



www.ijccr.org · ISSN: 1325-9547

Ruddick, W. (2023). Letters from the Field: Commitment Pooling – An Economic Protocol Inspired by Ancestral Wisdom. *International Journal of Community Currency Research* 27, 54-79.
<https://doi.org/10.15133/j.ijccr.2023.004>

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International Journal of Community Currency Research

VOLUME 27 (2023) 54-79

LETTERS FROM THE FIELD

COMMITMENT POOLING - AN ECONOMIC PROTOCOL INSPIRED BY ANCESTRAL WISDOM

William O. Ruddick

Founder of Grassroots Economics Foundation (will@grassecon.org)

ABSTRACT

This prospective report introduces the pooling of commitments, as a mechanism for curating and fairly exchanging resources within communities. This approach hinges on the idea that commitments can be effectively pooled to create a more equitable and collaborative economic system, building on the efficacy of traditional mutual service practices. To operationalize this concept, the paper presents a protocol being piloted by Grassroots Economics called Commitment Pooling. The Commitment Pooling Protocol is designed to aggregate commitments (via digital systems) while facilitating the management and fair exchange of resources. The study describes the background, development, and potential impact of this approach, demonstrating how it can support autonomous, decentralized, non-monetary, and polycentric systems of Commitment Pooling. The emphasis is on fostering community well-being, aligning individual economic transactions with the ethos of mutual service and collective agency. Through practical use cases and analysis, the paper shows the versatility of this protocol in various socio-economic contexts, highlighting its potential in building more inclusive and resilient economic systems.

KEYWORDS

Commitment, Pool, Voucher, Mutual Service, Economics, Resource Coordination, Well-Being, Polycentric Systems.

1. INTRODUCTION

'Grassroots' is a term used to describe the strength of bottom-up and community-driven systems; a single root of grass does little to hold the soil together, while grass roots woven together are incredibly strong. This concept is grounded in the work of Grassroots Economics (GrE), a non-profit foundation based in Kenya since 2009, dedicated to nurturing prospering economies built by thriving communities in diverse settings including urban, rural, peri-urban, and refugee areas. Believing in the power of group resource coordination for well-being, GrE initiatives have been established in over 100 communities in Kenya, with growing impacts in other nations. These initiatives involve solidarity, collective decision-making and local empowerment, often overlooked in traditional economic discourse that tends to prioritize macroeconomic indicators and mainstream market mechanisms. In a quest to conceptualize and develop protocols that span a full spectrum of economic systems, this paper explores fundamental socio-economic properties inherent to all such systems.

Economics is traditionally defined to be the study of resource coordination and exchange of assets. We define 'pooling' as an example of such coordination. When resource coordination is applied at the community-level, we refer to this as 'grassroots economics' that can apply in theory to any group of agents that wish to coordinate their resources in fair and inclusive ways. The study of grassroots economics is not new, but the development and nuanced understanding of different forms of coordination is lacking in literature (Seyfang, 2013). This paper delves into the fundamental social dynamics of resource coordination through grassroots economics, aiming to leverage these insights into tangible protocols and patterns of action.

This document presents a brief window into this extensive journey, highlighting a protocol that GrE is exploring for resource coordination. The paper theorizes concepts not as isolated phenomena unique to Kenya or GrE programs, but as universally applicable mechanisms that transcend regional and cultural boundaries. Kenya, with its rich tapestry of economic landscapes, from traditional rural and refugee communities to bustling urban centers and tribal societies, provides a rich canvas for this exploration. The diverse socio-economic contexts encountered here – from ancestral, non-monetary economic practices in sacred forests to the bustling trade in Mombasa city, and the mosaic tribes and myriad social groups – have shaped GrEs' programs which have expanded from informal settlements to various urban, rural and refugee community settings. GrE's studies have yielded a deep understanding of how people across different contexts share, collaborate, and strategize towards common goals.

This paper is organized as follows: Section 2 serves a terminological disambiguation of foundational concepts like commitment, pooling and peering. Section 3 provides a brief documentation of GrE's work, specifically the integration of digital vouchers with indigenous mutual service traditions in Kenya, which then is the basis of what I call the Commitment Pooling Protocol found in Section 4. In the same section, I explore the possible use cases of the protocol beyond GrE's work and Section 5 concludes.

2. THEORETICAL FOUNDATIONS

2.1 Commitment

According to Bergstra and Burgess' (2014) work on Promise Theory, **a commitment is a promise that requires a non-returnable investment of resources on the part of the promiser (commitment issuer)**. Trust, according to Promise Theory, is built through the interdependence and flow of commitments. In a community, the fulfillment of one commitment often relies on others fulfilling theirs. This interconnectedness means that reliability becomes critical as parties consistently meet their commitments, trust grows. We will use the term voucher to represent a formalized commitment of the issuer to redeem the voucher as payment for specified goods or services (fulfilling their commitment) with various terms and conditions, such as expiration and transferability. A subscription can also be thought of as a formalized commitment; you pay money upfront for a subscription and you use it over time for repeated, specified services of the issuer. A bus ticket or even airline reward points can be considered formalized commitments or vouchers. My mother holds about 5 forms of loyalty points - all of which are vouchers or formalized commitments of various businesses.

National Currency can be seen as a formalized commitment or voucher redeemable by the state for tribute or tax payments and if lucky, state services. When the state and banking system produce increasing supplies of their vouchers without clear commitments to providing some services, the risk of over issuing or overselling these vouchers is high and can result in a poor unit of account and can also cause inflation where the nation's subjects must increasingly pay for the state's lack of commitment.

Note that the state is not alone here, the risk of over issuance (over commitment) can happen with individuals, groups and businesses as well. It is important to note that when vouchers are used as a general medium of exchange, there is a risk of glossing over their true backing or commitment. One would not want a telecom top-up credit to become the de facto national currency as it would risk the simple failure of that company (a single point of failure) to crash the entire system.

A single business can issue a voucher, like a telecom issuing an airtime credit, i.e., a token redeemable for using the mobile phone network's services. In Kenya, exchangeable airtime credit became a viable medium of exchange starting in 2008. Such vouchers can flow and circulate as a medium of exchange if the terms and conditions allow it. However, in either case of a business or group-issued voucher or individual-issued voucher, one would be wary if the supply of vouchers greatly exceeded the issuer's (group or individual) ability to redeem them.

While any individual voucher could theoretically act as a general medium of exchange, a polycentric interconnected network of pooled vouchers can provide more robustness and resilience. Learning from the rotating labor traditions like Mweria (as we will discuss further), commitments can be pooled in order to be exchangeable for one another. These systems of exchangeable commitments are fundamentally different in many ways from monetary systems. We will demonstrate in the next section how vouchers can be part of an polycentric exchange mechanism when used in the context of pooling.

2.2 Pooling across Disciplines

Near a mangrove forest, where I have the privilege of living and learning from the vibrant communities around me, a profound understanding of resource management dances through daily life. Through my work with GrE, I have been deeply inspired by the ancient traditions here, which enact a deep knowledge of pooling systems. As I have been sharing my findings to others in various ways - from informal knowledge sharing sessions to GrE's research and extension work with other scholars - I observe consistency. The concepts of pooling seems to be universally resonant across various fields of study (see Table 1).

Table 1. Pooling Concepts Across Disciplines

Subject	Pooling Concepts
Economics and Resource Management	Collective Savings Schemes, Joint Investment Funds, Collective use and management of resources, Cooperative Economic Models, Commitment Pooling
Social Sciences and Anthropology	Communal Welfare Programs, Collective Action Initiatives, Collective Norms, Shared Beliefs, Common Values, Community Solidarity Practices
Information Technology and Computer Science	Cloud Computing and Storage, Resource Pools, Data Warehousing, Distributed Computing Frameworks, Peer-to-Peer (P2P) Networking, Mesh Networks
Systems Theory and Network Science	Integrated Resource Management Systems, Unified Supply Chains, Resource Aggregation, Collective Intelligence, Network Collaboration Protocols
Environmental Science and Ecology	Community-led Environmental Conservation Pools, Sustainability and Land Trusts, Ecosystem Services Trading, Resource Sharing Agreements

Psychology and Behavioral Economics	Group Incentives, Risk Sharing, Collective Action, Social Reciprocity, Incentive Alignment
Indigenous Practices and Ancestral Wisdom	Communal Resource Pools, Collective Land Stewardship, Integrated Community Support Systems, Traditional Bartering, Mutual Service/Aid Practices

Pooling is aggregating and distributing resources for collective use or benefit. In traditional Kenyan communities, pooling is a vibrant way of life in communal land stewardship and shared agricultural practices — a living testament to how communities organize themselves to show great collective strength.

Pooling seamlessly extends into many modern contexts . In Economics, pooling is seen in collective savings schemes and joint investment funds, and in Environmental Science, community-led conservation efforts show how collective management can preserve natural resources for the greater good.

One of the core elements in pooling is peering. Peering, in its essence, represents fair exchanges of resources. In the realm of Economics and Resource Management, this can be seen in practices like barter systems and direct trade. In rural Kenya, peering finds its roots in traditions that reflect a profound connection and mutual respect among individuals, such as knowledge transfer, reciprocal exchange, and mutual service and aid practices.

