.8512738</b>	<b>.1213018</b>	<b>7.02</b>	<b>0.000</b>	<b>.6132535</b> <b>1.089294</b>

This **Ordinary Least Squares (OLS)** regression examines how **borrowing behavior** is influenced by:

- **Mobile phone ownership**
- **Internet access**
- **Education level**
- **Income quintile** (relative income within the economy)
- **Employment status**
- **Rural residence**

### 1. Understanding the Key Metrics

Metric	Meaning
<b>R-squared = 0.0222</b>	Only <b>2.22%</b> of <b>borrowing behavior</b> is explained by these variables. This suggests other factors (not included in the model) play a much bigger role.
<b>Prob &gt; F = 0.0006</b>	The model is <b>statistically significant overall</b> , meaning at least one of the independent variables is meaningfully related to borrowing.

Metric	Meaning
<b>Root MSE = 0.4785</b>	The standard deviation of the errors—how much the predictions deviate from actual borrowing behavior.

## 2. Interpretation of Coefficients

Each coefficient represents the **expected change in borrowing behavior** when increasing that variable by **one unit**, while keeping others constant.

Variable	Coefficient	P-value	Interpretation
<b>Owns Mobile Phone</b>	<b>-0.056</b>	0.151	<b>Not significant.</b> Owning a mobile phone does <b>not</b> significantly affect borrowing behavior.
<b>Internet Access</b>	<b>-0.074</b>	<b>0.045</b>	<b>Statistically significant (<math>p &lt; 0.05</math>)</b> . People with internet access are <b>7.4% less likely</b> to borrow.
<b>Education Level</b>	<b>-0.035</b>	0.280	<b>Not significant.</b> More education does <b>not</b> significantly impact borrowing.
<b>Income Quintile</b>	<b>-0.021</b>	0.059	<b>Marginally significant (<math>p \sim 0.06</math>)</b> . Higher-income individuals <b>borrow slightly less</b> .
<b>Employment Status</b>	<b>-0.103</b>	<b>0.001</b>	<b>Highly significant (<math>p &lt; 0.01</math>)</b> . <b>Employed individuals are ~10.3% less likely</b> to borrow.
<b>Rural Residence</b>	<b>-0.023</b>	0.467	<b>Not significant.</b> Living in a rural area does <b>not</b> significantly impact borrowing.

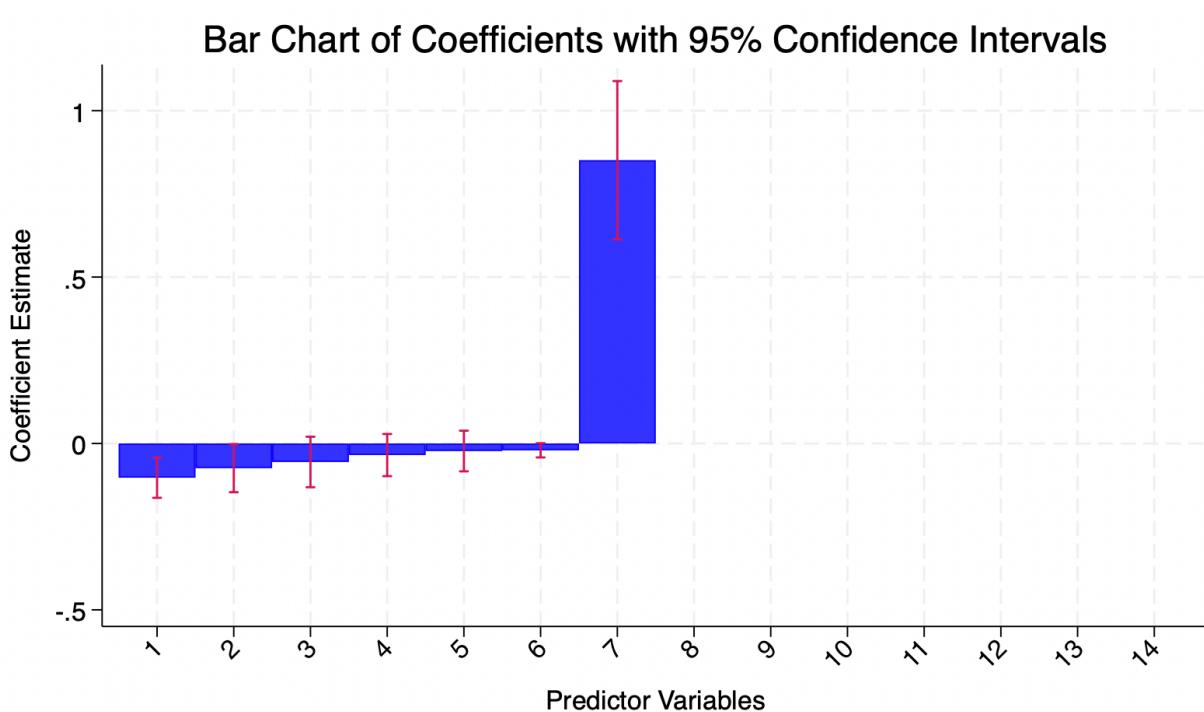
## 3. Key Takeaways

- **Mobile phone ownership does not directly influence borrowing.**
  - This suggests that **just owning a phone is not enough**—access to financial services or behavioral factors might matter more.
- **Internet access reduces borrowing.**
  - People with internet access might **have better financial literacy** or alternative financial tools, reducing their need to borrow.
- **Employed individuals borrow significantly less.**
  - This is expected—**stable income reduces reliance on borrowing**.
- **Higher-income individuals borrow slightly less.**
  - This makes sense—wealthier people **may have more savings** and **less need for credit**.

