The Macroeconomic Relevance of Mobile Money

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Overview

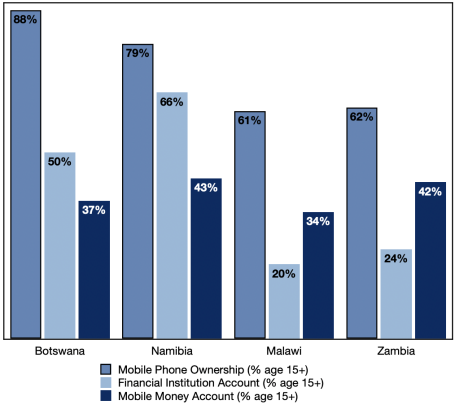
Summary

Registered mobile money accounts have exceeded conventional bank accounts in most developing economies (*Sahay et al., 2020*).

- The structural shift may entail revisiting monetary policy conduct and analysis (*Aron et al., 2015*).
- We examine the implications of money growth before (2003 - 2011) and after (2012 - 2020) mobile money emergence.
- The inclusion of mobile money improved inflation and real output growth forecasts.
- After the emergence of mobile money, money growth shocks accounted for a larger proportion of inflation forecast errors.
- Following the emergence of mobile money, inflation and real output growth became more resilient to real and monetary policy shocks.

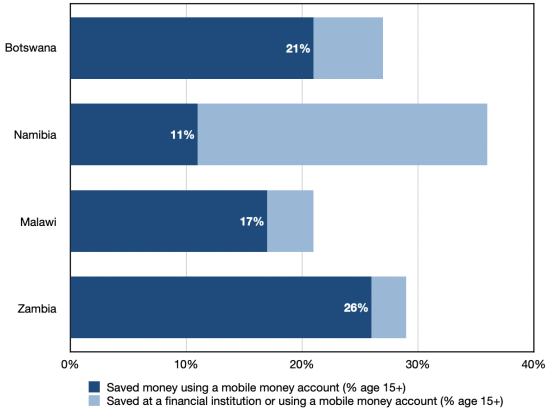
Motivation

Figure 1: Mobile Phone and Mobile Money Usage (2021/2022)



Data Source: The World Bank's Global Findex Database

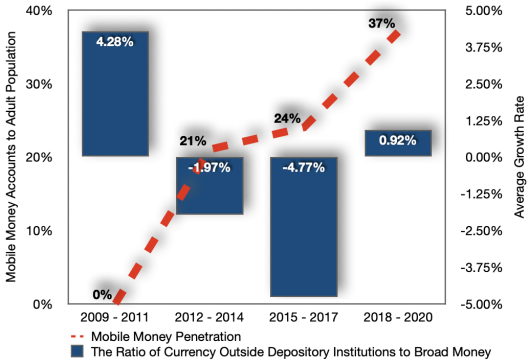
Figure 2: Saving Pattern (2021/2022)



Data source: *The World Bank's Global Findex Database*

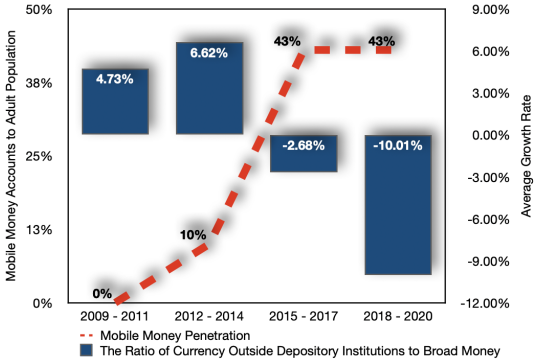
Motivation

Figure 3: Currency Outside Depository Institutions (Botswana)



Data Source: The Global Findex Database and Bank of Botswana

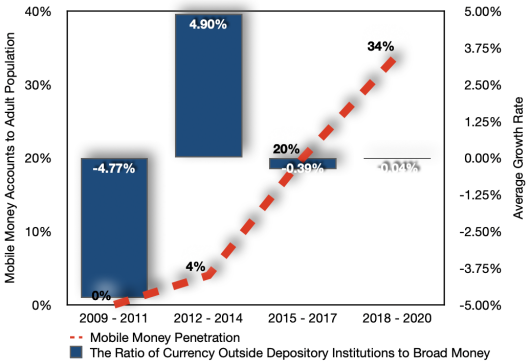
Figure 4: Currency Outside Depository Institutions (Namibia)