Although economics and anthropology have a lot to say about direct exchange, important insights can be learned from networking technologies and systems theory as well. In Information Technology, peering typically occurs through Peer-to-Peer (P2P) Networking, a form of direct and decentralized communication that allows individuals to enter into various forms of market and nonmarket exchange. Systems Theory provides concepts for understanding network collaborations and direct data synchronizations. As we will demonstrate later, pooling as socio-economic practice and protocol demonstrates how individual autonomy can be orchestrated to yield collective welfare without blind faith in external markets.

The principles of pooling are not merely academic concepts, however; Instead, they are deeply embedded in human interactions and the natural world. One reason that these concepts resonate across disciplines — from Ecology to Computer Science to Systems Theory — is because they reflect fundamental aspects of nature and life: syntropy and symbiosis among living organisms, connectivity in networks, and the shared destiny of biophysical or imagined communities.

In embracing these principles, we're not just applying theories but are reconnecting with ancient wisdom that has sustained diverse types of communities for generations. As we move forward, whether in developing technologies, managing resources, or building communities, we need to remember the strength found in direct connections, mutual commitments, and collective actions.

By looking through the lens pooling across disciplines, I see a universal blueprint for ecological sustainability, societal cooperation, and mutual care — a reminder that, in diversity there can also be unity, and in sharing, there is strength.

Now that we have defined commitment and pooling. **Commitment Pooling can be seen as aggregating and making exchangable individual commitments to create a more equitable and collaborative economic system.** In simple terms, the resource that is being pooled is commitments. This practice is not new, but it is important to characterize it separately from other terms like gift economy or mutual credit. This ancient system, inspired by age-old wisdom, can drive sustainable economic models and community solidarity practices in contemporary contexts. Through commitment pooling, a curation of commitments can act as a store of wealth (pooling) for a community while at the same time, though a relative value indexing process, host an exchange system (peering). The rest of this paper will motivate the development of a Commitment Pooling Protocol based on the learning of Grassroots Economics' work with indigenous traditions.

3. GRASSROOTS ECONOMICS IN ACTION

The study of resource coordination in ancient cultures often centers around themes of colonization, power structures, and hierarchies, eclipsing interest in understanding the harmonious social dynamics that previously existed. Pioneers like Marcel Mauss (2016/1950) observed communities supporting each other without apparent reciprocity or monetary exchange, a phenomenon that he memorably labeled “gift economies.” The term has had the unfortunate effect of implying that these cultures were astonishingly altruistic and self-sacrificial, and somehow abnormal. Yet, as I have observed at GrE, through accounts from living elders, traditional cultures that thrive without money or markets have utilized myriad resource coordination and exchange systems such as calendars, ledgers, indirect reciprocity, accounting, debt systems and resource pooling. The communities we have worked with have shown themselves to be pragmatic in their pursuit of sustainable socio-economic structures, challenging the notion of solely altruistic motivations.

I founded GrE without a deep understanding of these non-monetary systems, by following the path of Community and Complementary Currencies as described by Bernard Lietaer (2013). This inspiring field led me to believe that by redesigning or reinventing money, I could bring about systemic change to advance well-being.

With this optimism, I began introducing these concepts with local communities in 2010 by sharing information about projects like Worgl in Austria, Deli Dollars (now BerkShares) in Massachusetts, and Bancos Palmas in Brazil. All of these projects had developed some form of community money, a bearer instrument that could, under certain conditions (which we will expand on further), act as a medium of exchange.

Following this introduction by 2014, dozens of initial groups in Kenya developed their own common voucher denominated in national currency (Kenyan Shillings). Vouchers were divided among participants based on their capacity to offer goods or services to the community. The vouchers represented commitments created by group members, redeemable as payment for their goods and services. Features like demurrage – the gradual expiration of the usable quantity of vouchers held by anyone and renewed into a community fund – helped discourage hoarding and encourage circulation.

It was a worthwhile strategy, yet it sometimes felt strange to apply a complex jumble of modern economic concepts to social circumstances in Africa. The ideas did not have clear grounding in the cultural situation of the communities. As a result, we see some groups performing worse than others, which prompted an inquiry. It turns out that a social contract among voucher-issuing groups was the key their sustained usage and impacts.

3.1 Formalizing Mutual Service Practices

GrE found the successful voucher using groups were those practicing Mweria, an indigenous tradition of the Mijikenda tribes on the coast of Kenya. Generally, the terms like Mweria refer to a tradition of mutual services as well as a collective noun for people. In many languages, the collective nouns for a ‘group’ of humans appear to be the names of types of mutual service groups.

These ancient mutual service practices exist across the globe, as described by Wang (2014), and are known in academia as Rotating Labor Associations (ROLAs). They are primarily a means of gathering commitments for resources (good and services) of the community and fairly exchanging them, but have the effect, as well, of building social cohesion and sharing skills. They coincided with seasonal transitions and many aspects of life such as education, cooking, weddings, and funerals. Typically, one person or family gives commitments of support to others and, in return, draws on the commitments of others to meet their own needs such as farming, building houses and grain stores, and teaching their children.

As GrE began to understand the dynamics of Mweria (see Figure 1), we began to discover other names for these ancient traditions elsewhere. We found voucher-using groups among the Luo tribe near Lake Victoria with a similar tradition of Nyoluoro, and the Kamba and Kikuyu in Central Kenya who used a similar system called Mwethia and Gobato, among many others. They seemed to be everywhere, in all indigenous communities and languages we could find within Kenya and our partners in other countries.

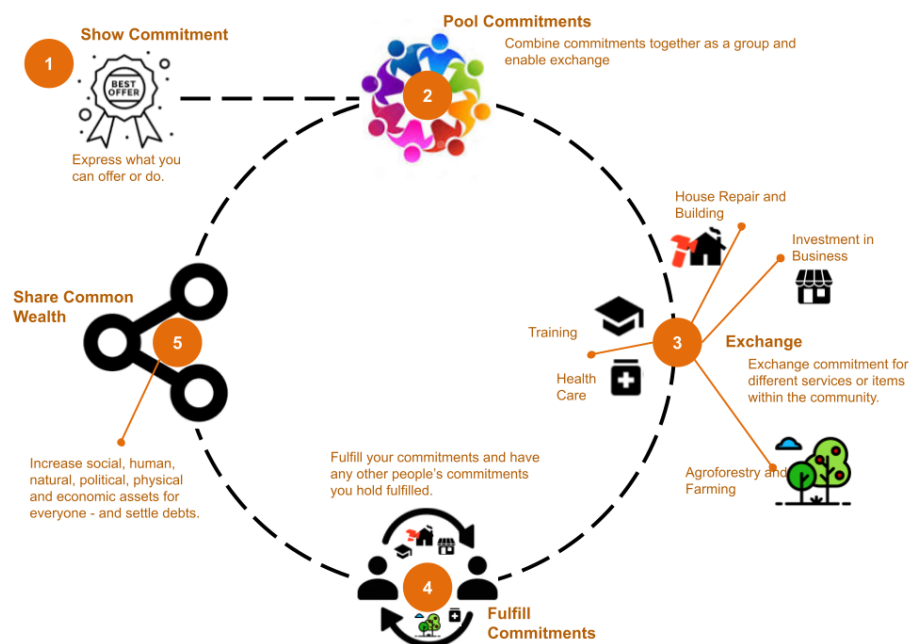


Figure 1: Generalized ROLA-style Mutual Service Tradition

In the Kwale-based communities that GrE has been learning from, these practices disappeared and/or transitioned around the time of colonization, according to Chibwara (2023). "Duruma people started working for money rather than for each other," said a village elder. "The last Mweria I saw was in 2003, when I was 17. It's amazing to see the practice coming back!" Soon after 1901 colonizers forced the Kenyan population into hut-taxation, a regressive tax imposed on households regardless of their income, levied as wage slavery, an alternative to chattel slavery that began with the earlier colonizers. Consequently, the long-standing tradition of mutual service began to disappear. A local saying speaks to how people viewed the new system of hut taxation: "Those who would lose their traditions become slaves."

Many of these traditional ROLAs became or were replaced by so-called Rotating Savings and Credit Associations (ROSCAs). These systems were also known as Village Savings and Loan Associations, Savings and Internal Lending Cooperative, or more commonly in East Africa, Chama or Merry-Go-Round. Instead of pooling commitments of goods and services among each other, people started to pool their (often very limited) national currency. While the ROLA traditions helped them build homes and entire farms, the pooling of cash served as a peer-supported savings mechanism. In a typical merry-go-round, each member of the group contributes a fixed amount of money, usually on a regular basis, into a communal fund. Each person would, for example, contribute ~100 Kenyan Shillings weekly to a different member of the group. The pooled amount of ~100 KSH * number of members is then rotated among the members, with each member receiving the pooled sum on a rotating basis.

In recent years, the GrE team realized that many groups were starting to pool their vouchers, much as a ROSCA pools holdings of the national currency. At each meeting, the group would give a member an allotment of vouchers (i.e., commitments for resources), and then spend them during the week, either in synchronous group activities like collectively building a grain store or asynchronously by "spending" voucher-commitments individually. Instead of pooling scarce cash, group members were pooling a group commitment, via a group-issued voucher, one that members could create themselves through GrE's Sarafu.Network. In essence, the shared value no longer needed to revolve around Kenyan Shillings.

