BLOCKCHAIN TECHNOLOGY
AND THE GOVERNANCE OF
FOREIGN AID

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Abstract

Blockchain technology has been considered a vehicle to foster development in poor countries by promoting applications such as secure delivery of humanitarian aid, digital identity services, and proof of provenance. This article examines whether (and if so how) blockchain technology—if appropriately designed—can enhance the effectiveness (and efficiency) of foreign aid governance, thereby moving beyond completely anonymous contexts. Foreign aid governance is plagued by lack of credible commitments among states which are further exacerbated by information asymmetries and which often undermine aid effectiveness. In this context, blockchain technology holds two promises. First, through guaranteed enforcement of smart contracts, it can strengthen the credibility of state commitments, for example collective burden-sharing rules among a group of donors or recipient-country compliance with policy conditionality in return for aid. Second, through leveraging prediction markets, blockchain technology can allay information problems related to the verification of real-world events along the entire aid delivery chain. Overall, the article shows that blockchain technology can be understood as a mechanism with institution-like features, with significant potential to complement real-existing institutions. The article also suggests that deploying blockchain technology in semi-trusted environments and at the international level avoids many of its well-known disadvantages.

Keywords: Foreign aid, Blockchain, Ethereum, smart contracts, international organizations, World Bank, New Institutional Economics

JEL Codes: F30, O19, O30

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1. Introduction

Blockchain technology—a cryptographically linked digital ledger of transactions distributed across all participants of a peer-to-peer network—has enabled 'trustless' interactions among individuals without the need for a central authority. As a new ‘platform technology’ (Allen 2017), it has spawned a wide array of use cases, from cryptocurrencies, land registries, supply chain management, e-government, and delivery of humanitarian aid (Hileman and Rauchs 2017; Swan 2015; Wellisz 2018; Wigley and Cary 2017).

From an economic perspective, blockchain technology is a new type of ‘economic institution’ (Davidson, De Filippi, and Potts 2018). While blockchain technology may increase factor productivity, reduce transaction costs, and enhance market efficiency, its key benefit is to offer “an alternative organizational mechanism to reach agreement about economic facts” (Davidson, De Filippi, and Potts 2018, 11), alongside established institutions such as markets, firms, the state, or relational contracts (Hodgson 2015). If this is so, then blockchains should have the highest use potential in areas where traditional mechanisms to reach consensus are flawed. To many policy experts, one such area is foreign aid.

The key dilemma in foreign aid is the ‘broken feedback loop’ between individual donors and ultimate recipients of aid (Svensson 2006). The difficulty for donors to reliably measure outcomes and to verify recipient behavior makes it difficult to establish consensus about the facts upon which aid relations are built. To a large extent, aid agencies can be understood as institutional solutions to these challenges because they can intermediate between individual donors and ultimate beneficiaries (Martens 2005). However, the creation of aid agencies—as donors of so-called Official Development Assistance (ODA)—generates new challenges. For instance, despite high-level donor pledges to design aid interventions sustainably, organizational incentives within donor agencies, strategic interests, and limited transparency often give rise to inefficient spending, with negative repercussions on aid effectiveness (Monkam 2012). In bilateral aid relationships, the key problem is that recipients often do not follow through with promised reforms while donor countries disburse aid nonetheless due to conflicting motives (Swedlund 2017). In the case of multilateral aid, a key problem is that individual donors renege on their promise to share a collective financing burden for joint development programs (Mascarenhas and Sandler 2006). In all the above cases, actors are unable to make credible commitments because effective institutions that would allow them to do so are missing.

In this article, I explore the potential of blockchain technology to enhance the effectiveness of foreign aid governance, building on the notion that blockchains
are a mechanism with institution-like features. Blockchain technology can improve the functioning of existing institutions—understood as systems of social rules that structure social interactions (Hodgson 2006)—both formal and informal. An example of an informal institution in foreign aid governance is the practice of ‘conditionality’ whereby donors provide funding for development only when recipients satisfy certain conditions. By contrast, international development organizations (IDO) such as the United Nations entities, the World Bank, and the International Monetary Fund are formal institutions, many of which uphold informal institutions through their activities. IDOs maintain administrative structures that make them the most centralized institutions in world politics and that allow them to collect information, verify compliance, and enforce commitments. While centralization helps allay some collective action dilemmas in aid governance, it increases transaction costs and generates ‘agency slack’ (Martens et al. 2003; Nielson and Tierney 2003; Vaubel 2006).

