Interoperability between mobile money agents and choice of network operators: the case of Tanzania

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Motivation: mobile money

- Mobile money provided by telecom operators is the main driver of financial inclusion in Sub-Saharan Africa.

- According to Research ICT Africa survey from 2017 in Tanzania, 55.4% of respondents used mobile money while 17.4% had a bank account.

| Country | Phone | | Financial | | | N |
	Phone Basic	Smartphone	Mobile Money	Bank	Card	
Ghana	52.2%	25.8%	51.6%	30.6%	8.03%	1,196
Kenya	54.7%	33.6%	80.5%	42.2%	19.9%	1,216
Mozambique	41.4%	17.0%	23.9%	24.4%	20.6%	1,220
Nigeria	48.8%	16.5%	2.49%	38.2%	31.0%	1,804
Rwanda	43.9%	10.7%	33.9%	32.7%	8.96%	1,217
Senegal	59.0%	22.1%	32.8%	10.6%	4.7%	1,233
South Africa	41.6%	43.9%	7.58%	57.2%	33.2%	1,794
Tanzania	45.4%	20.3%	55.4%	17.4%	10.6%	1,200
Uganda	43.7%	13.2%	47.8%	2.7%	6.79%	1,855
Total	47.4%	22.8%	34.8%	28.9%	17.0%	12,735

Motivation: mobile money usage in 2011 and 2017

- Usage of mobile money has been growing but with large differences across countries.
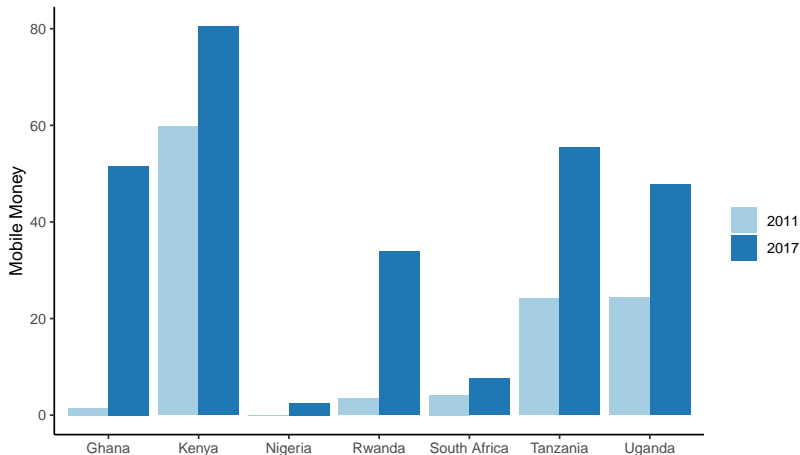
Motivation: network of agents

- Mobile money users need to deposit and withdraw cash at cash-in and cash-out points, which may be a bank agent, mobile money agent or an automated teller machine (ATM).

- A large network and proximity of agents may be a key determinant when choosing a mobile money provider.

- In 2012, Airtel filed a complaint with the Competition Authority of Kenya against exclusive arrangements with agents by the market leader Safaricom.

- Interoperability may mitigate market domination.

Contribution

- We study how interoperability at the level of agents impacts market structure.

- We construct unique database which combines:
  - Survey data of 1,200 individuals in Tanzania collected in 2017 by Research ICT Africa with geo-location information.
  - Geo-location of mobile money agents, cell towers, ATMs, bank branches and other infrastructure.
  - Nighttime light intensity data which approximates the level of economic development at the location of survey respondents.

- We estimate how the choice of mobile network operator (and mobile money provider) depends on the distance from mobile money agent.

- We conduct counterfactual simulations by imposing interoperability at the level of agents.

Empirical literature on mobile money

- Adoption and use of mobile money in low income countries:
  - In Kenya: Mbiti and Weil (2015), Jack and Suri (2014)
  - In Uganda: Murendo et al. (2018)
  - In Tanzania: Economides and Jeziorski (2014)
  - in Sub-Saharan Africa: Grzybowski and Mothobi (2017)

- The role of regulatory framework for mobile money usage:
  - Gutierrez and Singh (2013)
  - Lashitew et al. (2019)
  - Bourreau and Valletti (2015).