The pooling of the group-issued voucher more than doubled the number of community farms and houses developed yearly from GrE's previous work. This promoted 'market days', periodic events where sellers directly interacted with buyers, as opportunities for people to use their vouchers to buy and sell goods and services individually, in a classic

market sense (i.e., exchange without pooling). However, once ROLA-like pooling traditions were combined with vouchers for commitment pooling, GrE saw a remarkable surge of social benefits: increased skill sharing, a greater sense of group purpose, social cohesion, and trust, greater individual participation in governance decisions, increased environmental restoration work, and more infrastructure construction. GrE also saw an aggregate increase in people's financial assets such as savings of Kenyan Shillings, reduced debt, and more mutual commitments being made among group members. According to Njoroge (2023), the impact from these GrE programs has been overwhelmingly positive. Nearly 100 groups are practicing 1,637 voucher-based ROLA traditions in less than one year as of December 2023. Over 30 houses have been built, and over 139 farms developed and improved in 2023. While before the ROLA traditions, utilizing vouchers for markets alone, GrE did not see any large asset development but rather increases in exchanges.

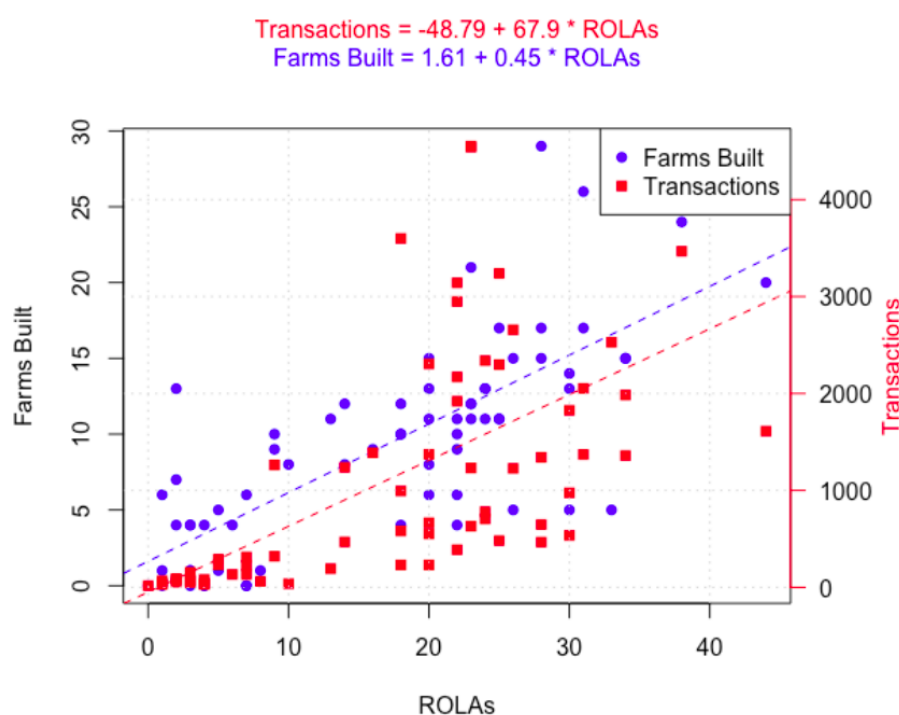


Figure 2. Voucher Exchanges/Transactions and Farms Built per ROLAs conducted

Figure 2 suggests that as voucher-based ROLAs increase, farms and exchanges of goods and services also increase, based on data collected from Kenyan rural communities from June to December 2023. Employing a simple linear regression, holding other things constant, an increase in one event of ROLA conducted by the group increases transactions or exchanges of the group-issued voucher by 68 times. The effect on farms built (among other asset developments like housing) is much more modest, but still positive. Without ROLAs, there are still 1.61 farms built but introduction of ROLAs increases it by 0.45.

The GrE team has worked with over 100 groups since 2010, of which 15 completely stopped using their vouchers. It is worth focusing on the reasons why. Those groups that disbanded or barely used the vouchers generally regarded the group-issued voucher as a 'money'. People had little or no sense that they themselves were personally responsible for it. They treated the vouchers as if they would simply be accepted like national currency, no questions asked, even though no one had an obligation or liability to do so. Unsurprisingly, these people saw the voucher system as a poor replacement for the national currency. Other factors also contributed to abandonment of the vouchers, such as political factors, loss of trust and inability to use the digital system. These results seemed to be a testament as well to Ostrom (1990)'s seminal paper on Commons Governance, where a clear definition of domain and responsibilities are required to maintain a healthy commons. In particular, GrE found that the more clearly defined the commitments are for specific goods and services underlying the vouchers (i.e., Kenyan Shillings worth of farm labor, hair salon, day care, tomatoes), the greater the observed impact. Within the groups using a single group-issued voucher, the process of defining commitments to each other became the basis for the usage of the

shared voucher to be circulated within them. For example, if member A commits KSH 100 of tomatoes, member B commits KSH 100 of potatoes, and member C commits KSH 100 worth of cabbages, the group-issued voucher then comprises the basket of these goods or services or the pooled commitment. When rotating this group-issued voucher to member A, then they will receive all three of the committed goods of tomatoes, potatoes, and cabbages.

Then, surprisingly, individuals with ties to different voucher networks, i.e., those who belong to 2-3 distinct ROLAs, began to act as brokers, offering to exchange their pool of vouchers, enabling people to trade with “outside” networks. GrE’s trainers (a.k.a. Grassroots Economists) working with and being paid in vouchers by several groups would also act as natural brokers. In addition, with the online functionality GrE built at Sarafu Network, we saw the use expanded beyond group-issued vouchers. Individuals and businesses began issuing their own vouchers, gift cards, loyalty points and subscriptions.

With the success of voucher-issuing ROLAs, I had to ask myself, ‘When does the idea of a group-issued voucher actually make sense? If both individuals and groups are now making commitments and pooling them was the basis for these time-tested mutual service traditions, should we not, at GrE, be supporting these traditions? And if so, how?’ In other words, the question facing GrE was no longer, ‘How to redesign money?’, but rather, ‘How to support pre-monetary or non-monetary practices in order to coordinate resources more harmoniously and at greater scale?’ If pooling of national currency was actually a step backward – a retreat from highly effective ROLAs to the colonial monetary system controlled by outsiders – why not support the pooling of individual and group commitments more directly?

Groups that continued to rely on their ROLA traditions saw the vouchers as a way to keep track of their individual and pooled commitments to each other. Without ROLA traditions for pooling, groups would not really care if any of the members rejected the vouchers; they saw it as an amorphous, alien system in which no one had a real stake. For instance - if Sally pays me for goods that I made with a group-issued voucher (as a general commitment against the goods and services of the members), I may see this as Sally’s debt to me, yet I can nonetheless use the voucher to acquire goods or services from someone else (Bob) who may have no such knowledge of the previous transaction. As the group voucher circulates, it can easily lose its association with individual participants and the group, and simply become an abstract, fungible, derivative, money-like object with little “meaning or relationship.” GrE discovered that the voucher-system-as-an-alternative-currency approach can fall apart quite easily without some form of strong traditions (like ROLA) or enforcers to settle debts.

Consider instead, holding Sally’s direct commitment (formalized as an individual-issued voucher) and trading it with Bob, who “lives within” the ROLA culture. Sally’s debt to Bob would not be a group commitment anymore; the ROLA tradition and its governance systems ensures that people are held accountable for their debts. A pool of such commitments – a collection that is exchangeable, but in a community that honors ROLA traditions – helps create and preserve all community relationships while enabling exchange without national currency or a singular money-like bearer instrument. As Bob sees Sally’s commitment can be exchanged with a pool of other commitments of members, he gains confidence in its value and reliability, further solidifying his trust in the system.

3.2 Practical Foundations

When working with communities, GrE started adopting what is called the Visionary Process from 2020 based on the work of the Uganda Rural Development Training (URDT) Program. This involves assessing the current realities of individuals and groups through an asset-based well-being survey. The survey encompasses the six assets of Integral Human Development according to Heinrich (2009), namely: Political, Spiritual & Human, Social, Natural, Physical Infrastructure, and Financial/Economic. We find that this approach aligns seamlessly with the African concept of ‘Kaya’, significant to various Bantu-speaking populations, representing home, clan, or society, including sacred forests, governance, all shared resources, and all parts of the community integral to its well-being (Spear, 1978). Moreover, Kaya’s multi-dimensional definition is crucial in our understanding of the interconnected nature of the resources in a society.



Figure 3. Illustration of Visionary Approach to Community Action Planning

Based on this understanding of the Kaya and asset mapping, GrE assists people in developing their vision and subsequently producing an action plan with Specific, Measurable, Relevant, and Time-bound (SMART) steps. Within this plan, the assets or resources of the family or the community are organized for a common use towards their individual and collective visions. The core methodology GrE has learned and disseminated is aiding in defining and formalizing commitments of the people, agents or organizations toward their various resources. Pooling of commitments to providing resources acts as a method of mutual service that can produce fairness and multiplier effects across all six asset classes of Integral Human Development named above.