Blockchain technology can enhance the effectiveness of the currently existing aid governance institutions in at least three ways. First, blockchain technology allows states to make more credible commitments. To that end, countries would need to codify all aid relationships as ‘smart contracts’ (residing on a blockchain) to import guaranteed execution when predefined conditions are fulfilled. Second, blockchain technology would automate routine activities of IDOs, such as the maintenance of transaction records and digital file archives as well as the settlement of procurement contracts and conditional cash transfers. Third, blockchain technology can be used to leverage hitherto untapped sources of information to verify compliance and to make better-informed policy decisions. In particular, blockchain-based prediction markets provide reliable information about real-world events which underpin aid relations governed by smart contracts.

By showing in which ways blockchain technology can enhance governance in the area of foreign aid, my article contributes to several debates in the social-scientific literature. First and foremost, it casts light on the economic ontology of blockchain, providing evidence of its institution-like properties (Davidson, De Filippi, and Potts 2018). Use cases in foreign aid delivery—often piloted by IDOs—abound, covering areas such as conditional cash transfers, digital identity, remittances, supply chain management, communal energy exchanges, and property rights (Wigley and Cary 2017). However, blockchain technology has not been applied to enhance aid governance—an area that is plagued by missing institutions (Ostrom et al. 2002, 7)—where it would in certain cases allow political institutions to function better.

Second, by showing how blockchain technology may affect aid governance, I cast light on the neglected relationship between blockchain technology and existing institutions. How does blockchain technology interact with traditional
institutions—both formal and informal? Does it coexist with these institutions, or does it challenge their primacy? My analysis suggests that on balance it is complementary rather than substitutive. It is substitutive for complete contracts, which are more efficiently handled by smart contracts, while also holding promise to reduce the cost of verification (Wright and De Filippi 2015). Conversely, blockchain technology is complementary to currently existing IDOs, which are better placed to handle contingencies, which may arise under incomplete contracting (Maskin and Tirole 1999).

Third, I contribute to a voluminous literature on the determinants of aid effectiveness and the effectiveness of international organizations more generally. Scholars have examined the various ways in which foreign aid can be made more effective, emphasizing aid allocation modalities in this regard. However, all aid modalities—such as project aid, program aid, and budget support—have tradeoffs in that they address some agency problem but inadvertently create others (Bigsten and Tengstam 2015; Easterly 2005; Knack and Rahman 2007; Martens 2005; Molenaers, Dellepiane, and Faust 2015). While circumventing recipient governments is considered to be another alternative (Dietrich 2013), it tends to shift the locus of agency problems to the non-governmental sector. Blockchain technology has the potential to enhance the effectiveness of all preexisting aid governance mechanisms. Others have examined how IDOs can become more effective (Gutner and Thompson 2010; Lall 2017; Tallberg et al. 2016), emphasizing the need for agent autonomy (Gulrajani 2017; Honig 2019; Lall 2017). While centralization fosters autonomy (Abbott and Snidal 1998), it may also create undesirable outcomes and organizational dysfunction (Barnett and Finnemore 1999). Blockchain-based aid governance—as a decentralized alternative—promises to avoid the pitfalls of centralization while removing possibilities for manipulation.

In the remainder of this article, I proceed as follows. Section 2 discusses common challenges to effective foreign aid delivery and the main institutional responses meant to address these challenges. Section 3 introduces blockchains and its existing applications related to development promotion. Section 4 explains how blockchains can be deployed to improve foreign aid. Section 5 concludes.

2. Challenges to effective foreign aid delivery

Foreign aid governance is plagued by broken promises. Aid delivery modalities—such as project aid, program aid, budget support, and results-based aid—reflect the continual attempts of policy-makers to enhance the credibility of their commitments. In a historical view though, all aid modalities thus far became unfashionable because they did not solve the collective action problems (Swedlund 2017). The inability of states to make credible commitments
highlights the lack of institutions in aid governance (Ostrom et al. 2002). In the following, taking a New Institutional Economics perspective, I systematically discuss the most common types of commitment problems in aid giving; how existing institutions and aid delivery mechanisms (imperfectly) address them; and which challenges remain to be addressed.

Private charity and non-governmental organizations (NGOs)

A significant body of research studies private charitable giving (Andreoni 1990; Mastromatteo and Russo 2017; Nunnenkamp, Öhler, and Schwörer 2013). In its purest form, private aid would involve a single donor and a single beneficiary. A key problem in this regard is that it is difficult for a potential donor to identify a recipient with specific needs important to the donor. Currently available technology facilitates individual donations by creating matching markets.¹ A central authority administers a platform to create matches and ensure a ‘feedback loop’ on aid donations. For such platforms to be effective, participants on both sides must trust the integrity of the central authority, for example to use personal data only for intended purposes. Participants may be liable to pay a fee to use the service. In case of information asymmetries (and prohibitively high verification costs for donors), the agency can expend less match-making effort than desired by the donor.