Data Source: The Global Findex Database and Bank of Namibia

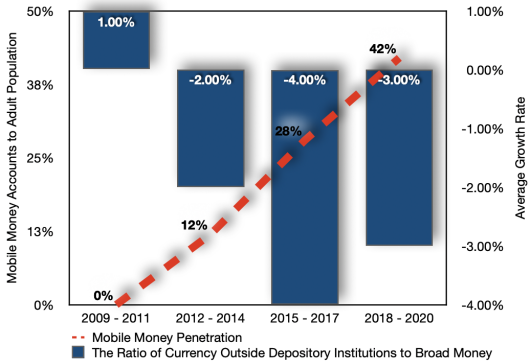
Motivation

Figure 5: Currency Outside Depository Institutions (Malawi)



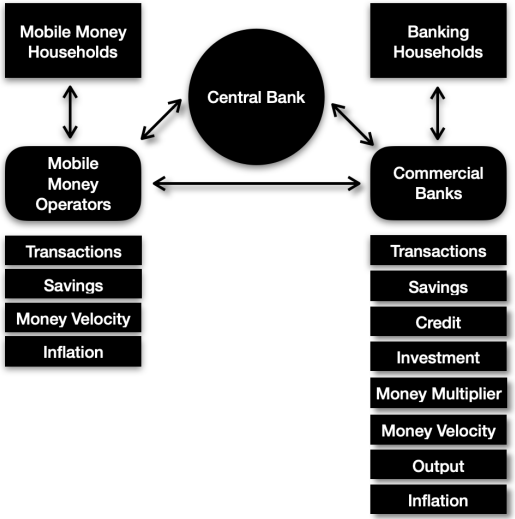
Data Source: The Global Findex Database and Bank of Malawi

Figure 6: Currency Outside Depository Institutions (Zambia)



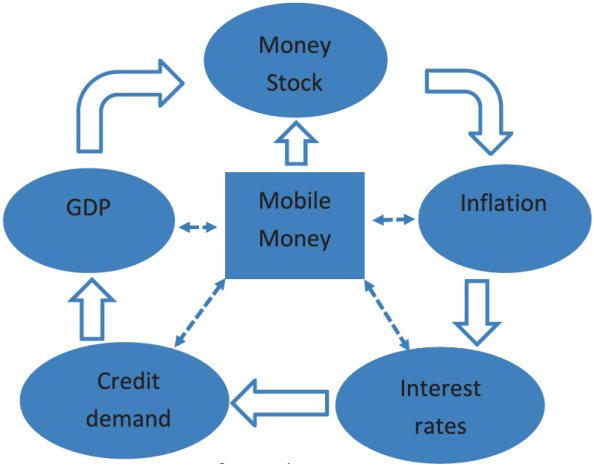
Data Source: The Global Findex Database and Bank of Zambia

Motivation



Source: Authors

Motivation



Source: Mawejje and Lakuma (2017)

Objectives

- **To investigate the macroeconomic relevance of mobile money, we specify three objectives:**

  1. Examine the importance of money growth to forecasting inflation and real output growth before and after mobile money emergence.
  2. Analyze the contribution of money growth shocks to inflation and real output growth forecast errors before and after mobile money emergence.
  3. Examine the response of inflation and real output growth to real and monetary policy shocks before and after the emergence of mobile money.

Related Literature and Contribution

- **Micro level analysis of mobile money**
  1. Amoah et al. (2015) and Aggarwal et al. (2020).
  2. Batista and Vicente (2020).
  3. Aron (2018) analysis of existing literature.
- **Macro level analysis of mobile money:**
  1. Wiafe et al. (2022) for Ghana
  2. Lapuken (2015) for Malawi.
  3. Aron (2015) for Uganda.
- **Contribution of the Study**
  1. Heterogeneity considerations
  2. Bayesian approach to address data limitations
  3. Robust identification and forecasting techniques.