- The effects of mobile money on individuals and enterprises using randomized controlled trial:
  - Batista and Vicente (2013), and Batista and Vicente (2018) in Mozambique
  - Aggarwal et al. (2020) in Malawi
  - Wieser et al. (2019) in Uganda.

- There are no empirical papers focused on interoperability.

Mobile money vs. mobile banking

- **Mobile money** is an electronic wallet service (e.g., M–Pesa):

  - Linked to a unique mobile phone number and provided entirely on the mobile networks.
  - Services: money transfers, payment of bills, cash–in, airtime top–up and others.
  - Transactions are settled through the network of agents established by an MNOs.

- **Mobile banking** enables access bank account:

  - Provided by a bank or other financial institutions in addition to other banking services, or independently by MNOs.
  - Services: transfer money, pay bills, virtual bank card, point of sale terminal or an ATM.

Interoperability levels

- **Account-to-account (A2A):** users can transfer money between two accounts held at different mobile money providers or between a mobile money provider and a bank – reduces transaction costs.

- **Agents-level**: agents can services multiple mobile money providers – reduces investment costs.

- **Merchant-level**: allows consumers to transact at any retailer, regardless of the account held by the merchant.

Data

- **Survey data** conducted by Research ICT Africa in 2017 in 9 African countries: Ghana, Kenya, Mozambique, Nigeria, Rwanda, Senegal, South Africa, Tanzania and Uganda.

- **Nighttime Lights (NTL**) stemming from the Visible Infrared Imaging Radiometer Suite (VIIRS) from the *Suomi* satellite provided by the Earth Observations Group (EOG), Payne Institute for Public Policy. We use the yearly cloud-free averaged data from 2016.

- **OpenStreetMap (OSM)** provides infrastructure data on the geo-location of cities and towns, banks and ATMs, railway stations and bus stops, and of major roads.

- **OpenCelliD:** information on geo-location of cell towers, the date of creation and technology: GSM, UMTS and LTE.

Locations of surveyed individuals in Tanzania
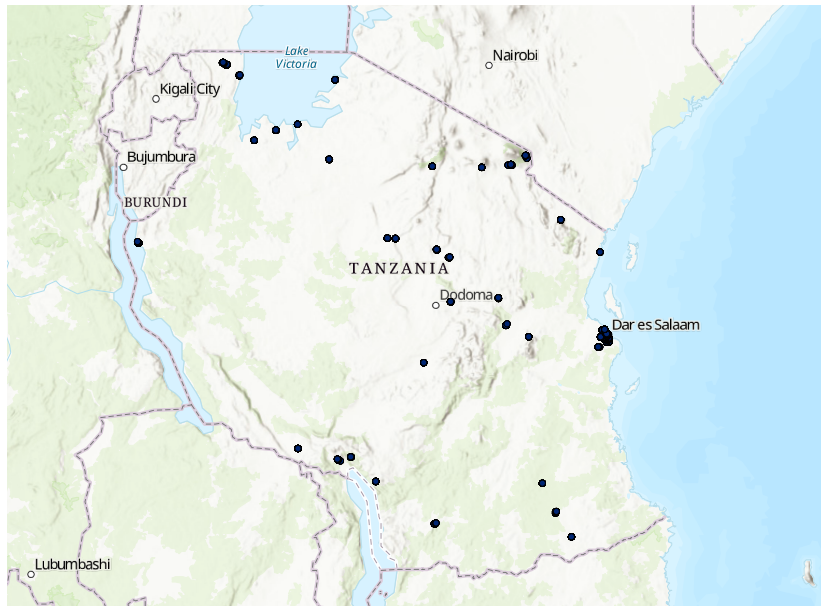
Shares of mobile operators and mobile money providers