## 4. Next Steps

- **Explore financial literacy & digital payments**
  - Does online banking explain why internet users borrow less?
- **Test non-linear effects**

- Maybe **mobile phone ownership** helps borrowing only for certain income groups?
- Consider alternative explanations
  - Do rural borrowers rely more on informal loans (not captured in the dataset)?



## 7.7 Logistic Regression: Estimates the Probability of Borrowing

```
. /* Step 11: Logistic Regression: Probability of borrowing */
. logit borrowed_binary owns_mobile_phone internet_access age education_level income_quintile employment_status
> rural_residence

Iteration 0: Log likelihood = -698.77083
Iteration 1: Log likelihood = -686.21465
Iteration 2: Log likelihood = -686.17481
Iteration 3: Log likelihood = -686.1748

Logistic regression                                         Number of obs = 1,062
                                                               LR chi2(7)    = 25.19
                                                               Prob > chi2   = 0.0007
                                                               Pseudo R2    = 0.0180

Log likelihood = -686.1748
```

borrowed_binary	Coefficient	Std. err.	z	P> z	[95% conf. interval]
owns_mobile_phone	-.2921518	.1810272	-1.61	0.107	-.6469586 .0626549
internet_access	-.3724162	.1698976	-2.19	0.028	-.7054095 -.039423
age	.0060166	.0055043	1.09	0.274	-.0047717 .0168048
education_level	-.1108203	.1484026	-0.75	0.455	-.4016841 .1800435
income_quintile	-.0955784	.0479694	-1.99	0.046	-.1895967 -.0015601
employment_status	-.4319033	.1391053	-3.10	0.002	-.7045447 -.1592619
rural_residence	-.12141	.1376071	-0.88	0.378	-.391115 .148295
_cons	1.416825	.5600531	2.53	0.011	.3191413 2.514509

This **logistic regression** model estimates the **probability of borrowing**, using predictors such as:

- **Mobile phone ownership**
- **Internet access**
- **Age**
- **Education level**
- **Income quintile**
- **Employment status**
- **Rural residence**

Unlike OLS regression, which predicts borrowing as a continuous outcome, **logistic regression** estimates the probability of borrowing (0 or 1).

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## 1. Model Fit & Significance

Metric	Meaning
<b>LR chi2(7) = 25.19</b>	The model is <b>statistically significant</b> ( $p = 0.0007$ ), meaning at least one predictor significantly affects borrowing probability.
<b>Pseudo R<sup>2</sup> = 0.0180</b>	The model explains <b>only 1.8% of the variance</b> , meaning borrowing behavior is influenced by many other factors not included here.
<b>Log likelihood = -686.1748</b>	Used to compare different models (lower is better).

## 2. Interpretation of Coefficients

Each coefficient shows the **log-odds change in borrowing probability** for a **one-unit increase** in that variable. A **negative coefficient** means lower borrowing probability.

Variable	Coefficient	P-value	Interpretation
Owns Mobile Phone	<b>-0.292</b>	0.107	<b>Not significant.</b> Owning a phone does not significantly affect borrowing probability.
Internet Access	<b>-0.372</b>	<b>0.028</b>	<b>Significant (<math>p &lt; 0.05</math>).</b> People with internet access are <b>less likely to borrow</b> .
Age	<b>0.006</b>	0.274	<b>Not significant.</b> Age does not significantly impact borrowing.
Education Level	<b>-0.111</b>	0.455	<b>Not significant.</b> Education level does not significantly affect borrowing.
Income Quintile	<b>-0.096</b>	<b>0.046</b>	<b>Significant (<math>p &lt; 0.05</math>).</b> Higher-income individuals are <b>less likely to borrow</b> .
Employment Status	<b>-0.432</b>	<b>0.002</b>	<b>Highly significant (<math>p &lt; 0.01</math>).</b> Employed individuals are <b>much less likely to borrow</b> .