Non-governmental organizations (NGOs) are aid agencies that often develop expertise in a single development issue. Specialization largely is the result of structural forces, such as the ability to generate public attention for concrete development challenges and to mobilize donor resources based on single issues (Aldashev and Verdier 2010). By pooling contributions from individual donors with similar preferences, NGOs can afford the fixed costs of screening potential beneficiaries and monitoring beneficiaries during project implementation. However, because NGOs operate in a competitive environment, they face incentives to under-emphasize project failures and divert resources to fundraising rather than project implementation (Cooley and Ron 2002). NGOs also do not have incentives to coordinate their interventions, which may lead to inefficient duplication. Hence, while private aid provision through NGOs alleviates the challenge of peer-to-peer donations to ascertain the trustworthiness of potential beneficiaries, it generates additional challenges relating to the organizational incentives of NGOs that operate in a competitive aid industry.

Official development assistance—bilateral aid

Bilateral donor agencies essentially exist as a (coercive) solution to a collective action problem among donor-country citizens with heterogeneous aid preferences (Martens 2005). Bilateral aid involves a bilateral donor agency and an official counterpart in a recipient country concluding an aid contract. An aid
contract is an institutional arrangement that mitigates (but not eliminates) risks arising from misaligned preferences. Through the lens of the principal-agent framework, the donor is the ‘principal’ that delegates implementation responsibility to the recipient as its ‘agent’—which has superior knowledge about local conditions and potentially divergent interests. Information asymmetry and divergent interests create agency problems that donors seek to address by taking precautionary arrangements, such as ex-ante contract design and ex-post controls (Martens 2005; McCubbins and Schwartz 1984; Moe 1984).

In project aid—the most commonly used modality—donor governments can ex-ante specify the types of interventions and thereby limit the flexibility of aid funds for the recipient. Project implementation is often delegated to an entrusted contractor. While aid projects are likely to achieve their intended outcomes, their aggregate effects may be weak because they fail to internalize their effects on the wider economy (Mosley 1986). In addition, as control lies primarily in the hands of donors, recipient-country ownership is weak; the involvement of a contractor adds another actor in the aid delegation chain, with the risk of increasing agency problems because contractors may have private interests beyond project success.

In program aid, and so-called ‘general budget support’ as its purest form, donors transfer aid to the recipient without further specifying inputs (Molenaers, Dellepiane, and Faust 2015). This increases the ex-post risk that recipients redirect aid funds to purposes other than the donor-specified ones. To insure against such risk, donors impose so-called ‘conditionality’—a commitment to disburse funds when the recipient satisfies certain conditions, ranging from the introduction of public financial management systems to respect for human rights and democratic governance. While conditionality can serve as an ex-ante screening technology—making recipients ineligible that do not meet certain desired conditions—it is often used as an ex-post technology to compel compliance. Conditionality has become widely used after the Cold War as a strategy to abate moral hazard by recipient governments.

As an institution designed to solve agency problems, conditionality is not without its own problems. One is that it is not easy to monitor recipient behavior and to verify breaches with agreed conditions. Even where monitoring is possible, it is costly and thus eats up resources that should be available for alleviating development needs. A second one is that donors often cannot credibly commit to enforce conditionality, which would require them to terminate aid flows when conditions are breached (Rodrik 1995). This is difficult, especially when the donor has a strong interest in recipient welfare. Anticipating that the donor will be a ‘Good Samaritan’, the recipient will receive the aid and violate conditions because it need not fear aid suspensions (Svensson 2006).
The problems with ex-post conditionality prompted donors to employ ex-ante conditionality. In particular, donors use aid channels strategically to mitigate agency problems. When recipient governments are corrupt, donors ‘bypass’ them and channel aid through NGOs (Dietrich 2013). Bypassing can thus be seen as an informal institution that serves to reduce the preference misalignment by altogether replacing the relevant agent with a more trustworthy one. While this strategy has short-term advantages, it deprives donors of the possibility to build more capable states through direct engagement—donor countries with generally more faith in government at home are therefore less likely to use it (Dietrich 2016). Furthermore, bypassing raises agency problems on the part of NGOs, as discussed earlier.

Different bilateral aid modalities involve different agency problems. Across aid modalities, donors trade off ex-ante transaction costs versus ex-post uncertainty (Martens 2005). Ex-ante costs are highest for project aid, which involves screening recipients, identifying contractors, and preparing project documents. Ex-post uncertainty is highest for unconditional aid transfers, which give recipients considerable flexibility as regards the use of funds. In such circumstances, donors need to maintain capacities for monitoring recipient behavior and sanctioning violations. Bilateral aid relations involve a minimum degree of trust as all contracts are necessarily incomplete and specifying every possible contingency would be prohibitively costly.