Methodology

The Structural Variance Auto Regressive (VAR) Model

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ \gamma_{mr} & 1 & 0 & 0 \\ \gamma_{yr} & \gamma_{ym} & 1 & 0 \\ \gamma_{\pi r} & \gamma_{\pi m} & \gamma_{\pi y} & 1 \end{bmatrix} \begin{bmatrix} r_t \\ m_t \\ y_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} c_r \\ c_m \\ c_y \\ c_\pi \end{bmatrix} + \begin{bmatrix} \phi_{rr}^{(1)} & \phi_{rm}^{(1)} & \phi_{ry}^{(1)} & \phi_{r\pi}^{(1)} \\ \phi_{mr}^{(1)} & \phi_{mm}^{(1)} & \phi_{my}^{(1)} & \phi_{m\pi}^{(1)} \\ \phi_{yr}^{(1)} & \phi_{ym}^{(1)} & \phi_{yy}^{(1)} & \phi_{y\pi}^{(1)} \\ \phi_{\pi r}^{(1)} & \phi_{\pi m}^{(1)} & \phi_{\pi y}^{(1)} & \phi_{\pi\pi}^{(1)} \end{bmatrix} \begin{bmatrix} r_{t-1} \\ m_{t-1} \\ y_{t-1} \\ \pi_{t-1} \end{bmatrix} + \begin{bmatrix} \phi_{rr}^{(2)} & \phi_{rm}^{(2)} & \phi_{ry}^{(2)} & \phi_{r\pi}^{(2)} \\ \phi_{mr}^{(2)} & \phi_{mm}^{(2)} & \phi_{my}^{(2)} & \phi_{m\pi}^{(2)} \\ \phi_{yr}^{(2)} & \phi_{ym}^{(2)} & \phi_{yy}^{(2)} & \phi_{y\pi}^{(2)} \\ \phi_{\pi r}^{(2)} & \phi_{\pi m}^{(2)} & \phi_{\pi y}^{(2)} & \phi_{\pi\pi}^{(2)} \end{bmatrix} \begin{bmatrix} r_{t-2} \\ m_{t-2} \\ y_{t-2} \\ y_{t-2} \end{bmatrix} + \begin{bmatrix} \epsilon_{rt} \\ \epsilon_{mt} \\ \epsilon_{yt} \\ \epsilon_{\pi t} \end{bmatrix} \quad (1)$$

1. **Estimation Technique**
   - Bayesian Estimation with Normal Diffuse Prior
2. **Identification Strategy**
   - Cholesky Decomposition and Sign Restrictions
3. **Forecast Evaluation**
   - Log Predictive Scores (LPS) and Continuous Ranked Probability Score (CRPS)
4. **Structural Shocks Analysis**
   - Forecast Error Variance Decomposition (FEVD) and Impulse Response Function (IRF)

Methodology

Identification Scheme

Table 1: Identification Restrictions of the Structural Shocks

Identification Restriction	Shock	Policy Rate	Money Growth	Output Growth	Inflation Rate
Sign	MP Shock	≥ 0	≤ 0	≤ 0	≤ 0
Sign	MG Shock			≥ 0	≥ 0
Sign	AD Shock		≥ 0	≥ 0	≥ 0
Sign	AS Shock		≥ 0	≤ 0	≥ 0

Note: Sign restrictions hold on impact and the next period.

- **Bayesian Model Specifications and Applications**
  1. 6000 iterations and 3000 burn-ins for the Gibbs Sampler
  2. Credibility Intervals at 95%
  3. One step ahead forecast evaluation

The Data

Figure 9: Time Series Plots (Botswana)

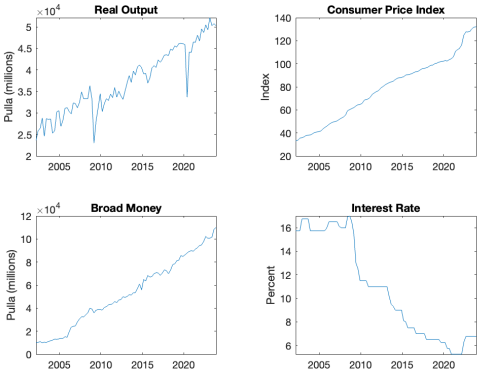
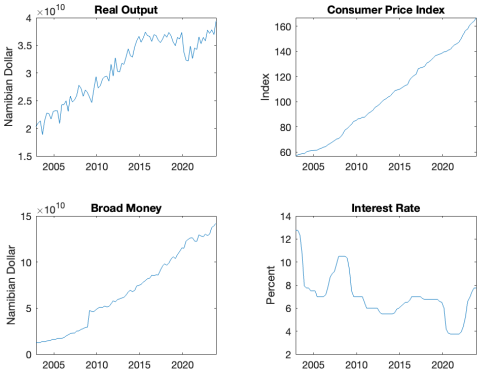