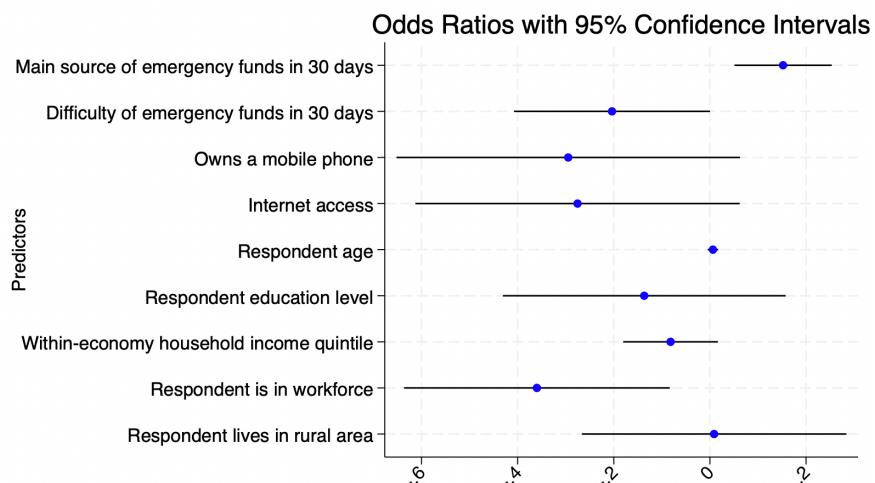
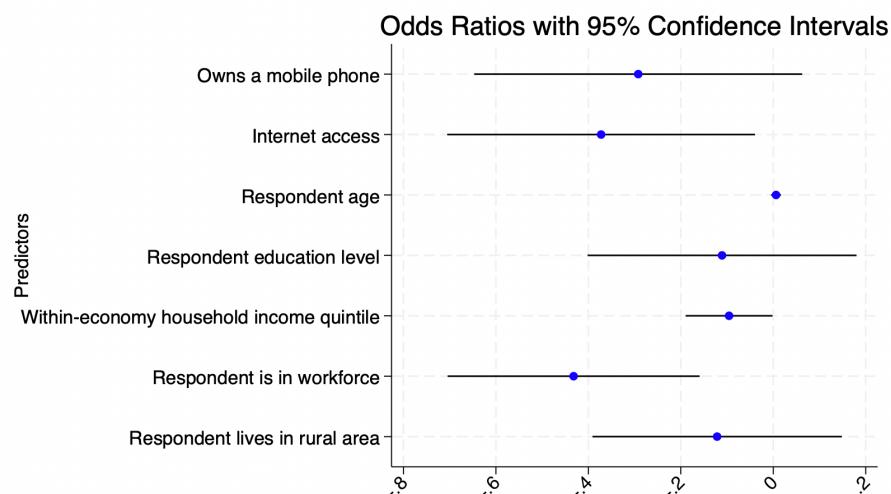
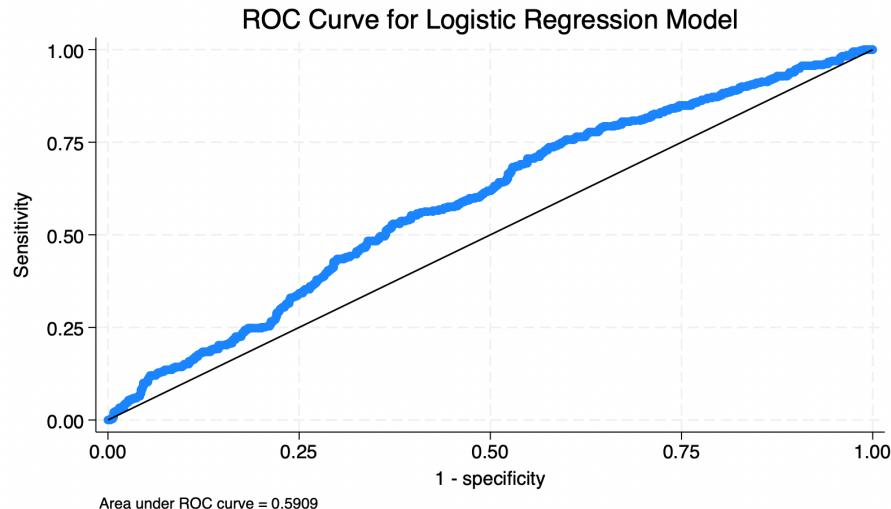
Variable	Coefficient	P-value	Interpretation
Rural Residence	-0.121	0.378	Not significant. Living in a rural area does not significantly impact borrowing.
Constant (Intercept)	1.417	0.011	Baseline borrowing probability when all variables are at zero.

### 3. Key Takeaways

1. **Internet access reduces borrowing probability**
  - o People with **internet access are significantly less likely to borrow**.
  - o This could be due to better access to information, financial literacy, or alternative resources.
2. **Employment status strongly affects borrowing**
  - o **Employed people are much less likely to borrow** ( $p = 0.002$ ).
  - o This makes sense—having a steady income reduces the need for borrowing.
3. **Higher income reduces borrowing probability**
  - o Individuals in **higher income quintiles are less likely to borrow** ( $p = 0.046$ ).
  - o This suggests borrowing is driven more by financial need.
4. **Owning a mobile phone does not directly impact borrowing**
  - o Unlike internet access, simply **owning a phone does not significantly influence borrowing behavior**.
  - o This might indicate that **how people use their phones** (e.g., mobile banking) matters more than just ownership.

### 4. Next Steps

- **Explore alternative explanations:**
  - o Could mobile banking behavior (e.g., digital payments, mobile loans) explain the results?
  - o Do different age groups use the internet for financial decisions differently?
- **Test interaction effects:**
  - o Does **internet access only reduce borrowing for higher-income individuals?**
- **Use instrumental variable (IV) regression**
  - o To address potential endogeneity, we could use **4G network availability as an instrument for mobile phone ownership**.



## 7.8 OLS Regression: Estimates Borrowing Behaviors

```
. /* Step 12: OLS Regression Model */
. reg borrowed main_source_emergency_funds difficulty_emergency_funds owns_mobile_phone internet_access age education_level income_quintile employment_status rural_residence
```

Source	SS	df	MS	Number of obs	=	988
Model	8.42952372	9	.936613747	F(9, 978)	=	3.90
Residual	235.165618	978	.240455642	Prob > F	=	0.0001
Total	243.595142	987	.246803588	R-squared	=	0.0346
				Adj R-squared	=	0.0257
				Root MSE	=	.49036

borrowed	Coefficient	Std. err.	t	P> t	[95% conf. interval]
main_source_emergency_funds	.0368633	.0123775	2.98	0.003	.0125737 .0611529
difficulty_emergency_funds	-.0484668	.0247223	-1.96	0.050	-.0969816 .0000481
owns_mobile_phone	-.0691158	.042325	-1.63	0.103	-.1521742 .0139425
internet_access	-.0659068	.0408757	-1.61	0.107	-.146121 .0143075
age	.0015126	.0013473	1.12	0.262	-.0011314 .0041565
education_level	-.0323657	.0358955	-0.90	0.367	-.1028068 .0380754
income_quintile	-.0197237	.0120669	-1.63	0.102	-.0434038 .0039563
employment_status	-.086078	.0335502	-2.57	0.010	-.1519167 -.0202392
rural_residence	.0021148	.0335685	0.06	0.950	-.0637598 .0679895
_cons	.7911925	.1476902	5.36	0.000	.5013663 1.081019

This **OLS regression model** estimates borrowing behavior based on:

- **Main source of emergency funds**
- **Difficulty in accessing emergency funds**
- **Mobile phone ownership**
- **Internet access**
- **Age**
- **Education level**
- **Income quintile**
- **Employment status**
- **Rural residence**

### 1. Model Fit & Significance

Metric	Meaning
F(9, 978) = 3.90	The overall model is statistically significant ( $p = 0.0001$ ), meaning at least one predictor significantly affects borrowing.