*Official development assistance—multilateral aid*

A significant share of official development aid is channeled through IDOs, such as the European Union, the World Bank, and the United Nations. The essential feature of such organizations is that they pool resources from various donors which collectively delegate operational decisions over aid programs to a multilateral bureaucracy (Hooghe and Marks 2015). The conventional wisdom is that IDOs—as hubs of expertise with global presence and implementation capacities—help donor governments realize economies of scale in aid delivery (Hawkins et al. 2006). But even without relative advantages in technical expertise, IDOs are beneficial for donors with diverging development preferences regarding aid selectivity (Annen and Knack 2015).

IDOs exist as a solution to commitment problems at four levels. First, IDOs promote cooperation among donor countries when their collective effort is needed. For instance, the financing of development has traits of a pure public good (Mascarenhas and Sandler 2006; Olson and Zeckhauser 1966; Sandler 2007)—as individual contributions are near-perfect substitutes for each other—and most IDOs have institutionalized burden-sharing mechanisms to avoid cheating by individual donors (Xu 2016). Second, IDOs—widely perceived as
relatively humanitarian donors—allow bilateral donor governments to signal their developmental intentions to their own domestic audiences (Milner 2006). Third, IDOs help donors make credible commitments vis-à-vis recipients, for example with regard to enforcing policy conditionality (Rodrik 1995). From a recipient perspective, aid predictability is also a problem. While there is some evidence for bilateral aid that donors eventually disburse less aid than they originally committed (Canavire-Bacarreza, Neumayer, and Nunnenkamp 2015)—for example due to changing priorities—IDO help (partly) address this problem by increasing the cost of reneging. In return, IDOs give donors confidence that recipients will implement policy reforms. IDOs are uniquely positioned to monitor projects, verify results, and follow through with sanctions (Abbott and Snidal 1998), while bilateral donors would be constrained by competing motivations. Fourth, IDOs are useful for recipient governments as credible commitment devices for economic policy choices (Dreher and Voigt 2011), particularly in the realm of regime transition toward democracy (Mansfield and Pevehouse 2012).

In addition, IDOs exist to coordination problems. Donors generally fail to coordinate their aid activities (Fuchs, Nunnenkamp, and Öhler 2015; Gehring et al. 2016; Knack and Rahman 2007), but ill-coordinated aid imposes additional costs on stretched state administrations of recipient countries which have to deal with several hundreds of donor missions every year (Acharya, Fuzzo de Lima, and Moore 2006; Knack and Rahman 2007). Informal institutions such as lead donorship have done little to remedy this problem (Steinwand 2015). Theoretically, IDOs such as the European Union have a role to coordinate bilateral aid activities to avoid phenomena such as ‘aid darlings’ and ‘aid orphans’ (Bigsten and Tengstam 2015). However, aid coordination remains limited, as IDOs do not have the means to compel bilateral donors to abandon isolated activities and instead channel funds multilaterally.

While addressing many problems in aid delivery, IDOs are not without its own challenges. In particular, full-fledged IDOs generate significant administration costs relating to their high degree of bureaucratization. For example, overheads of around 35% for individual IDOs are not unusual, and the sheer number of different IDOs—230 major IDOs (Kharas 2007)—involve non-trivial coordination costs. To make matters worse, IDOs also generate agency costs for donors, beyond the inevitable loss of control resulting from multilateral delegation. IDOs may be able to pursue activities even beyond collectively delegated mandates (Barnett and Finnemore 1999), especially when donor countries have diverging aid preferences (Nielson and Tierney 2003). Multilateral agencies—by having local presence in almost all countries—have informational advantages over individual donors, which they may exploit to benefit their own agendas, for example by over-representing certain needs. Donor countries may contain agency drift by ex-ante measures and ex-post
controls, which increase the cost of delegation. Ex-ante measures pertain to the
design of the contract(s) between donors and agencies. There is evidence that
donors have reinforced ex-ante control over the past decade. The growing use of
special-purpose trust funds—ad-hoc governance mechanisms among like-
minded donors that provide earmarked resources to the hosting IDOs—provides
an example (Reinsberg 2017). However, while earmarking addresses the
problem of agency slack, it increases transaction costs due to negotiating
contracts, raising funds and managing them, and reporting on results.
Transaction costs also increase because donors must verify correct use of fund
resources, which is often delegated to external auditors. Indeed, several cases of
conflict were reported, leading to kickbacks of donor funds from the trustee. Ex-
post measures emphasize control of agent behavior, including measures such as
shadow bureaucracies (Dijkstra 2014), review of reports in the formal governing
bodies (Nielson and Tierney 2003), and relying on signals from watchdog
organizations such as NGOs (Weaver 2007).

