Quantitative Impact Assessment of Collaborative Credit Systems

The self-organized community characteristic of Collaborative Credit Systems and their complementary nature to the official economic and monetary system may be used to increase the resilience of communities, especially during economic, financial and political crises. Moreover, their adoption can be used to tackle ecological crisis by rewarding consumption and production behaviors or providing a tool to manage sustainable community-led investments (Blanc, 2011). For example, the NU Sparpaaps in Rotterdam from 2002 and 2003 was based on the issuance of *green points* rewarding "*green*" behaviors of the 11,000 households involved in the project, i.e. waste recycling, use of public transportation, local organic food consumption[1].

Nevertheless, this research field is still almost unexplored especially by quantitative analysts, even if the recent increasing adoption of digital technologies has opened up new frontiers for quantitative research. Indeed, this phenomenon can be studied today using the most advanced tools provided by network and data science.

The main two pillars of my research proposal are the network and data analysis of two real case studies – i.e. the Sarafu and the Sardex Networks, and the agent-based modelling part. This work will be strongly interdisciplinary covering also fields outside of network and data science – such as economics, econometrics and game theory. Hopefully, this will contribute to innovate the research methodology in those different disciplines, and most importantly it will trigger the quantitative research about Collaborative Credit Systems. In fact, future researches in economic networks, trade networks, transaction and currency networks may consider the adoption and the improvement of the methodology developed throughout my work to evaluate and optimize their performance and resilience.

More specifically, the quantitative analysis of these currency systems can be used to measure their performance, to quantify their economic impact and to simulate their functioning. This huge amount of transaction data and related individual features can be used to calibrate data-driven simulations in order to optimize such networks finding the optimum of parameters, to predict the effects of changes in control variables and the effect of exogenous shocks.

[1] http://qoin.org/wp-content/uploads/2012/03/NU-spaarpas-English1.pdf

First Research Question. *How to measure the performance of CCSs using network analysis tools?*

For the network analysis of Sardex and Sarafu Networks, I will improve the existing methodology (see Methodology part), starting from cyclic motifs and brokerage analyses. In particular, the first improvement will regard the modification of such analyses for directed and weighted network. Secondly, in addition to the credit healthiness index, more specific performance metrics will be adopted, such as the risk exposure and the evolutionary fitness (for more details see Methodology part). Eventually one of the main objectives of my quantitative analysis is to understand the network dynamics, particularly the emergence of trade cycles (or cyclic motifs) and brokerage activities, and I will investigate their impact testing several techniques – such as measuring the spillover effect of adding a new community, new user and/or a new bridge between two communities (see Feasibility part).

Second Research Question. *Starting from a data-driven agent-based model based on a real case, how can we optimize the system and find the best governance?*

The agent-based simulation will contribute to the understanding of the observed network structure and dynamics, especially the emergence of trade cycles and brokerage activities (see Methodology part). In order to build up the agent-based model, I will refer to the existing literature about game network formation models (in particular, Jackson, 2008, pp. 384-388; Cassese and Pin, 2018) and two-country dual-currency models (in particular, Matsuyama, Kiyotaki and Matsui, 1993; Zhou, 1997; Trejos and Wright, 1995b, 1996) to set up a dual-currency agent-based model (Borivoj, 2015; Marimon et al., 1990) which can be used to simulate and explain observed network dynamics. Indeed, the model can also be calibrated and verified on real data, and eventually adopted to simulate the observed mechanisms into Sardex and Sarafu Networks and test different governance options by varying pre-defined control variables.