This process of commitment pooling seems to be part of a virtuous upward spiral— as visions are fulfilled in groups and objectives are met, more assets become available to commit to and pool. This enables the realization of further visions, continuing the cycle of resource coordination toward greater and greater well-being. For instance, GrE has seen groups increasing in the assets they manage (like houses, business and houses) as well as general well being (social, skills, governance, environment) year by year following the revival of traditional ROLA practices utilizing vouchers. Commitment Pooling, executed with the use of vouchers, appears to fit the inclusive nature of the Kaya, extending from relationships to households, neighbors, villages, towns, and larger society.

In seeing the success of ROLA traditions merged with voucher usage and building upon the historical context of mutual service practices like Mweria, the development of economic protocols at GrE represents a fusion of traditional community support systems with contemporary technology. The essence of these practices, rooted in shared commitments and resource pooling, has been formalized into the Commitment Pool Protocol.

While GrE's vouchers embody the formalized and quantified commitments between individuals and groups, the Commitment Pooling protocol facilitates the pooling of these vouchers on a larger scale. This change from traditional ROLA pooling of informal commitments to digital commitment pooling through decentralized ledger technology addresses the challenges of scale and efficiency observed when traditional systems face capitalist predation. It's a transformative step that not only seeks to preserve the core values of mutual service but also expands their resilience, reach and applicability in today's diverse economic landscapes. The next section delves into the specifics of formalized commitments and the Commitment Pooling Protocol, illustrating how they might serve as modern embodiments of age-old communal principles.

4. COMMITMENT POOLING PROTOCOL

4.1 Key Functions

As we look at the indigenous mutual service practices of ROLA, there are several key functions that stand out. These functions have been formalized by GrE into what we call the Commitment Pool Protocol along with software reference implementations available at the end of this paper. With this protocol, one can create and manage a collection of commitments (formalized as vouchers). In the ROLA tradition, a group of neighbors express their commitments toward their mutual wellbeing. For example, one might promise the group a day's labor, another, 20 coconuts. The commitments are valued relative to one another, and then considered as a whole, which is analogous to 'pooling'. The ability to create relative value indices and also limit the maximum amount of any one commitment in the pool are crucial to maintain balance and de-risk individual failure to fulfill commitments. If anyone's commitments far overshadow the rest, then that system would be overexposed to the risk of that person's failure to fulfill their commitment.

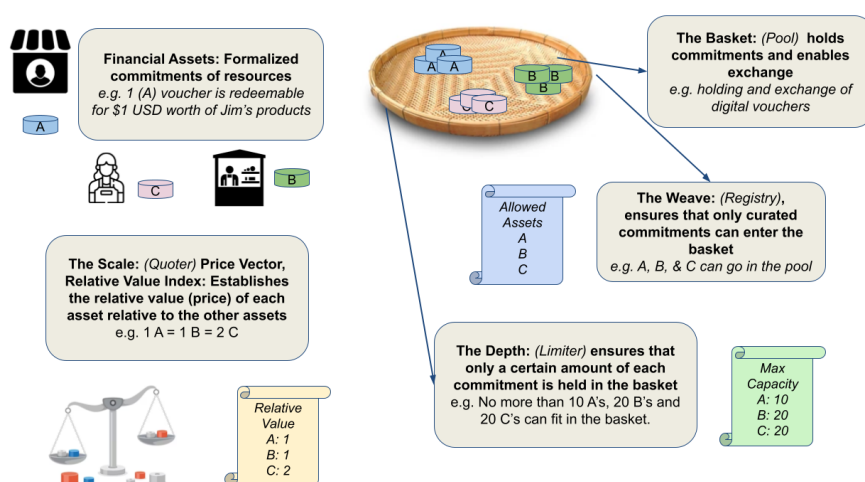


Figure 4. Illustration of a Commitment Pool

Below are the basic functions of a commitment pool that can guide the building of a common protocol which can be implemented in many ways, depending on the implementing technology, capacity of the community, its cultural context and their legal environment:

Key Protocol Functions

1. **Curation:** This is the process of selecting, organizing, and managing the various commitments that are included in the pool, with the following considerations

a. **Selection of Assets:** These can be any form of commitment formalized into an exchangeable instrument. The pool holds the assets and makes their contents exchangeable. This includes a registry or list of allowable assets in the pool ranging from goods, services as expressed in an expected output or work hours.

b. **Limiter:** specifies the maximum quantity of each commitment that can go in the pool. This can also be considered a drawing right for the assets in the pool.

c. **Quoter:** A Relative Value (a.k.a. price) Index that establishes the relative exchange value of each item in the pool - also provides an intrinsic unit of account (e.g., add or move the example here from before). Note that pricing (relative value) can be abstracted to be handled in many ways. Pricing information can also come from automated market makers, oracles, or define static rates. This gives the freedom to adjust relative value as needed by a community managing a pool. In

practice, GrE is using static rates (often 1:1) rather than fluctuating rates to make sure the systems are understandable to users.

2. **Aggregation:** This enables assets to be deposited within the pool.

3. **Peering:** This enables the commitments to be exchanged for each other based on their relative value. This may as well include fees while checking for various conditions. Note that peering is a term used to describe fair exchange and we will discuss it further.

a. Pool stewards may define a fee as a flat rate or percentage of each exchange in the pool. This can be directed to anyone that is providing deposits or a group controlling the pool and also act as an insurance fund incase of voucher defaults.

Inherited Functions

4. **Historical accounting or memory:** The ability to recall previous states for accountability.

5. **Proof of identity, authentication and permissions:** Who is liable to fulfill or able to exchange formalized commitments.

a. **Permissions:** Each function of the pool has permissions that can be granted to a group, individual, or in some context like distributed ledger, completely removed (sealed) such that no one can ever change them again. Each function of a Commitment Pool has permissions that can be granted to a group, individual, or in some context like distributed ledger, completely removed (sealed) such that no one can ever change them again.

b. **Access listing:** Should the Commitment Pool Stewards only want certain people to be able to use a Commitment Pool, they could create an allowed user and/or disallowed user list. This is also true with the Voucher contracts - they can be restricted or allowed to use by the issuer.

6. **Stewardship & Governance:** How are decisions made on curation and pool usage.

7. **Enforcement & Execution:** How are the operations of the system enacted or executed.

While in the traditional context the inherited functions would come from the physical community and governance systems, some can also be expanded on and inherited from digital operating systems, virtual machines and digital decentralized ledger environments.

All the information of a Commitment Pool implementing the Commitment Pooling Protocol key functions can be described in the following table:

Table 2. Key Functions of Commitment Pooling

Authorized Assets	Holdings	Asset Limits	Asset Relative Value (Price)
A	10	10	1
B	0	10	1
C	0	20	2

Table 2 illustrates an example of the basic enumerated functions of a Commitment Pool that would allow a maximum of 10 A and B, and 20 C in it. After an initial deposit of 10 A, anyone holding B could place them into the pool to pull out a maximum of 10 A, resulting in the following change shown in Table 3:

Table 3. Changes in Value of Key Functions after Initial Transactions

Authorized Assets	Holdings	Asset Limits	Asset Relative Value (Price)
A	0	10	1
B	10	10	1
C	0	20	2

4.2 Revisiting the Functions of Money

Let's touch briefly here on how commitment pools relate to the classically ascribed functions of money: store of value, unit of account and medium of exchange.

1. Store of value: The pool stores commitments to valuable resources.
2. Unit of Account: A relative value index that relates the value of formalized commitments (vouchers) to each other intrinsically produces a unit of account. For example, if we have 3 vouchers A, B and C, and their relative value is listed as 4, 4, 8 - then we know that the ratios of their values (A/B) produces a common measurement (unit of account). See more on Scalar to Vector Units of Account below.
3. Medium of Exchange: Classically this refers to a thing, a noun, some singular bearer instrument (digital or physical) that is exchanged in-lieu of actual goods and services. While in a pool of commitments we have no singular thing that enables exchange. Rather there is a conduit, field or exchange space created. The structure of the pool, with its relative value index, and curation of commitments - enables exchange between any commitments in the pool without a derivative or singular medium. In other words, no single currency or money is required to facilitate exchange - any voucher within the pool can act as a medium. Note that the exchange function we will describe as peering below.

4.3 From Scalar to Vector Units of Account

Scalar units of account like USD provide a single standardized (scalar) measure of value for all transactions in all dimensions of value across a market. In contrast, a vector derived from a relative price index represents multiple values simultaneously, maintaining relative worth between diverse assets without relying on a single standard measure.

Expanding from a single scalar unit of account, like the USD, into a relative price index vector is akin to Dirac's use of a four-dimensional vector in the wave equation, which revealed previously unknown states of matter. Just as Dirac's approach expanded our understanding of the physical universe, moving to a vector-based system for our units of account allows us to perceive and interact with the economic space in a more nuanced and multidimensional manner. This shift enables the discovery of new economic relationships and potentials, similar to uncovering new states of matter.

In essence, moving to vector math in economics allows for a richer, more nuanced understanding of value, reflecting the complexity of human needs and societal priorities more accurately than a single scalar measure like the USD could ever achieve. For example, instead of measuring all goods in terms of USD, a vector approach might measure bread, fish, and fuel in their respective units while maintaining their inherent value relationships.