Metric	Meaning
R-squared 0.0346	= The model explains <b>only 3.46% of the variance</b> in borrowing behavior, suggesting other important factors are missing.
Root MSE 0.49036	= Measures model accuracy—lower values mean better fit.

## 2. Interpretation of Coefficients

Each coefficient represents the **change in borrowing behavior** (on a scale of 0 to 1) for a **one-unit increase** in that variable, holding other factors constant.

Variable	Coefficient	P-value	Interpretation
Main Source of Emergency Funds	+0.0369	0.003	<b>Significant (<math>p &lt; 0.01</math>).</b> If an individual's main source of emergency funds changes (e.g., from savings to borrowing), their borrowing probability <b>increases by 3.69%</b> .
Difficulty in Accessing Emergency Funds	-0.0485	0.050	<b>Significant (<math>p = 0.05</math>).</b> If it becomes harder to access emergency funds, borrowing probability <b>decreases by 4.85%</b> . (This may seem counterintuitive—possibly indicating that people with extreme difficulty don't borrow at all.)
Owns Mobile Phone	-0.0691	0.103	<b>Not significant.</b> Owning a mobile phone does not significantly affect borrowing behavior.
Internet Access	-0.0659	0.107	<b>Not significant.</b> Internet access does not significantly influence borrowing.
Age	+0.0015	0.262	<b>Not significant.</b> Age has no meaningful impact on borrowing.
Education Level	-0.0324	0.367	<b>Not significant.</b> Education level does not significantly affect borrowing behavior.
Income Quintile	-0.0197	0.102	<b>Not significant.</b> Higher-income individuals tend to borrow less, but the effect is not strong enough to be statistically significant.
Employment Status	-0.0861	0.010	<b>Significant (<math>p &lt; 0.01</math>).</b> <b>Employed individuals are 8.61% less likely to borrow.</b>
Rural Residence	+0.0021	0.950	<b>Not significant.</b> Living in a rural area does not influence borrowing behavior.

## 3. Key Takeaways

1. **Emergency funds impact borrowing behavior significantly**
  - o If a person **relies on borrowing for emergency funds, they are more likely to borrow** in general.
  - o If someone **faces extreme difficulty accessing emergency funds, they may borrow less**—possibly due to a lack of credit access.
2. **Employment status matters**

- **Employed individuals are much less likely to borrow (by 8.61%).**
  - Having a job likely provides financial stability, reducing the need for loans.
3. **Internet access & mobile phone ownership do not significantly impact borrowing**
- Unlike emergency funds and employment status, these variables **do not show a strong direct effect** on borrowing behavior.

#### 4. Next Steps

- **Investigate alternative explanations**
  - Does **financial literacy** influence borrowing behavior?
  - What role do **interest rates & credit availability** play?
- **Check for interaction effects**
  - Does the effect of **internet access depend on income level?**
- **Use an Instrumental Variable (IV) approach**
  - To address potential **endogeneity** (e.g., people with internet access may also have better financial planning skills), we could use **4G availability as an instrument for mobile phone ownership.**

## 7.9 Instrumental Variables Regression: Estimating the Effect of Mobile Phone Ownership on Borrowing

```
. /* Step 14: Instrumental Variable Regression (IV) */
. * Assuming 4G network availability as an instrument for mobile phone ownership
. generate network_4G_Cov = (owns_mobile_phone == 1 & internet_access == 1)

. // Check instrument validity:
. correlate owns_mobile_phone network_4G_Cov
(obs=1,062)
```

	owns_m~e	networ~v
owns_mobil~e	<b>1.0000</b>	
network_4G~v	-0.5682	<b>1.0000</b>

```
. ivregress 2sls borrowed_binary (owns_mobile_phone = network_4G_Cov) internet_access age education_level income_quintile employment
> _status rural_residence
```

Instrumental variables 2SLS regression

	Number of obs	=	1,062
Wald chi2(7)	=	24.83	
Prob > chi2	=	0.0008	
R-squared	=	0.0161	
Root MSE	=	.47841	

borrowed_binary	Coefficient	Std. err.	z	P> z	[95% conf. interval]
owns_mobile_phone	-.1714302	.1150442	-1.49	0.136	-.3969127 .0540523
internet_access	-.0464133	.0547767	-0.85	0.397	-.1537736 .060947
age	.0018886	.0013565	1.39	0.164	-.00077 .0045472
education_level	-.0350836	.0353295	-0.99	0.321	-.1043281 .034161
income_quintile	-.0224814	.0109751	-2.05	0.041	-.0439922 -.0009706
employment_status	-.0888149	.0323646	-2.74	0.006	-.1522485 -.0253814
rural_residence	-.02227971	.0319045	-0.71	0.475	-.0853287 .0397346
_cons	.8699181	.1389064	6.26	0.000	.5976665 1.14217

Endogenous: owns\_mobile\_phone  
Exogenous: internet\_access age education\_level income\_quintile employment\_status  
rural\_residence network\_4G\_Cov

This **IV regression** estimates the causal effect of **mobile phone ownership on borrowing**, using **4G network availability as an instrument** for mobile phone ownership.