Figure 10: Time Series Plots (Namibia)



The Data

Figure 11: Time Series Plots (Malawi)

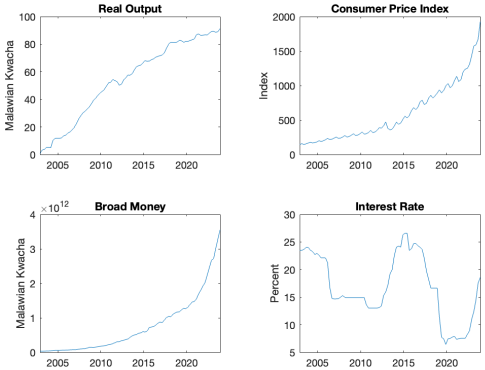
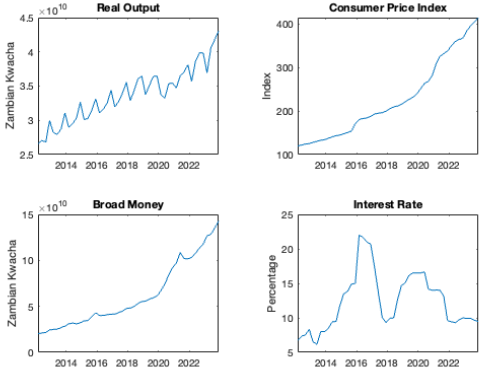


Figure 12: Time Series Plots (Zambia)



Bayesian VAR Model Stability Condition

Table 2: Roots of the Characteristic Polynomial (Modulus)

Country	Model	Lag	r_t	m_t	y_t	π_t
Botswana	Before Mobile Money	Lag (1)	0.967	0.631	0.033	0.007
		Lag (2)	0.647	0.600	0.033	0.001
	After Mobile Money	Lag (1)	0.941	0.642	0.033	0.021
		Lag (2)	0.642	0.620	0.023	0.017
Namibia	Before Mobile Money	Lag (1)	0.788	0.648	0.060	0.010
		Lag (2)	0.674	0.622	0.012	0.007
	After Mobile Money	Lag (1)	0.948	0.625	0.024	0.005
		Lag (2)	0.693	0.607	0.021	0.005
	Broad Money	Lag (1)	0.933	0.646	0.025	0.015
		Lag (2)	0.688	0.614	0.015	0.000
	Mobile Money	Lag (1)	0.940	0.656	0.023	0.003
		Lag (2)	0.667	0.638	0.006	0.003

Bayesian VAR Model Stability Condition

Table 3: Roots of the Characteristic Polynomial (Modulus)

Country	Model	Lag	r_t	m_t	y_t	π_t
Malawi	Before Mobile Money	Lag (1)	0.933	0.659	0.046	0.016
		Lag (2)	0.695	0.568	0.016	0.002
	After Mobile Money	Lag (1)	0.962	0.636	0.067	0.011
		Lag (2)	0.653	0.621	0.020	0.000
	Broad Money	Lag (1)	0.973	0.654	0.050	0.008
		Lag (2)	0.669	0.629	0.020	0.005
	Mobile Money	Lag (1)	0.970	0.648	0.047	0.003
		Lag (2)	0.668	0.648	0.006	0.003
Zambia	Broad Money	Lag (1)	0.846	0.668	0.033	0.015
		Lag (2)	0.703	0.630	0.015	0.009
	Mobile Money	Lag (1)	0.817	0.646	0.032	0.015
		Lag (2)	0.683	0.646	0.032	0.012

Two Period Inflation Forecast Comparison

Table 4: Inflation Forecast Evaluation

Country	Training Dataset	CRPS	LPS
Botswana	After Mobile Money	0.225*	−1.329*
	Before Mobile Money	0.525	−1.850
Namibia	After Mobile Money	0.356*	−1.368*
	Before Mobile Money	0.384	−6.986
Malawi	After Mobile Money	13.522	−5.009
	Before Mobile Money	2.503*	−3.371*

Note: * signifies a relatively superior forecast of the two periods.