In sum, while multilateral aid—the provision of pooled aid resources through
IDOs—entails considerable benefits in terms of addressing collective action
problems among bilateral donors and at the donor-recipient level, it creates new
challenges related to the institutional self-interest of such organizations. No
single best solution exists to overcome the collective action problems in aid
delivery. The nature of foreign aid—“with a broken information feedback
loop”—combined with the nature of public administrations and aid agencies—
“with multiple hard-to-measure objectives and often multiple principals”—put a
number of inherent constraints on the performance of foreign aid programs
(Martens et al. 2003, 30).

3. Blockchain technology

What is blockchain technology?

In the broadest sense, ‘blockchain technology’ refers to the combination of four
previously existing technologies: cryptography—allowing secure verification of
transactions; peer-to-peer networks—building resilience against attacks;
blockchain as a data structure—allowing anyone to validate that a given
transaction was performed; and consensus mechanisms—making central
authorities to validate transactions unnecessary (Ravikant 2013). In a narrow
sense, a blockchain merely is a data structure that encodes arbitrary state
transitions and represents them as a chain of cryptographically linked blocks
(Hileman and Rauchs 2017). Blockchains realize their full potential for practical
applications when coupled with a consensus mechanism that ensures the
canonicity of the data.
Consider how a blockchain would process a single transaction. A transaction can involve virtual currency, contracts, records, and other information. The transaction history of the blockchain is represented by a unique hash—a representation of arbitrary amounts of data with a fixed length of 256 bits. The hash is created by the hash function, which cannot be inverted to obtain the original data. A participant requests a new transaction indicating the public key of the recipient and adding a digital signature with a private key. Once propagated to the network as a new block, other participants look for proof-of-work—essentially a solution to the above hash inversion problem. When a network node finds a proof-of-work, it broadcasts the block to all nodes, which then accept it when the transaction is valid in accordance with the blockchain protocol. For example, for a virtual currency transaction to be valid, the sender must possess the relevant currency units and no currency unit must be spent twice. Nodes accept a block by creating the next block on the chain, using the hash of the accepted block as the previous hash. This terminates the transaction. Distributed to all member nodes in the network, the ledger permanently records the history of transactions that take place between network peers. All validated transaction blocks are linked from the node to the most current block, which implies that everyone can verify the complete transaction history in the network, even without knowing the exact identity of transacting parties. The consensus protocol ensures that the shared ledgers are exact copies, lowering the risk of fraudulent transactions. An attacker—for instance trying to send previously spent bitcoins to herself—would need to convince a majority of nodes that her competing transaction history is the blockchain, which is extremely unlikely as long as computational power is sufficiently decentralized (Diedrich 2016).

The unique features of blockchain technology imply advantages for certain applications compared to conventional data structures. It is particularly useful under circumstances of incomplete trust; where interactions are impossible without some error, delay, or fraud; and where some level of digital infrastructure exists (Nelson 2018). This makes it useful in any process in which participants need to access, verify, send, or store information securely, but in which a central authority to ensure the sanctity of the data is not available. These benefits must be weighed against the costs. In particular, decentralization involves the need for a consensus mechanism (a slow process that uses up a lot of energy), multiple layers of encryption, and regulatory issues. In fact, the slow uptake of blockchain technology—even in areas in which it would be most useful to do so—hints to regulatory uncertainty and lack of experience (Pisa 2018; Potts 2017). While the legal implications of blockchain technology are not yet fully understood (Deakin and Markou 2018), they are less relevant for international interactions, which are the focus of the present paper.
Blockchain architectures: Ethereum, smart contracts, and decentralized applications

Blockchain architectures consist of different layers. The so-called application layer relies on the subordinate technical layers of the blockchain which implement the above workflow. A particularly powerful tool on the application layer is the *Ethereum Virtual Machine* (EVM)—a computer running on top of the Ethereum blockchain.³

Ethereum is the primary platform to devise ‘smart contracts’—pieces of code that self-execute under pre-specified conditions (Szabo 1994). Smart contracts enable certain conditions to be imposed automatically on transactions, such as that a specified quorum of participants must endorse them, or that another transaction must be completed first (Diederich 2016). The former setup is useful for corporate accounts, to ensure that payments can only be released when a majority of managing directors agree. The latter setup is useful for market transactions, where a buyer could use a smart contract to automatically release payment to a supplier of a good once the good has arrived at a specified location (Krishna, Fleming, and Assefa 2017).

Since its launch in 2011, Ethereum has facilitated the development of a whole ecosystem of decentralized applications (dApps) that piggyback on its functionality.⁴ DApps have their backend code running on the Ethereum blockchain and thus import all its desirable properties—censor-proofness, auditability, and transparency. DApps also have frontend code and user interfaces that can refer to the backend. In contrast, non-blockchain Apps combine a user interface with a centralized server, which raises privacy issues.