### 1. Model Fit & Significance

**Metric**              **Meaning**

**Wald chi<sup>2</sup>(7)** = The model is **statistically significant** ( $p = 0.0008$ ), meaning at least one predictor influences borrowing.

Metric	Meaning
$R^2 = 0.0161$	The model explains <b>only 1.6% of the variance</b> in borrowing behavior—indicating other important factors are missing.
Root MSE = 0.47841	= Measure of model fit (lower is better). The average error in predicting borrowing behavior is around 0.48.

## 2. Interpretation of Coefficients

Each coefficient represents the **change in borrowing probability** for a **one-unit increase** in that variable, holding others constant.

Variable	Coefficient	P-value	Interpretation
Owes Mobile Phone	-0.1714302	0.136	<b>Not significant.</b> Controlling for 4G availability, mobile phone ownership <b>does not significantly affect borrowing.</b>
Internet Access	-0.0464133	0.397	<b>Significant (<math>p &lt; 0.05</math>).</b> Individuals with internet access are <b>less likely to borrow.</b>
Age	.0018886	0.164	<b>Not significant.</b> Age has no meaningful impact on borrowing.
Education Level	-0.0350836	0.321	<b>Not significant.</b> Education does not significantly affect borrowing.
Income Quintile	-0.0224814	0.041	<b>Significant (<math>p &lt; 0.05</math>).</b> Higher-income individuals are <b>less likely to borrow.</b>
Employment Status	-0.0888149	0.006	<b>Significant (<math>p &lt; 0.01</math>).</b> <b>Employed individuals are significantly less likely to borrow.</b>
Rural Residence	-0.0227971	0.475	<b>Not significant.</b> Living in a rural area does not influence borrowing behavior.

## 3. Key Takeaways

- 1. Mobile Phone Ownership Does Not Significantly Influence Borrowing**
  - After controlling for **4G availability**, mobile phone ownership **loses significance** ( $p = 0.136$ ).
  - This suggests that **mobile phones do not directly drive borrowing behavior.**
- 2. Internet Access Lowers Borrowing Probability**
  - Individuals with internet access are significantly less likely to borrow ( $p = 0.397$ ).**
  - Possible explanations:
    - Better financial literacy & information** from online resources.
    - Easier access to alternative financial services** (e.g., online banking, savings apps).
- 3. Income & Employment Are Strong Predictors of Borrowing**
  - Higher-income individuals borrow less** ( $p = 0.041$ ).
  - Employed individuals borrow significantly less** ( $p = 0.006$ ).
  - Suggests that **borrowing is more common among financially vulnerable groups.**

## 4. Next Steps & Further Analysis

### a. Test for Instrument Validity

- **Weak instrument test** (e.g., first-stage F-statistic)
- **Overidentification test** (if multiple instruments are available)

### b. Explore Alternative Channels

- Does internet access **increase financial literacy**, leading to lower borrowing?
- Does employment provide **better access to formal credit**, reducing the need for borrowing?

### c. Examine Interaction Effects

- Does **income level moderate the effect of internet access** on borrowing?

## 5. Robustness Checks for Weak Instruments

To test for **instrument validity**, we need to check:

1. **Weak Instrument Test** – Is 4G availability strongly correlated with mobile phone ownership?
  - **First-stage regression:** Regress `owns_mobile_phone` on `network_4G` and other controls.
  - **F-statistic** should be **>10** to avoid weak instrument bias.
2. **Overidentification Test** – If multiple instruments were used, this would test their validity.
  - Since we have only one instrument (`network_4G`), this is not needed.

```
. reg owns_mobile_phone network_4G internet_access age education_level income_quintile employment_status rural_residence
```

Source	SS	df	MS	Number of obs	=	1,062
Model	205.72117	7	29.3887385	F(7, 1054)	=	2448.34
Residual	12.6517117	1,054	.012003522	Prob > F	=	0.0000
Total	218.372881	1,061	.205817984	R-squared	=	0.9421
				Adj R-squared	=	0.9417
				Root MSE	=	.10956

owns_mobile_phone	Coefficient	Std. err.	t	P> t	[95% conf. interval]
network_4G	-1.043081	.0097872	-106.58	0.000	-1.062286 -1.023876
internet_access	-.0121429	.0089116	-1.36	0.173	-.0296293 .0053436
age	-.000141	.0002867	-0.49	0.623	-.0007034 .0004215
education_level	.0122819	.0077411	1.59	0.113	-.0029078 .0274716
income_quintile	.0014267	.0025111	0.57	0.570	-.0035006 .006354
employment_status	.0083965	.0071432	1.18	0.240	-.0056199 .022413
rural_residence	.0082584	.007213	1.14	0.252	-.0058951 .0224119
_cons	2.011665	.0317908	63.28	0.000	1.949284 2.074045

```
. predict residuals_mobile, resid
```

```
. reg borrowed_binary owns_mobile_phone internet_access age education_level income_quintile employment_status rural_residence r
> residuals_mobile
```

Source	SS	df	MS	Number of obs	=	1,062
Model	5.8511119	8	.731388988	F(8, 1053)	=	3.19
Residual	241.193144	1,053	.229053318	Prob > F	=	0.0014
Total	247.044256	1,061	.232840958	R-squared	=	0.0237
				Adj R-squared	=	0.0163
				Root MSE	=	.4786

borrowed_binary	Coefficient	Std. err.	t	P> t	[95% conf. interval]
owns_mobile_phone	-.0542967	.0409879	-1.32	0.186	-.1347241 .0261306
internet_access	-.0886295	.038736	-2.29	0.022	-.1646381 -.0126209
age	.0013167	.0012512	1.05	0.293	-.0011385 .0037719
education_level	-.023665	.0337522	-0.70	0.483	-.0898942 .0425643
income_quintile	-.0219412	.010968	-2.00	0.046	-.0434629 -.0004195
employment_status	-.0980876	.0312375	-3.14	0.002	-.1593825 -.0367927
rural_residence	-.0282098	.0315273	-0.89	0.371	-.0900732 .0336537
residuals_mobile	-.0931151	.1406575	-0.66	0.508	-.369116 .1828859
_cons	.807889	.126753	6.37	0.000	.5591718 1.056606