Two Period Real Output Growth Forecast Comparison

Table 5: Two Period Comparison of Real Output Growth Forecast

Country	Training Dataset	CRPS	LPS
Botswana	After Mobile Money	3.905*	−3.741*
	Before Mobile Money	5.073	−4.018
Namibia	After Mobile Money	1.608*	−3.081*
	Before Mobile Money	5.139	−3.540
Malawi	After Mobile Money	0.393*	−1.510*
	Before Mobile Money	0.555	−1.857

Note: * signifies a relatively superior forecast of the two periods.

Monetary Activity Measure and Inflation Forecasting

Table 6: Inflation Forecasts Evaluation

Country	Measure	CRPS	LPS
Namibia	Mobile Money	0.368*	−1.367*
	Broad Money	0.387	−1.439
Malawi	Mobile Money	13.546*	−5.011*
	Broad Money	14.543	−5.072
Zambia	Mobile Money	0.743*	−2.111*
	Broad Money	0.768	−2.177

Note: * signifies a relatively superior forecast of the two measures.

Monetary Activity Measure and Real Output Growth Forecasting

Table 7: Real Output Growth Forecast Evaluation

Country	Measure	CRPS	LPS
Namibia	Mobile Money	1.775	−3.140
	Broad Money	1.567*	−3.081*
Malawi	Mobile Money	0.378	−1.480
	Broad Money	0.362*	−1.450*
Zambia	Mobile Money	2.524	−3.316
	Broad Money	2.422*	−3.282*

Note: * signifies a relatively superior forecast of the two measures.

Results and Interpretation

Forecast Error Variance Decomposition (FEVD)

Figure 7: Botswana's FEVD Before Mobile Money

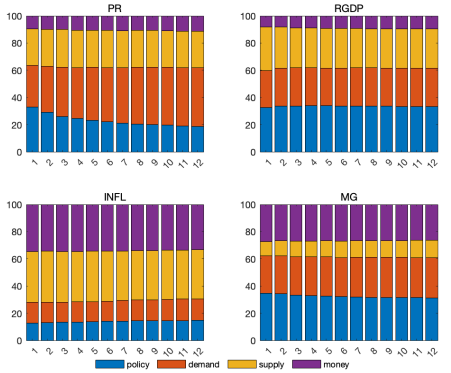
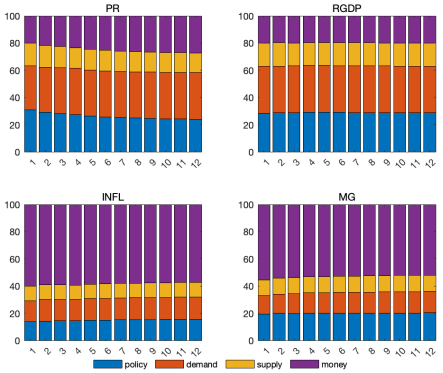


Figure 8: Botswana's FEVD After Mobile Money



Results and Interpretation

Forecast Error Variance Decomposition (FEVD)

Figure 9: Namibia's FEVD Before Mobile Money

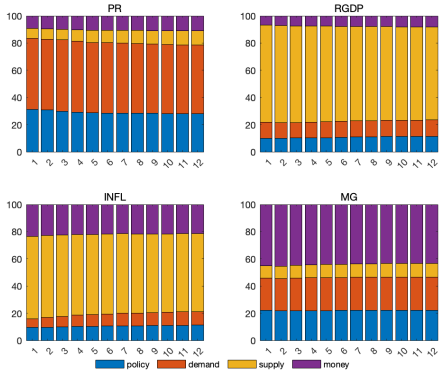
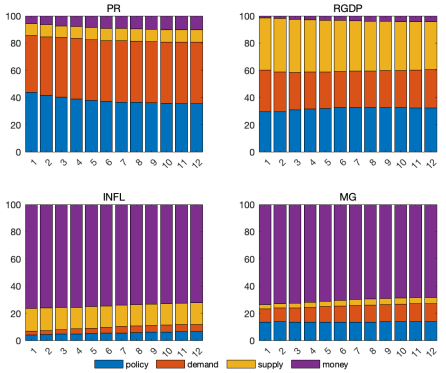


Figure 10: Namibia's FEVD After Mobile Money



Results and Interpretation

Forecast Error Variance Decomposition (FEVD)