Imagine a relative value (aka price) index like A 1, B 1, C 2 Where C (1 liter of fuel) is worth twice as much A (1 loaf of bread) or an A (loaf) and a B (a 1 kg fish) as a vector in the A,B,C space/ economic dimensions. The vector in A,B,C [1,1,2] points in a certain direction in that space. If the relative values A = 1 and B = 1 and C = 2 were based on market rates in dollars, like A = \$1 USD (of bread) and B = \$1 USD (of fish) and C = \$2 USD (of fuel) and the price index [1,1,2] is used to enables exchange between A, B and C, the rate of A to B is $\text{rate}_A / \text{rate}_B = 1/1 = 1$ and the

rate of B to C is $\text{rate}_B / \text{rate}_C = 1/2 = 0.5$. These relative values would be the same if the USD value or price shot up to 10x where it was. If A = \$10 USD (of bread) and B = \$10 USD (of fish) and C = \$20 USD (of fuel) and the price index (vector) is now [10,10,20] the relative prices are still the same; the rate of A to B is $\text{rate}_A / \text{rate}_B = 10/10 = 1$ and the rate of B to C is $\text{rate}_B / \text{rate}_C = 10/20 = 0.5$.

So the relative value index has an interesting property, instead of a scalar unit of account we have a derived price vector that can be imagined to point in a specific direction (or value) in the A,B,C economic dimension. (A) could be a formalized legal commitment (contract) against loaves of bread, B could be a commitment toward the goods and services of a group of fishermen, and C could be a commitment toward fuel. In the exchange space or pool - each commitment (a unit vector in their own space) is given a relative value to the others, creating a vector or direction in that space (pool) - all this is among a market or network of other pools. This form of unit of account derived from a relative value index is similar to what Keynes was talking about with Bancor (as a proposed global unit of account). But instead of starting with a global top-down version, each person, community, region could have their own relative value index and those can interact and aggregate into larger regional indices (and vector units of account).

So what happens with the relative value of A,B and C when or if the value of the USD were to collapse? If after a collapse A = \$10,000 USD (bread) and B = \$10,000 USD (fish) and C = \$20,000 USD (of fuel) and they maintain their relative value index as [10000, 10000, 20000] their relative values to each other stay the same. One could still exchange fish for bread at the same 1:1 rate they did before. Of course these ratios would likely change for certain commitments of resources, and the pool operators could reflect those in a new index - or decouple from the USD market in the extreme case where the USD is no longer viable.

This accounting vector can be operated on by generators to see how it interacts with a market or other conditions while preserving certain elements. Consider the relative value index vector [1,1,2] within our commitment pool. Let's apply a matrix representing market conditions across a region, adjusting the prices due to specific regional factors:

Equation 1. A change of environment affecting a price vector.

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1.5 \end{bmatrix} \times \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 3 \end{bmatrix}$$

This result shows how, even with an increase in the value of fuel (reflected by the factor 1.5 in the matrix), the pool can adapt, recalibrating the internal exchange rates without impacting the fundamental 1:1 exchange rate between bread and fish.

4.4 Implementation

The section explores strategic approaches to shifting from traditional monetary systems to a more decentralized, community-based economic model, particularly in contexts of economic instability or currency scarcity. This involves leveraging the Commitment Pooling Protocol to create a resilient, polycentric economic framework that can support communities, especially in areas like rural Kenyan villages. By fostering the creation of formalized commitments denominated in local currencies and integrating these with decentralized ledger technology, we aim to develop a robust network of mutual service systems. These systems are designed to be adaptable, ensuring community empowerment and sustainable development through direct exchanges and barter systems, thereby reducing dependency on unstable national currencies. The approach is aimed at not just mitigating the impacts of economic downturns but also at kickstarting local economies by facilitating the circulation of community asset vouchers, thereby enhancing local production, trade, and overall well-being.

4.4.1 Transition Paths

Economic Collapse vs Economic Scaffold: In an era marked by increasing economic volatility and uncertainty, transitioning to a polycentric system becomes a promising strategy for safeguarding against currency instability and promoting resilient economic frameworks. For instance, if you were worried about the collapse of the USD or any National Currency or simply wanted to strengthen it, what would you want people to do? If there were some trillions of dollars of assets added to the market—all denominated in USD—that would certainly help. Let us consider now an organization like the Organization of the Petroleum Exporting Countries (OPEC). The oil denominated in USD boosts the USD itself. OPEC's control over oil pricing and production levels has significant impacts on global oil markets and, by extension, on the demand for the USD as the primary currency for oil transactions. If everyone can (or must) buy oil in USD, it creates a demand for USD. So if communities, businesses and groups across the US were to create formalized commitments denominated in USD and have them follow the Commitment Pooling Protocol, there would be a diverse portfolio of curated assets people can exchange, thereby providing liquidity. This form of liquidity investment would be a way to do two things:

1. Scaffolding (supporting from the bottom up) a failing USD (or other National Currencies used as units of account). Consider a scenario where the national currency is fluctuating - by creating a commitment pool with assets denominated in national currency, communities can retain purchasing power and ensure continued access to essential goods, thus scaffolding the national economy.
2. Cultivating an economic commons and exchange system that is immune or resilient to USD (or other National Currency) scarcity or collapse.

As we transition from a system dependent on national currency to a larger, polycentric, mutual service-based system, we need to acknowledge our current dependency on (or addiction to) the national currency. Although USD may initially be a dominant network token (in high demand) in these systems when allowed into pools, the resilience of the system is maintained through a web of non-state vouchers bridging pools that do not require USD. Therefore, while many communities, especially rural Kenyan villages operating with a scarcity of national currency, can transition directly to networks of mutual services, others, like those in urban areas, will need to find a path, such as the production financing system, that integrates national currencies and gradually pivots through and bypasses them.

Bootstrapping and Kickstarting: Vouchers can be used to initiate entrepreneurial activities and act as capital to foster self-sufficiency. As GrE works with clients and donors to increase well-being across Kenya, they engage communities by financing their production through purchasing their vouchers. The vouchers of these communities are given to refugees and internally displaced people and marginalized groups, so that they can redeem the vouchers for needed goods and services while building a relationship beyond a pure cash transfer that can be associated with disincentivizing people to seek long-term solutions to economic challenges.

The voucher-issuing groups, in turn, help train other people and community groups to develop asset mappings, future visions, and plans to reach them. The commitments of these community trained groups are also formalized into vouchers. In effect, the voucher-issuing groups are exchanging their goods and services to the community and using vouchers as an accounting tool to ensure they receive a fair share of the production that comes out of the group. Of course, people holding vouchers may not be able to use that particular production (e.g., school fee vouchers or farm produce). This is where pooling comes into play. If the vouchers someone holds are available in one or more pools, they can be exchanged within a larger network of vouchers. Note that currently, this form of exchange is being done by pilot Commitment Pools and manually by people in these areas acting as brokers (see nodes connecting multiple colored vouchers in Figure 5). Hence, the development of pools and automated systems to increase the efficiency of these exchanges, without obfuscating underlying values and relationships (as is often the case in monetary solutions), is a driving force for this paper and the formalization of the Commitment Pooling Protocol.

More importantly for this paper is the role that pooling would play in building larger networks to accommodate housing, childcare, food, transport, and so on, such that we can fully transition into a polycentric economic space.

This is the path GrE has been championing in Kenya, reaching across Kenya and growing globally via their open source decentralized application (dApp) Sarafu.Network. People or institutions holding assets like USD are able to purchase vouchers and curate pools that bootstrap/kickstart these networks. This is, in effect, a divestment from national currencies into portfolios of utility (commitments for resources), and exchange fees (as a percentage of the vouchers exchanged in the pool) can help fund and incentivize this curation. Note that in pooling assets in a way that enables exchange, enables liquidity among larger networks providing multiple routes for vouchers to be convertible.

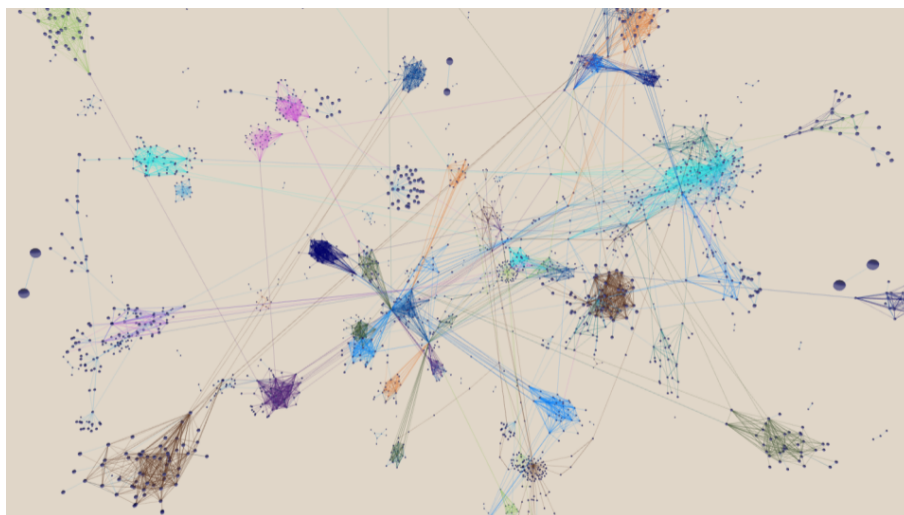


Figure 5. Snapshot of Sarafu Network Exchanges in January 2023

Figure 5 displays the network diagram of Sarafu.Network users as of January 12 2023 covering the previous 6 months, where each line represents the sum of historic transaction volume, each dot is a voucher holder, and each color is a different voucher. The distance between dots (holders) is calculated as the number of times they trade with each other (creating the clusters you see which correspond largely to community groups). Dots (voucher holders) that are connected to more than one color are acting as exchanges or bridges between the groups.