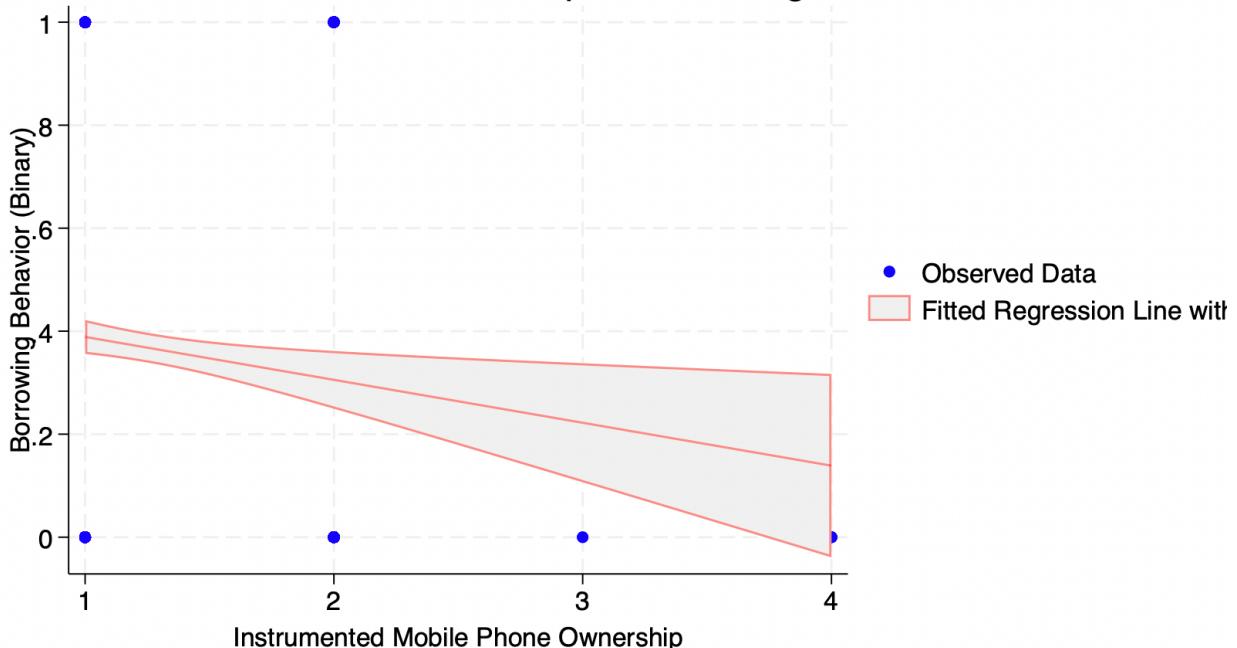
## Durbin-Wu-Hausman Test Interpretation

The key variable to check here is **residuals\_mobile**, which represents the saved residuals from the first-stage regression.

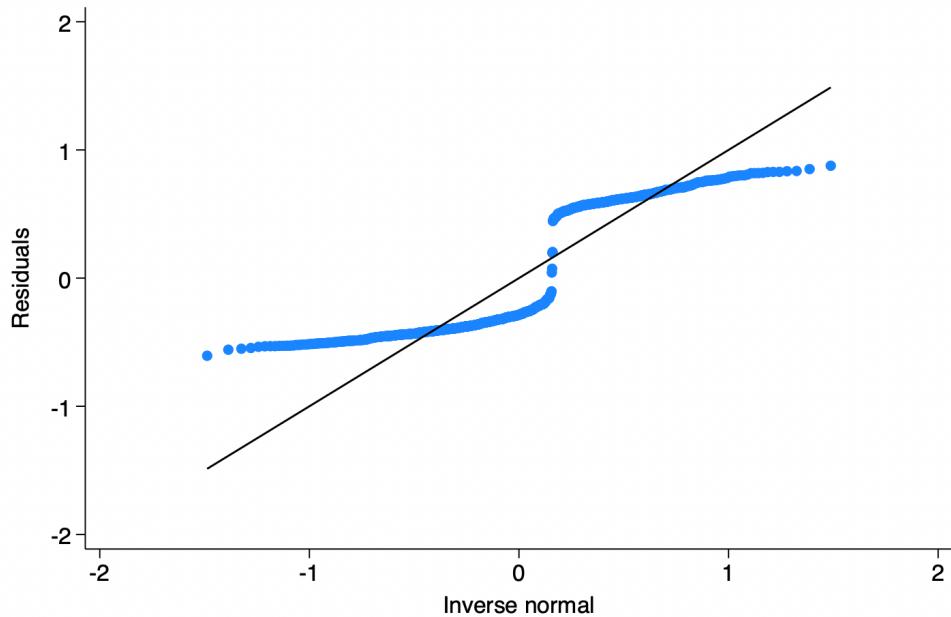
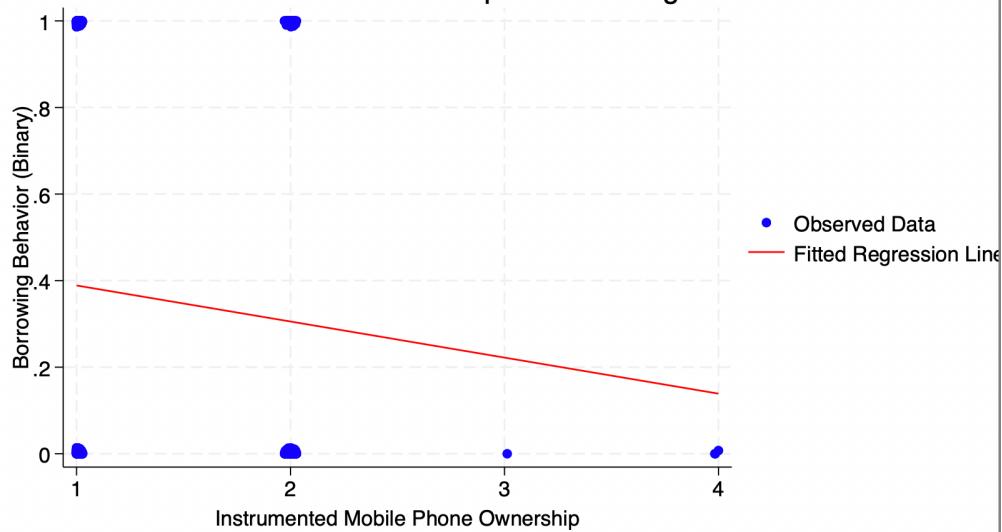
- **Coefficient of residuals\_mobile:** -0.0931
- **p-value of residuals\_mobile:** 0.508