- The shares of mobile phone operators in the survey.
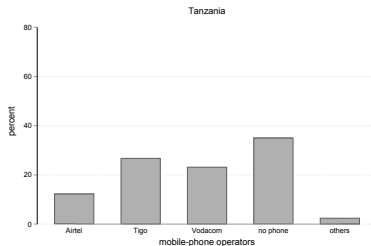
- The distribution of mobile money agents by network operators.
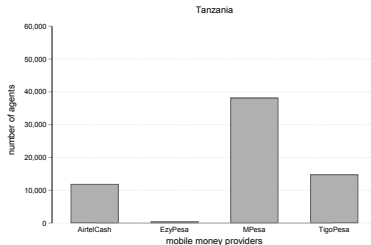
Mobile money and interoperability in Tanzania

- Timeline of launching mobile money:
  - 2008: M-Pesa (Vodacom)
  - 2008: Z-Pesa (Zantel), renamed to Ezy Pesa in 2012
  - 2009: Airtel Money (Airtel)
  - 2010: Tigo Pesa (Tigo)
  - 2016: Halopesa (Halotel)

- In 2013, the Bank of Tanzania began to encourage discussions on account-to-account interoperability. Bilateral interoperability agreements facilitated by by the Bill & Melinda Gates Foundation:
  - September 2014: Airtel and Tigo
  - December 2014: Tigo and Zantel
  - February 2016: Vodacom signed agreements with Airtel and Tigo.

- In 2015, the Bank of Tanzania issued the 'National Payment Systems Act' which mandated that all mobile money services be interoperable.

- By 2016 Tanzania became the first country in the world to achieve full interoperability between all of its mobile money services.

Distance to the closest mobile money agent from each provider

- The distribution of distance to the closest mobile money agent from each provider.

- Left figure: distribution of distance to agents from each mobile money provider in the full sample.

- Right figure: distribution of distance to agents from selected mobile money provider.
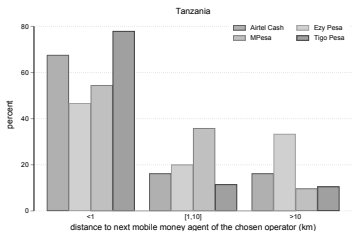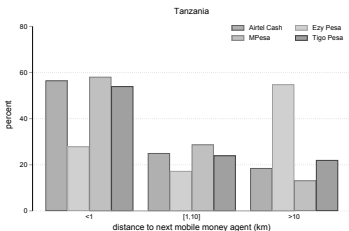
Summary Statistics

VARIABLES	(1) mean	(2) sd	(3) min	(4) p25	(5) p50	(6) p75	(7) max	(8) N
mobile money (0/1)	0.55	0.50	0.00	0.00	1.00	1.00	1.00	1,200
bank account (0/1)	0.17	0.38	0.00	0.00	0.00	0.00	1.00	1,173
credit card (0/1)	0.10	0.30	0.00	0.00	0.00	0.00	1.00	1,173
mobile phone (0/1)	0.66	0.47	0.00	0.00	1.00	1.00	1.00	1,173
smartphone (0/1)	0.20	0.40	0.00	0.00	0.00	0.00	1.00	1,173
light intensity	4.32	6.36	0.00	0.00	0.00	7.00	28.00	1,173
distance to next bank	20.03	29.07	0.03	1.17	5.10	26.51	140.56	1,173
distance to next ATM	24.76	28.41	0.03	2.63	14.19	36.09	110.58	1,173
distance to the road network	0.70	1.21	0.00	0.12	0.28	0.72	7.66	1,173
distance to the electricity grid	15.65	30.09	0.01	1.15	3.63	17.70	167.13	1,173
distance to next railway station	62.65	87.22	0.61	3.32	15.22	105.49	371.65	1,173
distance to next bus stop	14.82	28.19	0.03	0.71	3.46	14.80	139.37	1,173
distance to next town	23.32	18.84	0.01	13.99	20.97	25.96	111.05	1,173
distance to next city	57.92	65.48	0.63	7.42	33.64	111.97	253.34	1,173
LTE (4G) coverage (0/1)	0.41	0.49	0.00	0.00	0.00	1.00	1.00	1,194
UMTS (3G) coverage (0/1)	0.64	0.48	0.00	0.00	1.00	1.00	1.00	1,195
GSM (2G) coverage (0/1)	0.96	0.21	0.00	1.00	1.00	1.00	1.00	1,200

One-stage model: choice of network operators

- U_{ij} is linear utility which consumer i derives from choosing network operator j.