An even more sophisticated application—decentralized autonomous organizations (DAOs)—link several smart contracts together to form a self-governing system (Buerger 2016; Diederich 2016; Swan 2015). A DAO is a virtual entity that has a certain set of members which have the right to spend its funds and modify its code. The members would collectively decide on how the organization should allocate its funds, for example by requiring a two-thirds majority on important issues (while participants do not necessarily have an equal number of votes). This mimics actually existing collective organizations, but uses smart contracts for enforcement.

Design choices

A key design choice for any blockchain is its consensus mechanism. Two governance models can be distinguished. In a *permissionless blockchain*, such as Bitcoin, anyone with a computer and an internet connection can write consensus data. In a *permissioned blockchain*, however, the ability to manipulate the
blockchain is restricted. Permissions can be issued by a central authority; alternatively, consortium systems rely on the collective decision of participants without involving a central authority to govern participation rights. In permissioned blockchains, the validation process is controlled by pre-selected participants. Permissioned blockchain networks do not abrogate the requirement that every node on the network perform all of the computation for the entire network, but they break this computation into particular segments and thereby increase overall performance and literally reduce transaction costs relative to a permissionless blockchain (Monax 2017). Existing closed blockchains (for example among consortium banks) are modeled upon Ethereum, which provides the necessary flexibility to encode any consensus mechanism as smart contract. The design choice of a consensus mechanism involves tradeoffs. On the one hand, permissionless blockchains are preferable for decentralized computing applications where participants cannot trust each other and trust in a central authority is undesirable—which holds true for most anonymous market exchanges (specifically in totalitarian countries). Key applications are electronic cash, identity management (importance of an unowned platform recording identity data), and Internet of Things (importance to ensure longevity even when providers terminate maintenance) (Valkenburgh 2016). On the other hand, closed systems (with pre-identified authenticated users) may be a better choice for limited-purpose decentralized computing tasks, where consensus need not be open to all potential participants and participants can be trusted not to collude against the interests of the group (Valkenburgh 2016)—for example the settlement of derivatives in a consortium of banks.

**Blockchain-based applications for promoting development**

Many existing blockchain applications hold promise to promote development particularly in the poorest regions of the world. They do so by remediing local market failures, such as under-provision of financial services, hold-up problems in the agricultural production chain, and fake identities in digital marketplaces. In recent years, blockchain-based applications have proliferated, often co-sponsored by IDOs. I highlight a few cases below, noting that their commonality is to remedy market failures and enhance the functioning of institutions at the national level.

An important tool to boost financial inclusion are virtual currencies, with *Bitcoin* being its most prominent example (Brito and Castillo 2016; Nakamoto 2008; Tasca 2016). The key benefit of Bitcoin is that transactions cannot be censored by central authorities. Unlike fiat currencies—whose money supply is determined by central banks which keep a central ledger to ensure that money is not double-spent—no central authority governs the Bitcoin economy. Its underlying blockchain design avoids the double-spending problem: All participants share the transaction ledger and a proof-of-work consensus
mechanism ensures that only the canonical transaction history prevails (Ravikant 2013). Virtual currencies\(^5\) hold promise for more efficient payments, especially in weak-capacity states (He et al. 2016). Virtual currencies have proliferated in Africa, for example Tunisia, Senegal, and Kenya (Krishna, Fleming, and Assefa 2017).

Other applications hold promise to stimulate development by improving productive processes. Provenance.org is a traceability system for supply chains, which allows consumers at the point of sale to trace back the origins of their product and businesses to prove that their products comply with standards of sustainable development. The blockchain provides tamper-proof public evidence of the provenance of a product.\(^6\) Hyperledger.org provides similar functionality.\(^7\) Another example is Agriledger—a blockchain-based mobile application rolled out in Kenya, Myanmar, and Papua-Guinea that allows everyone engaged in local farming “to know where they are working, buying, selling, and sharing things” in an incorruptible way. This solution addresses collective action problems in agricultural cooperatives arising from lack of transparency, restricted access to information, and graft, which victimize small farmers who often sell below market prices, cannot deliver their produce in time, or lack access to finance.\(^8\)

Blockchain technology also holds promise to make government functions more transparent, accurate, and efficient—with applications extending to tax collection, delivery of public services, digital citizen identity, land registry management, and public records (Krishna, Fleming, and Assefa 2017). For example, Estonia was the first country to offer digital identification to facilitate eGovernment services. Blockchains also facilitate tax revenue collection by maintaining a record of all transactions and settling claims automatically. In the realm of the refugee crisis in Europe, blockchain solutions that combine digital identity and payment systems have become popular. Finland—using a technology developed by the Helsinki-based startup Moni—provides its refugees with a unique digital identity stored on a blockchain and access to payment systems.\(^9\) A similar solution combining digital identity and payment services is provided by Taqanu.\(^10\)