4.4.2 Technology

In order to bypass the cost of security printing paper vouchers, GrE transferred the voucher system into a digital system based on a database. In 2018, GrE moved off their single database onto distributed ledgers to ensure that the system would outlive GrE and government censorship. Some groups excelled far more than others at building farms and increasing their exchanges among each other as have been shown earlier. Larger networks of groups began to form, exchanging their different vouchers with each other. A network of non/quasi fungible unique commitments (formalized as digital vouchers) in connected curated pools on a network of decentralized ledgers seems to allow for an efficiency of resource coordination that rivals or at least supplements a lack in national currency.

It is important to note that the minimum viable technology for the pooling of commitments in mutual service practices is historically a group of humans as seen in traditional ROLA practices. No digital technologies are needed for a family, neighbors or even a clan to maintain a mutual service cycle as they collectively pool commitments in order to build granaries, houses, or farms during different seasons of the year. These practices are probably far older than we have any recorded history of. Yet modern technology has enabled the creation of common protocols and expanded these types of systems far beyond a single group of people relying on their own cognitive abilities to perform what decentralized ledgers do. So, while we move away from systems where a piece of paper or centralized digital record is meant to act as a ubiquitous medium of exchange and try to understand and reflect more indigenous systems, decentralized digital technology is one avenue. The specific form of technology that we have been building on at GrE is a decentralized ledger called Celo blockchain. By publishing vouchers as formalized commitments and pools as contracts or agreements on such decentralized ledgers, we begin

to disintermediate any one person, token, or technology provider as the executor of agreements or the record for accountability - developing the closest thing we have to an immutable system. As different technologies exist to produce more peer-to-peer systems and various and scalable consensus layers, I believe these protocols and principles will be more and more effective in developing well-being.

Copyleft and Knowledge Commons are core elements of Grassroots Economics Foundation (a Kenyan Non-Profit). We aim to ensure that generalized (globally applicable) traditional practices, once formalized, remain in the knowledge commons, accessible and modifiable by all, thus preserving their community-driven essence and preventing privatization. It is important to understand, respect and preserve the integrity and sovereignty of traditional knowledge systems. The practices I refer to, such as Mweria, are examples of systems deeply rooted in various cultures worldwide, particularly those on the brink of being forgotten or overlooked. My intention is not to appropriate, but to understand, respect, and revive these practices in collaboration with communities themselves.

4.4.3 Algorithms

GrE envisions an economy in which individuals, businesses and groups can signal commitments and exchange them widely, because a large network of trusted pools help to convert an individual's commitment into something backed by a much wider community, through the standardization of commitment pools. In this vision, one can expect to encounter a range of complicated and sophisticated scenarios. These scenarios call for algorithms that can navigate complex, multilateral trading environments. By combining the principles of graph theory and algorithmic efficiency, we can address three key optimizations: 1) maximizing multi-asset exchanges; 2) finding the best trade routes; and 3) maintaining balanced pools.

1. Maximizing Multi-Asset Exchange Opportunities: The first challenge is akin to organizing a vast, dynamic trade fair where participants have specific "want" and "offer" lists. Here, the objective is to enable as many satisfactory trades as possible. Algorithms in this scenario function as advanced matchmakers, pairing commitments with needs and utilizing networks of pooled assets to fulfill these desires. They employ iterative methods to continuously refine the trade matches, aiming to satisfy a growing number of users in each cycle of exchange while optimizing the number of successful trades. Commercial solutions like this already exist such as those mentioned by Fleischman (2020) but an open source version will be needed.

2. Optimizing Trade Routes: The second challenge is to identify the most efficient paths for exchanging assets when direct trades in single pools are not possible. This involves using algorithms to analyze various trade routes through intermediary pools, optimizing for various elements like minimal costs, geographic localization, balanced pool liquidity, and swift transaction completion. By assessing trading fees, liquidity levels, and current market values, these algorithms calculate the most cost-effective and efficient paths. The network of pools can be seen as a complex graph, where each pool represents a node and each possible swap an edge, allowing the algorithm to navigate and identify the most favorable routes. Note that solutions for effective routing are found in many decentralized exchanges such as Bancor and Uniswap.

3. Maintaining Pool Equilibrium: The third challenge is to ensure a healthy distribution of assets across pools. This involves algorithms that monitor and adjust the asset levels in each pool to maintain desired liquidity ratios, without interfering with trading. These algorithms realign pools with their target asset ratios. The aim is to optimize equilibrium with the fewest possible transactions, minimizing disruption to the overall system. Note that balancing assets in pools can be found in DAI, Balancers and many other web3 protocols.

For all these optimizations, the underlying algorithms must be adaptable, capable of responding to the fluid nature of pool liquidity and asset valuation. Transparency and trustworthiness of service providers are paramount, ensuring that every participant can rely on the fairness and security of the system. These advanced applications represent a convergence of economic principles and technology, paving the way for more efficient, and inclusive economic systems. Through these approaches, complex asset exchanges can be managed while maintaining balance and maximizing trade opportunities within a vast network of interconnected pools globally.

4.5 Use Cases

The following are several examples of implementing the Commitment Pooling Protocol within various social and technical systems.

4.5.1 Vending Machines

I will begin with a use case that might be considered mundane, where someone offers a service and simply wants national currency in return. It is important to note that the transition from a national currency centric economic system into a more polycentric mutual service system involves us tackling the current need for national currency.

Joan runs a small school and wants to sell subscriptions for her teaching services. She creates a voucher (A) worth \$100 USD of tuition fees, and also publishes a Commitment Pool and initiates it as follows:

Table 4. Illustration of Single-Service Voucher Set-up

Authorized Assets	Joan's Holdings	Asset Limits*	Asset Relative Value (Price)
(A)	0	*	1
USD	0	*	1

* Note: Max (uint256) denotes the highest number (maximum digits) possible on the ledger system.

She then places 10 of her (A) vouchers into the pool, inviting anyone to exchange them with USD. In other words, anyone can place \$10 USD into the pool and pull out her vouchers at a 1:1 rate. The pool would then contain \$10 USD and 0 (A) vouchers - note the total dollar value of the pool remains constant. This is akin to a simple vending machine, but instead of a physical product, there is a commitment/voucher, making the machine a sort of production financing facilitator. Joan places what she deems as \$10 USD worth of her asset (e.g., school tuition vouchers) in the pool and allows anyone to exchange it with \$10 USD (paying in advance), effectively giving her an avenue for production financing. Note that to remove the 10 USD from the pool, Joan could withdraw it (effectively closing the pool) or exchange it with more of her own (A) vouchers - So the pool would contain \$0 and 10 (A) vouchers. Also note that Joan has not yet set any limits.

While this example is for school tuition, a myriad of other types of commitments could follow the same model, such as a voucher for community-supported agriculture (CSA), a gym membership subscription, bus tickets, gift cards, airtime credit, and so on. This is comparable to a simple business contract, where a consultant sells a commitment for services to a client who can buy them with USD and redeem them over time for services, subject to terms and conditions specified in the voucher definition.

What makes this example different from someone going to the school and paying for next semester's tuition is that the vending machine is digital and can be accessed online, and anyone holding USD could swap them for tuition vouchers and vice versa. They could swap their remaining voucher (A)s for USD, given there is still some in the pool. Since this pool exists on a decentralized ledger, anyone with these assets can swap USD and voucher (A)s. This pool then begins to act as a general conduit or market connecting USD and voucher (A) and can be used among a network of other pools that contain USD or voucher (A)s..

It is also important to note that whenever one buys a voucher in advance, they are in effect financing production. The voucher issuer selling their voucher is getting some value (money or in-kind) up-front and is obligated to pay back the 'loan' in product (goods or services) (aka redeem the voucher) as specified by the terms of the voucher.

4.5.2 Collateralized Assets

The above case might seem risky. What if Joan does not accept back the vouchers, or her teaching (products or services) is not at the quality promised? While this can be handled under contract law and by state or community

legal systems for formal commitments, those processes are cumbersome and expensive. Seeing that her clients want some form of collateral, Joan adds more assets to her pool as follows:

Table 5. Illustration of Adding Diverse Vouchers to Joan's Pool

Authorized Assets	Joan's Holdings	Asset Limits	Asset Relative Value (Price)
(A)	10	*	1
(B)	0	10	1
(C)	0	10	1
USD	0	*	1

In the above pool definition, Joan has allowed vouchers B and C drawing rights in the pool. These might be assets she owns or they might be an invitation for others to place their vouchers in the pool, such that they can be exchanged for her vouchers or USD. Note that because of the Asset Limits she imposed (10 each), anyone holding (B)s or (C)s wanting to take any other asset out of the pool would be limited to a drawing right cap of 10 vouchers (B) or (C) that can go into the pool - this is a method of limiting risk and overexposure.

