Circulation of a digital community currency

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Extended Abstract

This work considers the circulation of a digital community currency—Sarafu—that saw tremendous growth and substantial use in Kenya during the COVID-19 pandemic. Community currencies are tokens of exchange that circulate in parallel to national currencies, typically serving a specific geographic area. We construct a weighted, directed, time-aggregated network out of Sarafu transactions over 16 months; this captures real, observed flow of money among 40,000 individuals. Most notably, this network lets us ask where and among whom Sarafu was circulating during this time period. We find that circulation was geographically localized, and occurring among users with diverse livelihoods. Our results demonstrate the utility of representing currency systems as flow networks and the interpretability of walk-based analyses on such networks as monetary circulation.

Digital accounting records for Sarafu in 2020-21 have been anonymized and published by Grassroots Economics (GE), the foundation that operates the community currency [5]. GE supports research on Sarafu as a part of its broader mission to empower local economies in marginalized areas of Kenya. Indeed, community currencies have a long history of supporting local development and stepping up during times of economic disruption [3, 2]. Obtaining a fine-grained understanding of the circulation of Sarafu during the COVID-19 pandemic is of relevance to monetary theory, development policy, and models of humanitarian aid [7, 6].

To study circulation we turn to the map equation framework, which is based around an entropy measure defined for flow networks [4]. The Infomap algorithm groups nodes to optimize for this measure: if a random walker stays for a long time among nodes within some nicely delineated modules, then less of the total flow in the network is unexpected, and it is possible to compress its description [1]. In our case, the link weights reflect real, observed flows of money and so the modules reflect sub-populations within which Sarafu was *circulating* during this time period. We consider the geographic embeddedness, mixing patterns, prominent users, and timescale of circulation in Sarafu using this and related network analysis methods.

We find that circulation was occurring locally among users with diverse livelihoods, even at the scale of a single village. Figure 1 compares users' reported geographic area with the toplevel modules identified by the Infomap algorithm. There is close correspondence, indicating that circulation is geographically localized. Moreover, Infomap recovers a nested, hierarchical structure and lower-level modules also appear to be geographically delineated. Within these sub-populations, we show that the circulation of Sarafu involves a diversity of economic activities. There are 14 categories into which user-reported livelihoods were grouped, the most common of which are *labour* in urban areas and *farming* in rural areas. Many other users report selling *food*, running a *shop*, or providing *transport*. A user selected at random would find themselves in a second-level module with on average 2000 other users, around 69% of whom pursue different economic activities than that they themselves report. Expected social and platform effects are of secondary importance to these geographic and occupational factors. *Keywords: transaction networks, flow networks, complexity economics, payment systems, community detection, infomap*

Figure 1: Visualization of the Sarafu flow network colored by users' geographic area (left) and top-level Infomap modules (right). Nodes are sized by relative total flow. In the left panel, purple corresponds to *Kinango Kwale* a rural area where GE has had a substantial presence for many years. Green is *Mukuru Nairobi*, an urban area that was the site of a targeted introduction of Sarafu by GE and the Kenyan Red Cross beginning in March 2020. A second targeted introduction began later, in early 2021, in *Kisauni Mombasa*; this area is shown in blue. The users in orange report a location in the remote rural county of *Turkana*. Light grey is *unknown*. In the right panel, top-level modules are matched in color. The dark-grey top-level module combines several less prominent localities that appear in the second-level Infomap modules.



The growth history of the Sarafu flow network is assessed using cumulative weekly snapshots. Beginning with the week of January 27th, 2020 we construct flow networks capturing the transactions made up through that week. We find that circulation patterns were established surprisingly early on in many localities, often prior to the weeks that saw the largest transaction volumes. Community-led informal financial institutions and faith leaders were especially prominent. Our results underscore the importance of local circulation in the establishment of community currencies, and how this requires diverse economic and financial activities to be present. Such interpretable conclusions demonstrate the explanatory power of network representations of monetary flow together with walk-based network analysis methodologies.

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