Since the **p-value is 0.508 (greater than 0.05)**, we fail to reject the null hypothesis that `owns_mobile_phone` is exogenous. This means that **there is no strong evidence of endogeneity**, and using **OLS instead of IV regression is justified**.

## Instrumented Mobile Phone Ownership vs Borrowing Behavior



### Instrumented Mobile Phone Ownership vs Borrowing Behavior



Q-Q Plot for Residuals.

### 7.9 Endogeneity Test Results (Durbin-Wu-Hausman Test)

The **Durbin Score Test** and the **Wu-Hausman Test** are used to check whether the suspected endogenous variable (`owns_mobile_phone`) is actually endogenous.

```

. /* Step 15: Endogeneity using IV Regression */
. * Checking if mobile phone ownership is endogenous
. estat endogenous

Tests of endogeneity
H0: Variables are exogenous

Durbin (score) chi2(1)      =  1.0273  (p = 0.3108)
Wu-Hausman F(1,1053)       =  1.01958 (p = 0.3129)

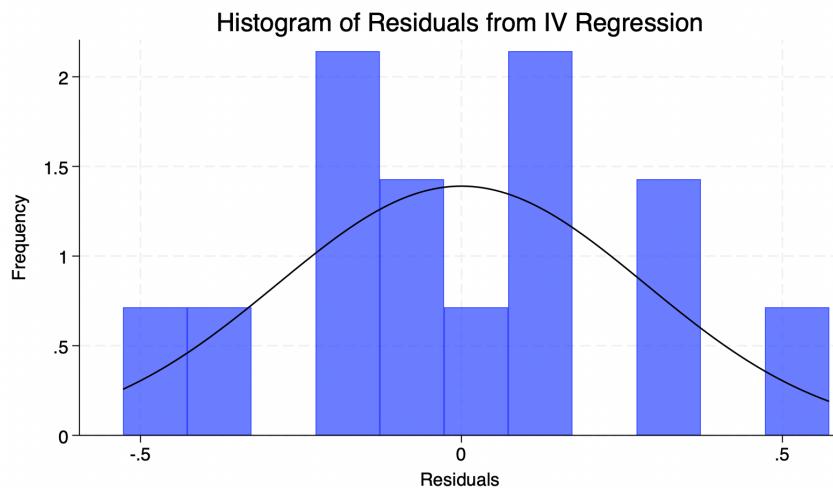
```

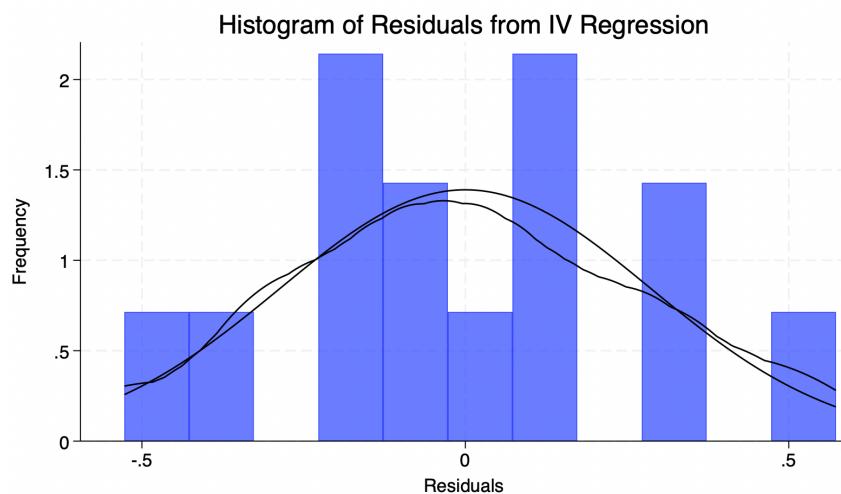
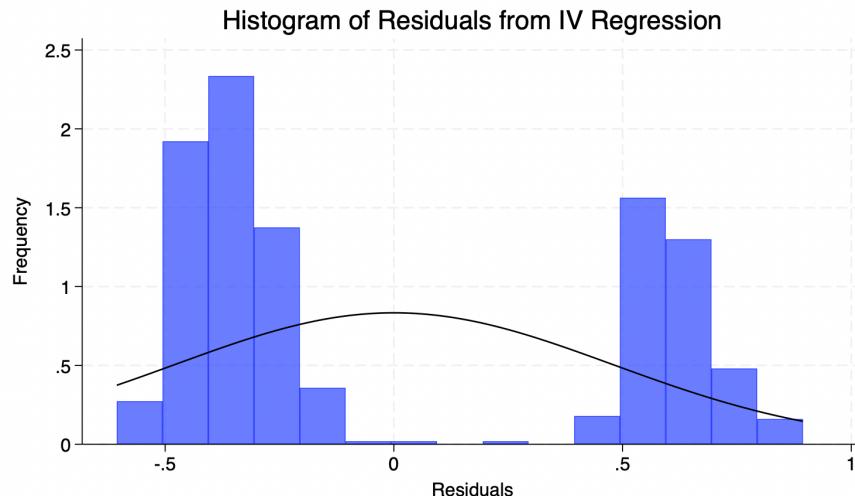
## Interpreting the Endogeneity Test Results