Figure 11: Malawi's FEVD Before Mobile Money

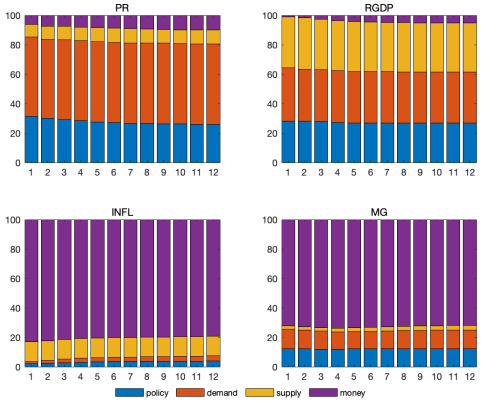
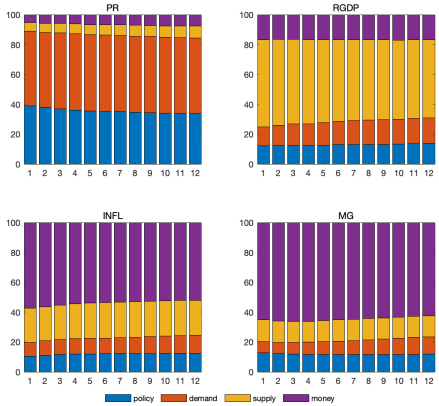


Figure 12: Malawi's FEVD After Mobile Money



Results and Interpretation

Forecast Error Variance Decomposition (FEVD)

Figure 13: Malawi's FEVD With Broad Money

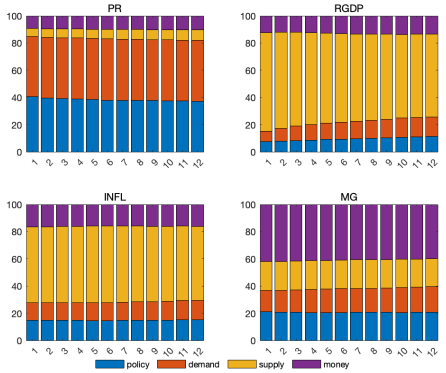
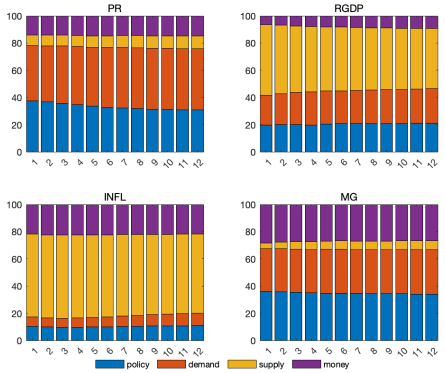


Figure 14: Malawi's FEVD with Mobile Money



Results and Interpretation

Forecast Error Variance Decomposition (FEVD)

Figure 15: Zambia's FEVD with Broad Money

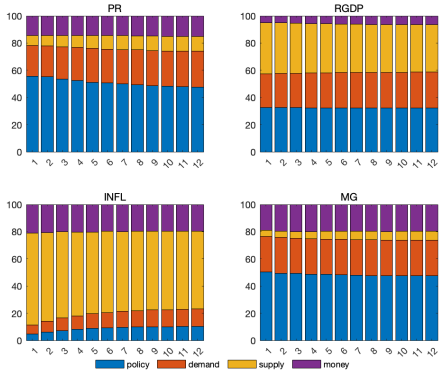
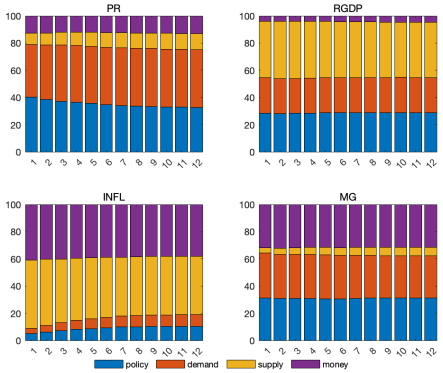