Let us assume Joan owns some of these other (B) and (C) assets, which are tuition / subscriptions to other schools in the area. Possibly she is in a close relationship with these other schools and seeds the pool by placing 5 of each into the pool, along with the existing 10 of her own vouchers (A).

Table 6. Changes in Joan's Pool After Setting Holdings for (B)s and (C)s

Authorized Assets	Joan's Holdings	Asset Limits	Asset Relative Value (Price)
(A)	10		1
(B)	5	10	1
(C)	5	10	1
USDC	0		1

As before, a buyer can place USD in the pool and pull out 10 (A)s. If for some reason the buyer does not want Joan's teaching services or they are unavailable, they could swap them ex. for 5 (B)s and 5 (C)s, acting as a form of collateral and increased utility. This might be useful when moving to a new area and changing schools.

Table 7. Changes in Joan's Pool After Buyer Swaps

Authorized Assets	Joan's Holdings	Asset Limits	Asset Relative Value (Price)
(A)	10	*	1
(B)	0	10	1
(C)	0	10	1
USD	10	*	1

Following that, the buyer who bought (A)s puts them back and is now holding 5 (B)s and 5 (C)s. Now anyone holding (A), (B), or (C) could pull out USD from the pool. If Jane, who is the issuer of (B)s (running another small school), decided to exchange 10 (C)s for 10 USD, she would effectively be tapping into a line of credit.

Note that pool transaction fees as well as other sources could constitute an insurance fund available for people holding defunct vouchers from a pool. So while having multiple assets in the pool does give more options to holders, ultimately dealing with the risk of defaults (non-functioning or non-redeemable vouchers) would be best spread across a group of people managing the pool.

4.5.3 Cooperative Ownership

Rather than solely relying on people to curate their own vouchers in pools, which may not happen spontaneously, one can imagine a case where the pool creator has none of their own created vouchers in the pool and simply wants to create a virtual exchange filled with digital assets they own, charging fees on exchanging them. This would be akin to creating an exchange out of a portfolio of assets that allows anyone holding those specific allowed assets to exchange them for other assets in the pool. The creator of such a pool could be a financial service provider or family foundation wanting to encourage collaborations between organizations it has invested into.

In looking more closely at the situation with Joan's collateralized pool holding several school tuition vouchers, we might notice that Joan has given herself the ability to put an unlimited amount of (A)s into the pool. If Joan's vouchers are not sealed (limiting how many can be created), she could mint (create) a large number of vouchers at any point and exchange them for everything in the pool. This would be akin to a 'rug-pull' where the creators of a decentralized finance project abruptly abandon it or withdraw all the funds invested in it, leaving people with worthless tokens or losing their investments entirely.

So, how can a buyer putting USD into the pool and pulling out (A)s feel safe that they could indeed exchange their (A)s for (B)s or (C)s in the future?

One option would be for the pool creator to limit the number of (A)s that could go in the pool while sealing the pool contract so that no one can change the limits or add new vouchers. This option would make the pool fully automated, meaning there is no longer an owner, yet the exchange functions of the pool could still be executed by anyone holding the allowed vouchers in the pool. While sealing the pool is an option to limit rug-pulls and freeze governance, let us assume that there is some need for adjustment as time goes on. There may be good reasons to expand the asset offerings inside the pool, change their relative values, as well as their holding limits. These functions are governance parameters and sealing prevents the pool from serving the ever changing political and social reality.

Another option besides sealing the pool, in order to maintain the ability to govern the pool, is for Joan to share ownership rights to other schools (Jim and Bob) to be able to vote on the parameters of the pool. The simplest version of this might be a multi-signature (multi-sig) wallet, where the signatories (given signing instructions) must all sign to make any changes, or 2 out of 3 as quorum might be able to make changes in order to safeguard someone losing their signing key.

If there were exchange fees on using the pool, these could also be divided among all three owners. Indeed, fees could be split among whoever deposited vouchers in the pool as well as an insurance fund in case of default of any vouchers in the pool to help in the maintenance and balancing of the pool.

Note that an initial or seed asset that is in high demand, could be used to start off a pool and curated voucher issuers could be approved to have a drawing right within the pool such that they can swap in their vouchers for the initial seed. This seed asset would be able to be exchanged for any other asset in the pool and could also represent a voucher or formalized commitment for some services.

4.5.4 Indigenous Mutual Service

As the concept of pooling at GrE formed around learning from indigenous mutual service, i.e., ROLA traditions such as Mweria, it is important to come back to them as a use case for other communities with similar practices. Traditionally, a group of people would commit to supporting each other with goods and services. One person could call upon the commitments of the community and in return give their own over time. Based on the formalization from our Commitment Pool Protocol, each person would formalize their commitment to services (as a voucher) and place these into the pool with a committee (like village elders or group leaders) managing permitted assets, limits, and relative values. Contrary to the previous examples, labor is not necessarily swappable with USD since ROLAs don't generally use money. However, there might be instances where hired labor is mixed with ROLA commitments. For this illustration, we keep it purely non-monetized.

Table 8. Initial Group Pool Allocation for Indigenous Mutual Service

Authorized Assets	Group's Holdings	Asset Limits	Asset Relative Value (Price)
(A)	10	20	1
(B)	10	20	1
(C)	10	20	1
(D)	10	20	1
Sum	40		

Each voucher could be redeemable for 1 day's worth of the group member's individual services and be given an equal value to each other (i.e., one person's time being equal to anyone else's). In the example for the table above, a person (named Katana) issuing their own (A) voucher is allowed to add 3 of their (A) vouchers to the pool (as they have not reached their asset limit of 20) and pull out 1 (B), 1 (C), and 1 (D) as an example. Note the sum of all the vouchers in this example pool will always be 40 when exchanging because in this case, the exchanges are without additional deposits or withdrawals.

Table 9. Changes in Group's Holdings

Authorized Assets	Group's Holdings	Asset Limits	Asset Relative Value (Price)
A	13	20	1
B	9	20	1
C	9	20	1
D	9	20	1

Katana, the holder of (1,B,C &D) could then request support, where the other members redeem their (B)s, (C)s, and (D)s in return for building a classroom that (A) needs. The next week, Njeri who issued their (B) voucher in the pool could put 3 more of their vouchers into the pool and pull out 1 of each of the others (as Katana did):

Table 10. Changes in Group's Holdings After Decrease in (B) vouchers

Authorized Assets	Group's Holdings	Asset Limits	Asset Relative Value (Price)
(A)	12	20	1
(B)	12	20	1
(C)	8	20	1
(D)	8	20	1

The holdings in the pool can be seen to represent the current debt that Katana and Njeri have to the rest of the group. Looking at this from the point of view of their balance of trade, Katana (A) and Njeri (B) have a debt of 2 vouchers (2 days of work), while Mary (C) and Fatuma (D) have a credit of 2 vouchers each. If we subtract all the credit (2+2) and debt (2+2) in the pool, we always reach an overall balance of trade (0).

This system satisfies the traditional mutual service example while also giving several opportunities for the group to choose to include other commitments like those of their neighboring village. Also each person can have commitments in several pools, acting as a bridge between them. This network of pools connected by shared commitments can act as a polycentric economic system.

5. CONCLUSIONS

5.1 Challenges

There are several key challenges and opportunities in cultivating networks of pools and performing resource coordination across vast regions and diverse assets.

Governance: A pool requires a robust governance structure to oversee its operations effectively. This governance model should delineate clear roles and responsibilities, ensuring that decision-making processes are transparent and inclusive. It must adapt to the evolving needs of the pool and its users, addressing any changes in the pool's environment. This governance framework will be instrumental in maintaining the integrity of a pool, ensuring that it operates efficiently and in the best interests of all participants.

Managing the Risk of Default: Managing the risk of default within the vouchers held in a pool is critical. This involves setting up mechanisms to monitor the creditworthiness of voucher issuers and assess the reliability of assets included in the pool. Strategies to mitigate risk include limiting exposure to high-risk vouchers and setting up contingency plans for a voucher no longer being redeemable - like insurance mentioned below. This risk management is essential to maintain trust in the pool and ensure its long-term viability. In the event of voucher defaults within the pool, the pool must have a clear and effective process for handling such situations. This would include removing the defaulted voucher from the registry of allowed vouchers, adjusting the relative value of the voucher to zero, and implementing strategies to stabilize or re-balance the pool with similar vouchers. Establishing loss protocols ensures the pool can maintain stability and continue operating even in the face of individual asset failures.

Implementing insurance mechanisms within a pool could provide additional security against defaults and other risks. Such mechanisms could involve insuring assets within the pool, with premiums or storing exchange fees into an insurance fund. This insurance would offer an extra layer of protection for pool participants, enhancing the overall safety and appeal of participating in holding pooled assets.

Tech and Interfaces: Maintaining polycentrality with the technology and interfaces requires reference implementations for formalized commitments and pools. As the world becomes more accustomed to holding diverse assets like airline miles, credit cards, mortgages, and loyalty points, and as more voucher-like instruments are created down to individuals, and groups making their own formalized commitments, the complexity may become overwhelming. While using algorithms that support trade route finding and balancing, the challenge is to make intuitive seamless user experiences.