- Z_i includes a set of individual/household characteristics and infrastructure variables, which determine choice of network operators.

- ξ_j denotes stand alone value of network operator j.

- ϵ_{ij} is the logit error term (type I extreme value distributed).

- Individual $i = 1, ..., N$ chooses network $k \in J$ when $U_{ik} = \max_{j \in J} U_{ij}$.

Two-stage model: usage of mobile money

- In the first stage, consumers choose any mobile subscription, and in the second stage they decide to use of mobile money.

$$Y_i = \begin{cases} 1 & \text{if } Y_i^* = Z_i\beta + \epsilon_i > 0 \\ 0 & \text{if } Y_i^* = Z_i\beta + \epsilon_i \leq 0 \end{cases} \tag{1}$$

$$V_i = \begin{cases} 1 & \text{if } V_i^* = X_i\gamma + \varepsilon_i > 0 \\ 0 & \text{if } V_i^* = X_i\gamma + \varepsilon_i \leq 0 \end{cases} \tag{2}$$

- A mobile network subscription, $Y_i = 1$, is chosen when the utility is greater than zero, $Y_i^* > 0$. The use of mobile money is observed only if $Y_i = 1$.

- Exclusion restriction: the adoption of mobile phones is determined by network coverage, which does not affect usage of mobile money services.

$$L(\theta) = \prod_{i=1}^{n} [Pr(Y_i^* \leq 0)]^{1-Y_i} \cdot [Pr(V_i = v_i | Y_i^* > 0) \cdot Pr(Y_i^* > 0)]^{Y_i}$$

Multinomial logit / Probit / Heckman

		Multinomial logit				Probit	Heckman	
	Phone	Airtel	Halotel	Tigo	Vodacom		Mobile money	Phone
Dist_agent	-0.012**					0.001	0.003	0.001
	(0.005)					(0.005)	(0.005)	(0.003)
Network dummies		-2.808***	-4.631***	-4.631***	-1.922***			
		(0.654)	(1.191)	(1.191)	(0.606)			
LTE<5km		-0.137	-0.009	-1.297***	0.141	-0.332		-0.181
		(0.446)	(1.045)	(0.384)	(0.384)	(0.349)		(0.208)
Dark		-0.458	-0.262	-0.827**	-1.004***	-0.915***	-0.532**	-0.519***
		(0.429)	(1.078)	(0.350)	(0.369)	(0.319)	(0.209)	(0.192)
Bank account		1.279**	2.528***	2.040***	1.494***	1.694***	0.264	0.900***
		(0.613)	(0.799)	(0.554)	(0.554)	(0.533)	(0.290)	(0.268)
Credit card		2.022*	0.978	1.652	1.629	1.721	0.360	0.813
		(1.145)	(1.334)	(1.116)	(1.115)	(1.102)	(0.383)	(0.522)
Electricity		0.511**	0.284	0.861***	0.576**	0.638***	-0.052	0.376***
		(0.243)	(0.575)	(0.211)	(0.209)	(0.175)	(0.179)	(0.103)
Age group 1	0.072					0.043	0.644*	0.033
	(0.356)					(0.356)	(0.340)	(0.211)
Age group 2	0.703**					0.700**	0.553	0.418**
	(0.354)					(0.354)	(0.364)	(0.212)
Age group 3	0.805**					0.826**	0.612	0.503**
	(0.370)					(0.370)	(0.381)	(0.221)
Age group 4	0.290					0.292	0.660*	0.187
	(0.391)					(0.391)	(0.375)	(0.236)
Age group 5	0.646*					0.659*	0.630	0.416*
	(0.390)					(0.391)	(0.405)	(0.235)
Observations	5,950					1,190	1,190	1,190