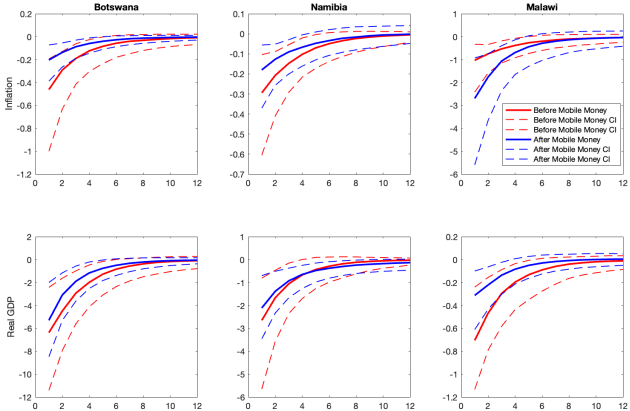
Figure 16: Zambia's FEVD with Mobile Money



Results and Interpretation

Impulse Response Functions (IRFs)

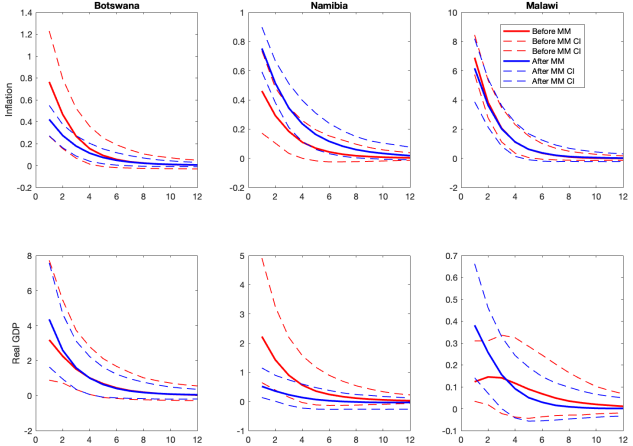
Figure 21: Response of Inflation and Real GDP to Policy Rate Shock



Results and Interpretation

Impulse Response Functions (IRFs)

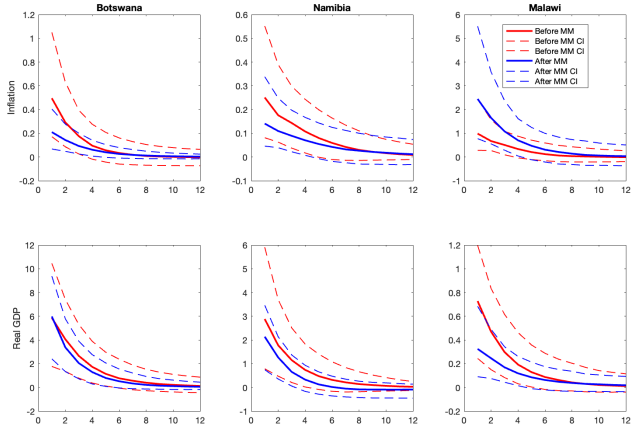
Figure 22: Response of Inflation and Real GDP to Money Growth Shock



Results and Interpretation

Impulse Response Functions (IRFs)

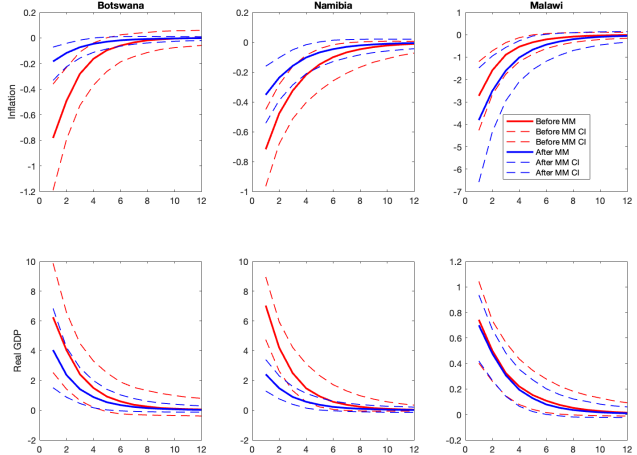
Figure 23: Response of Inflation and Real GDP to Aggregate Demand Shock



Results and Interpretation

Impulse Response Functions (IRFs)

Figure 24: Response of Inflation and Real GDP to Aggregate Supply Shock



Conclusion

- **Mobile money appears to be relevant for macroeconomic analysis.**
- **Monetary policy frameworks should adapt to the changing macroeconomic landscape shaped by digital financial innovations**.
- **An extension of the paper explores time-varying parameter models to account for non-linearity**.

Abridged References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Thank You

Questions? Comments?