IDO.s have realized the vast potential of blockchains and harness the technology for their own operations. The World Food Program (WFP), for example, uses blockchains to make assistance disbursements to Syrian refugees in Jordan faster, cheaper, better traceable, and more secure.\(^11\) In partnership with the World Identity Network, the United Nations Office for Project Services (UNOPS) and the United Nations Office of Information and Communications Technology (UN-OICT) launched a pilot initiative using blockchain technology to help combat child trafficking, notably by giving children born without a passport a secure digital identity.\(^12\)
Blockchain can also boost development in sovereign finance. In a recent interview, Christine Lagarde—director of the IMF—did not rule out that the IMF could develop its Special Drawing Right into a cryptocurrency (Lagarde 2017). Meanwhile, the IMF has intensified its research on how digitalization can improve government efficiency, for example through enhanced tax collection (Jacobs 2017), real-time public financial management (Misch et al. 2017), and targeted public spending (Aker 2017). A recent IMF staff paper is devoted to cryptocurrencies (He et al. 2016), and the organization held a high-level meeting on Bitcoin in Washington in April 2017.13

4. Can blockchain technology improve aid governance?

I now refer back to the problems in aid governance discussed earlier to examine whether (and how) blockchain technology could enhance the functioning of existing institutions. I begin with peer-to-peer donations under incomplete trust, which requires a permissionless blockchain and closely resembles existing blockchain-based money transfer platforms. I then turn to aid donations between governments—both bilaterally and multilaterally—which builds on permissioned blockchains and has yet to be implemented. Last, I explore how blockchain technology may be used by IDOs to enhance their operations.

Private charity

The key problems in peer-to-peer giving are lack of knowledge and lack of verification. Although modern communication technology has significantly reduced matching costs—potential donors and potential beneficiaries identifying each other—they still need to trust each other to not renege on their commitments.

Blockchain technology—in this case a dApp for private charitable giving—is already being deployed to solve this dilemma, enabling trustless interaction without an intermediary. One example is AID:Tech, which provides a blockchain-based platform for ensuring “the integrity of charitable contributions and social welfare programs” (Wellisz 2018).

Blockchain-based charitable giving may also be more complex. A donor could devise a smart contract specifying conditions under which a certain donation will be released. For example, a donor could make available funds to support greenhouse gas emission reductions and propagate this smart contract to a public blockchain. Consider planting trees as an accepted modality for absorbing greenhouse gases. A poor individual in a developing country would be able to tap into this donor funding by planting trees. As soon as the tree-planting is verified, the smart contract will release the specified amount of funds from the
donor to the recipient. In this example, a key challenge is validation of tree-
planting because trees are not digitally traceable. Tree-planting data can be
generated using a blockchain-based prediction market—for example Augur. The
market mechanism underlying a prediction market ensures that they are correct
because participants stake real money upon them. Outcomes are hard to
manipulate as thousands of participants report on outcomes using a consensus-
based system. Reporters receive half of the fees in the system multiplied by the
token shares they own. Because participants of the prediction market have an
incentive to not undermine the value of the token, they have incentives to
truthfully report. For their part, reporters do not need to worry about payments,
which are being guaranteed by smart contracts.\textsuperscript{14}

While verification of behavior is prohibitively costly in the non-blockchain
world, the above charity dApp would involve drastically lower costs, especially
when all assets can be digitally represented. Intermediaries may still be involved
as neutral parties verifying compliance, but their role would become less
important. This is good news to the extent that intermediaries may not be
trustworthy either, for instance because they can exploit their information
advantages to extract rents from donors.

In the long term, a charity dApp may also democratize aid because it eliminates
the need for domestic groups to lobby their government to alter aid allocations.
While diasporas indeed lobby donor governments to support ethnic kin abroad
(Anwar and Michaelowa 2006), they can do so directly using smart contracts
and blockchain-based identity services. In a similar vein, blockchain-based
payment systems already allow for efficient transfer of remittances, in contrast
to the current system in which intermediaries charge high fees (Wigley and Cary
2017). A likely long-term impact of the availability of this dApp is growing
pressure on centralized aid budgets. This trend is not stoppable because
governments (whose own aid agencies may suffer most from decentralizing aid)
cannot censor permissionless blockchains.