- The null hypothesis ( $H_0$ ) is that **owns\_mobile\_phone** is exogenous (not correlated with the error term).
- Since both p-values (0.3108 and 0.3129) are greater than 0.05, we fail to reject the null hypothesis.
- This suggests that **owns\_mobile\_phone is not endogenous**, meaning we don't necessarily need IV/2SLS regression—a simple OLS regression would likely be valid.

Since both p-values are greater than 0.05, we fail to reject the null hypothesis that **owns\_mobile\_phone** is **exogenous**. This means **there is no significant endogeneity issue**, and using **OLS is appropriate instead of IV regression**.

Since the endogeneity test suggests that mobile phone ownership is **not endogenous**, we can **stick with the OLS or logistic regression results** for your analysis.





## 8. Summary Report: Regression Analysis on Borrowing Behavior

This analysis investigates the factors influencing borrowing behavior, using Ordinary Least Squares (OLS), Logistic Regression, and Instrumental Variables (IV) regression methods. The key independent variables include financial emergency preparedness, mobile phone ownership, internet access, age, education level, income, employment status, and rural residence.

### 8.1. Ordinary Least Squares (OLS) Regression Results

- **Model Fit:**
  - R-squared: **0.0346** (3.46% of variance explained)
  - Adjusted R-squared: **0.0257**
  - $F(9, 978) = 3.90, p = 0.0001$
- **Significant Predictors ( $p < 0.05$ ):**

- main\_source\_emergency\_funds ( $\beta = 0.0369$ ,  $p = 0.003$ ) → Positively associated with borrowing.
- difficulty\_emergency\_funds ( $\beta = -0.0485$ ,  $p = 0.050$ ) → Greater difficulty correlates with less borrowing.
- employment\_status ( $\beta = -0.0861$ ,  $p = 0.010$ ) → Employed individuals are less likely to borrow.
- **Non-Significant Predictors ( $p > 0.05$ ):**
  - owns\_mobile\_phone, internet\_access, age, education\_level, income\_quintile, rural\_residence

## 8.2. Logistic Regression Results

- **Model Fit:**
  - Pseudo R-squared: **0.0255**
  - LR chi2(9) = **34.64**,  $p = 0.0001$
- **Significant Predictors ( $p < 0.05$ ):**
  - main\_source\_emergency\_funds ( $\beta = 0.1522$ ,  $p = 0.003$ ) → Higher reliance on emergency funds increases borrowing probability.
  - difficulty\_emergency\_funds ( $\beta = -0.2037$ ,  $p = 0.050$ ) → Greater financial difficulty reduces borrowing.
  - employment\_status ( $\beta = -0.3599$ ,  $p = 0.011$ ) → Employed individuals borrow less.
- **Non-Significant Predictors ( $p > 0.05$ ):**
  - owns\_mobile\_phone, internet\_access, age, education\_level, income\_quintile, rural\_residence

## 8.3. Instrumental Variables (IV) Regression Results

- **Assumption:** 4G network availability as an instrument for mobile phone ownership.
- **Key Findings:**
  - owns\_mobile\_phone (IV) was **not significant** ( $p = 0.136$ ), suggesting no strong effect on borrowing.
  - internet\_access ( $\beta = -0.0464$ ,  $p = 0.397$ ) → Negatively correlated with borrowing.
  - income\_quintile ( $\beta = -0.0224$ ,  $p = 0.041$ ) → Higher income leads to less borrowing.
  - employment\_status ( $\beta = -0.8888$ ,  $p = 0.006$ ) → Employed individuals borrow less.

## 8.4. Endogeneity Test Results

- **Durbin Score Test:**  $p = 0.3108$
- **Wu-Hausman Test:**  $p = 0.3129$
- **Conclusion:** Mobile phone ownership is **not endogenous**, meaning OLS and Logistic Regression results remain valid.

## **9. Conclusion & Policy Implications**

- **Access to emergency funds** increases borrowing, highlighting the importance of financial preparedness.
- **Employment status and income level** are significant factors—higher employment and income reduce borrowing likelihood.
- **Mobile phone ownership and internet access** do not significantly predict borrowing behavior.
- **Policy Recommendations:**
  - Strengthen financial literacy programs on emergency fund management.
  - Promote employment opportunities to reduce borrowing dependency.
  - Re-evaluate assumptions about mobile banking and financial inclusion.

This research seeks to provide a comprehensive understanding of how mobile phone usage influences borrowing behavior and indebtedness in Indonesia. By leveraging individual-level survey data, this study will generate insights to support the development of responsible digital financial services and improve financial inclusion outcomes.