Multinomial logit / Probit / Heckman

	Multinomial logit					Probit	Heckman	
	Phone	Airtel	Halotel	Tigo	vodacom		Mobile money	Phone
Income group 1	0.682*					0.700*	-0.476	0.372
	(0.406)					(0.408)	(0.429)	(0.246)
Income group 2	1.558***					1.574***	-0.236	0.865***
	(0.435)					(0.437)	(0.463)	(0.259)
Female	0.699					0.705	0.433	0.443
	(0.696)					(0.698)	(0.434)	(0.387)
Married	0.535***					0.567***	-0.069	0.338***
	(0.188)					(0.189)	(0.182)	(0.110)
HH size 2	-0.345					-0.337	-0.199	-0.217
	(0.341)					(0.340)	(0.280)	(0.198)
HH size 3	-0.511*					-0.496*	-0.214	-0.301*
	(0.286)					(0.285)	(0.244)	(0.164)
Primary	0.487*					0.515*	0.416	0.322**
	(0.267)					(0.266)	(0.291)	(0.159)
Secondary	1.044***					1.091***	0.730*	0.669***
	(0.308)					(0.307)	(0.377)	(0.183)
Tertiary	1.196***					1.266***	0.819*	0.795***
	(0.414)					(0.413)	(0.430)	(0.240)
Employed	0.619*					0.613*	0.323	0.372*
	(0.333)					(0.333)	(0.261)	(0.193)
Self_employed	0.482*					0.407	0.316	0.247
	(0.275)					(0.275)	(0.235)	(0.163)
Housework	-0.506*					-0.555*	0.328	-0.323*
	(0.287)					(0.288)	(0.264)	(0.172)
Student	-1.001***					-1.000***	-0.622*	-0.580***
	(0.357)					(0.358)	(0.356)	(0.210)
Retired	-0.854*					-0.888*	0.397	-0.494*
	(0.454)					(0.455)	(0.442)	(0.268)
ATM	0.392					0.403	-0.094	0.220
	(0.274)					(0.275)	(0.187)	(0.157)
Constant						-1.116*	0.583	-0.660*
						(0.587)	(0.922)	(0.351)
Rho							-0.173	
Observations	5,950					1,190	1,190	1,190

Simulated market shares under agent interoperability (1)

Provider	current	simulated	change
Airtel Cash	12.7%	12.7%	–0.2%
Ezy Pesa	1.7%	2.4%	44.4%
M–Pesa	23.9%	23.5%	–1.5%
Tigo–Pesa	27.2%	27.3%	0.2%
None	34.5%	34.1%	–1.2%

Simulated market shares under agent interoperability (2)

	Urban			Rural		
	current	simulated	change	current	simulated	change
Airtel Cash	13.8%	13.9%	0.2%	11.1%	11.0%	–0.8%
Ezy Pesa	2.3%	2.7%	15.3%	0.8%	2.1%	156.8%
M-Pesa	23.9%	23.7%	–0.7%	23.8%	23.2%	–2.5%
Tigo–Pesa	36.7%	36.6%	–0.2%	14.2%	14.4%	1.5%
None	23.3%	23.1%	–0.5%	50.1%	49.2%	–1.7%

	Light			Dark		
	current	simulated	change	current	simulated	change
Airtel Cash	14.1%	14.0%	–0.3%	11.4%	11.4%	–0.1%
Ezy Pesa	2.4%	2.7%	12.5%	1.0%	2.2%	118.9%
M-Pesa	23.3%	23.2%	–0.6%	24.4%	23.8%	–2.3%
Tigo–Pesa	40.5%	40.4%	–0.2%	14.5%	14.7%	1.1%
None	19.7%	19.7%	–0.3%	48.8%	48.0%	–1.6%

Conclusions

- We estimate how consumers' decision to subscribe to mobile operator (and mobile money provider) depends on the distance from mobile money agent.

- We control for nighttime light intensity to account for geographic differences in economic development and use a set of individual characteristics, and distance to physical infrastructure.

- The distance to agent has a significant impact on the subscription decision.

- But agent-level interoperability has only small impact on the market shares of network operators, where smaller operator marginally gain.

- Caution: in Tanzania interoperability between mobile money services were in place since 2016.