A wallet assistant (a person, AI-driven, or algorithmic) could analyze your personal asset holdings, examine all possible routes that connect you with the products you want, and adjust the value of the end product in terms of your own convertible assets. This could be done in a way where the vouchers and pools are simply backend data structures, and the user is simply buying products via a market interface that handles all the complex routing.

Utilizing the rich backend infrastructures on decentralized ledgers and developing seamless user interfaces as services, that are themselves not centralized and vulnerable to denial of access, is a huge challenge that needs support and coordination via a community utilizing the same protocol of commitment pooling.

Legal: The legal status of issuing, selling, and exchanging vouchers or digital assets has a strong precedent in existing store loyalty programs, bus tickets, and so on. Using national currency in these systems, calculating and paying taxes (when vouchers are sold for national currency) can be straightforward, similar to buying or selling a gift certificate. While there is currently an opening to help people to express their valued offerings as vouchers (formalized commitments) and pool them, there is a labyrinth of existing and potential legal caveats across hundreds of legal jurisdictions across the planet. Keeping up to date with these and ensuring that these systems are able to operate is a huge task that needs coordination.

Formalization: Formalizing traditional Rotating Labor Associations (ROLAs) and more generally Commitment Pooling into contemporary legal and technological frameworks presents several challenges, akin to the integration of Kadhi Courts within the Kenyan constitutional framework. These challenges stem from the intrinsic differences between ancient communal practices and modern legal and economic systems, and include:

1. Cultural Preservation: Translating Commitment Pools into legal language without losing cultural essence.
2. Technological Inclusivity: Developing accessible digital tools that respect traditional practices.
3. Legal Framework: Achieving legal recognition that respects Commitment Pools' unique, non-monetary nature.
4. Dispute Resolution: Integrating traditional conflict resolution within a formal legal structure.
5. Economic Integration: Valuing non-monetary contributions within the broader economy.
6. Community Autonomy: Maintaining grassroots control amidst formalization and scaling.
7. Regulatory Navigation: Aligning Commitment Pools with existing policies and regulations.
8. Adaptability: Ensuring the system remains flexible and sustainable as communities evolve.

5.2 Future Perspectives and Recommendations

Reviving traditional ROLA practices like Mweria has and will continue to help build resistance and independence of the colonized and impoverished people of Kenya. GrE's digital implementation enables Mweria to work at larger scales more suitable to a regional economy. But in the event of a failure of the technology, or indeed the economy, neither of which can be discounted as climate change starts to bite, the Mweria tradition ultimately exists between the people and would be a life-saver in such circumstances.

Overall, I see a future trend of moving back toward indigenous practices, in the form of digital voucher pooling. Below are some key recommendations for future work:

Research: As these tools have been used and become more available, transparent collection of public and anonymous data is available for analysis, AI training, and algorithm creation. Randomized control trials and impact analysis have become easier over the years using this data. Using the foundational protocol of Commitment Pool, one can now model the existing economic system as it is, as well as the transition to a more resilient polycentric ecosystem.

Healing Business Relationships: Employers and employees could change their relationship to one of mutual service, where the employee turned consultant values their services in the form of a voucher, which is sold to their employer turned client. Pools of such vouchers could derisk business contracts and create new organizational and cooperative structures.

Divestment into Utility: Changemakers, impact investors, and philanthropists could buy the vouchers of impactful organizations and individuals offering needed services and pool them together to enable cross-pollination and the development of local or thematic economies. They could retain a fair stake themselves with exchange fees that could be reinvested or distributed. Note that expiration on vouchers and pool fees provide several avenues for local taxation, basic income and supporting social services.

From Donations, Grants and Aid to Local Sustainable Production Financing: I have been inspired by Village Savings and Loan Associations (VSLA) and Savings and Internal Lending Cooperatives (SILC) as forms of Rotating Savings and Credit Associations (ROSCA). Firstly, because they are extensions of the ancient practices of Rotating Labor Associations - albeit they depend on external commitments (national currency). Secondly and most importantly, I am inspired by how they became viral and spread across Africa. SILC was developed and initiated by the Catholic Relief Services (CRS) while Care International initiated VSLA, a very similar model.

After over 20 years - SILCs and VSLAs are still growing and nearly ubiquitous as methodologies - yet most people on the ground have no idea Catholic Relief Services and Care were behind this. Perhaps this success in adoption of VSLA and SILC can be explained by how they incorporate best practices for pooling resources and dealing with scarce national currency, debt and community processes - but there are many great interventions that do not take off and scale. From my perspective, what CRS and Care did right was to ensure that the trainers - who still to this day offer their services to help setup and support VSLAs and SILCs - **were paid by the community themselves** for their services. Their commitments to supporting the community in a needed way are rewarded by the community themselves when they have enough cash. This caused and continues to cause a chain reaction that still works today.

Grassroots Economics - following this model ensures that trainers can be paid by the community **regardless** of the community having national currency. The community pays with their vouchers (commitments of resources). The trainers therefore have an incentive to make sure that the vouchers can be redeemed, creating a virtuous cycle - building community assets and importantly trust. With many such vouchers in circulation the ability to exchange between them builds further resilience and is the main focus of commitment pooling.

Vending Machines to Networks: Starting with national currency-denominated vouchers and pools involving national currency allowed vending machine-like contracts, we can model and integrate with much of the existing economy. At the same time, we provide the option for a transition path for people holding vouchers to exchange them directly through pools. This is a strategy, where we enable everyone to express their value in vouchers and add them to pools or support them to create their own. In some communities that have no access to national currencies, they can support each other by creating pools of their resources as is done in traditional mutual service. For other communities, the transition from a centralized national currency economy into a polycentric one will take more time but is entirely possible if at all necessary. With the ability to seal pool contracts and make them permissionless, there is also the possibility of censor-proof exchanges to safeguard against state overreach.

5.3 Encouragement

In this prospective report, I've attempted to appreciate the ancient wisdom of ROLAs and distill these learnings into the formalization of the Commitment Pooling Protocol. For me, it is more than a mere tool or protocol; but can

lead toward an embodiment of mutual service, and shared well-being, reflecting our interconnected efforts to sustain and nurture our communities.

My observations as part of Grassroots Economics (GrE) have shown that commitment pooling protocols and principles transcend geographical and cultural boundaries, offering lessons that can revolutionize economic practices globally. We've seen how commitment pooling can foster unity and strength, akin to the interwoven roots of grass holding the soil together. The realization that we are surrounded by forms of intention and commitment from bus tickets and loyalty points, to gym subscriptions and telecom airtime credit - begs the question; how can we all express our commitments and pool them together for our mutual well being?

Looking ahead, I hope these insights inspire further exploration and innovation. I invite global thinkers and communities to adapt Commitment Pooling to their unique contexts, facilitating polycentric economic systems focused on well-being and sustainability. The blend of indigenous practices and technology being pioneered at GrE offers a practical pathway to more inclusive and resilient economic systems, aligned with overall wellbeing.

In conclusion, the journey with GrE is an evolving story of discovery and growth that I am grateful to be part of. We stand at a crossroads where ancestral wisdom meets technological potential. This journey requires humility, collaboration, and dedication to the greater good. I am thankful to everyone who has joined and supported this path and look forward to the future.

By sharing these findings, I aim to spark a global dialogue on building economic systems that prioritize well-being. This paper is an invitation to join in a shared journey toward a future where economics encompasses more than finance, embodying a harmonious blend of intentions and shared prosperity.

GLOSSARY

1. **Commitment:** A promise that requires a non-returnable investment of resources on the part of the promiser.
2. **Commitment Pooling:** Aggregating individual commitments or resources to create a more equitable and collaborative economic system.
3. **Digital Decentralized Ledgers:** Technologies like blockchain used for creating immutable records of transactions and commitments as well as executable contracts that implement the Commitment Pool protocol.
4. **Grassroots Economics:** An approach focusing on bottom-up, community-driven systems, emphasizing resource coordination and mutual service.
5. **Integral Human Development:** A development model inspired by the Catholic Relief Services, encompassing six asset classes: Political, Spiritual & Human, Social, Natural, Physical Infrastructure, and Financial/Economic.
6. **Kaya:** A word in the Bantu language group, representing home, clan, society, sacred forests including shared resources and integral parts of community well-being.
7. **Mutual Service Traditions (Mweria, Nyoluoro, Gobato, etc.):** Indigenous practices of pooling resources and commitments for communal support, found in various cultures.
8. **Peering:** Fair exchange of resources
9. **Polycentric Systems:** Economic systems with multiple decision-making centers, focusing on decentralized, non-monetary interactions.
10. **Pooling:** Collecting assets for common usage.
11. **Promise Theory:** A framework examining the development of trust in systems of agents.

12. **Rotating Labor Associations (ROLAs):** Traditional systems of pooling labor and resources for communal projects.
13. **Rotating Savings and Credit Associations (ROSCAs):** Systems where community members pool monetary resources, usually rotating the distribution among members.
14. **Commitment Pool:** A protocol that facilitates the curation, management, and exchange of assets.
15. **Vouchers:** Formalized commitments representing a promise to redeem for specified goods or services with terms and conditions.

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ACKNOWLEDGMENTS

Thanks so much to Matthew Slater, Patricia Marcella Evite, Leander Bindewald, Aude Péronne, and David Bollier who gave extensive edits and helped clarify the concepts in this paper.