\textit{Bilateral aid}

Albeit not a currently existing use case, blockchain-chain based aid governance
could allow states to make more credible commitments, thereby enhancing aid
effectiveness. To that end, states would need to replicate all (existing) aid
contracts on a permissioned blockchain. Only states would initially be allowed
to write consensus data on the blockchain; entrusted third parties such as IDOs
could be added (or nominated as entrusted central authority to permit access). A
permissioned blockchain is the appropriate choice because its participants can be
trusted not to collude against the interest of the group, because each participant
draws tangible benefits from the system.
Governing aid relations as a set of smart contracts holds promise to enhance the effectiveness of aid delivery. For example, a smart contract may specify that a donor government transfers a specified amount to a recipient government if the latter improves its public financial management (PFM) system. Blockchains drastically reduce—if not eliminate—possibilities for cheating. Neither donors nor recipients can shirk on their commitments. A key issue is to verify that PFM improvements actually occurred. To that end, states could invite the World Bank as an entrusted third party to verify PFM reform. Following a seal of approval written onto the blockchain, the smart contract would release donor funds automatically. For other types of policy conditions, other methods of verification are conceivable. For example, states could rely on a prediction market running on a permissionless blockchain among recipient-country citizens, who could bet on the level of respect for human rights of their government. These prediction markets are tamper-proof because participants stake money on their predictions and no central authority can censor them. Finally, some conditions—for example debt levels in the government budget—are easily digitalized, in which case there is no need for third-party verification.

A decentralized entity governed by smart donor–recipient contracts has key advantages in comparison to current approaches. Current donor practice involves a combination of different strategies to mitigate agency problems—policy conditionality, project aid, and bypass aid—and each of those has its own limitations, notably selective enforcement of conditionality that disadvantages geo-strategically unimportant impoverished countries; long-term reduction of state capacity; and aid fragmentation. In contrast, blockchain-based bilateral aid governance could strengthen recipient-country ownership because recipients themselves can formulate development plans (‘Poverty Reduction Strategy Papers’) as smart contracts to which donors can pledge resources. Because cheating becomes less attractive, the importance of project aid may decrease, with potential benefits for aid harmonization. Finally, while smart contracts reduce the need for actual enforcement, there is a continued need for independent verification of soft conditions—a role that third parties such as IDOs (but also NGOs) will fulfill.

Chances are likely to be high that states will adopt the above blockchain-based system because it enhances the welfare for both sides. For the donor, blockchains guarantee recipients enact policy reforms, thus providing leverage against aid critics at the domestic level who question its effectiveness. But blockchains also allow recipient governments to rally global support around national development plans. Domestic constituents would support the blockchain due to its promise of greater transparency of aid governance. Nonetheless, blockchain technology is no panacea: Its added value as an institutional technology is greatest for the governance of complete contracts, particularly the ones involving digital assets which absolve the need for offline
enforcement. But it has little benefit for incomplete contracts, which require parties to renegotiate key aspects of their aid relationship.

**Multilateral aid**

A narrow application of blockchain-based aid governance would be to enhance the efficiency of multilateral agency operations in recipient countries. Several use cases are conceivable. In the area of procurement, smart contracts could automate the entire process while reducing the incidence of fraud. An example of a blockchain-based procurement platform is *Teneris*, which governments can use to solicit bids from suppliers of goods and services—a process that is often plagued by bribery and bid rigging (Wellisz 2018). Even though possibilities for fraud remain when assets are not digitally traceable, the transparency of the platform enables big data analysis on procurement data to detect likely fraud.

In the area of development policy lending—which involves cooperation of IDOs with recipient governments—smart contracts would enable IDOs to disburse aid when pre-defined policy conditions are fulfilled. This application would be similar to the one previously discussed for bilateral aid. Finally, blockchain holds promise to enhance the evaluation functions of IDOs. For one thing, the inherent transparency of blockchain would facilitate organizational learning because the ledger of past projects would be held by all IDO staff, thereby reducing the siloization of knowledge—but without increasing centralization. In addition, blockchain technology could improve the accuracy of project evaluations. Under the current system, project managers self-evaluate their projects, complemented by re-evaluations from evaluation departments. A blockchain-based evaluation system would rely on prediction markets that allow for real input from ultimate beneficiaries. All stakeholders have incentives to participate in this market. Donors want to report back concrete results to their communities and should hence be willing to invest into reliable information (Buntaine, Parks, and Buch 2017). Local beneficiaries have incentives to participate in this market and to report truthfully. As they have local information to predict project success, they can invest into shares reflecting the likelihood of project success and earn a profit when project success becomes publicly known. As holders of the natural token in the prediction market, they have incentives for truthful reporting. While recipient governments may have incentives to exaggerate project success—for example because their aid receipt depends on results—they would need to compete against the aggregate verdict of the public prediction. The less successful a project really is, the costlier it is for the government to manipulate the prediction market outcome. Ideally, it would be prohibitively costly to do so.

Blockchains would also help mitigate collective action problems among donors in multilateral aid—a key rationale for real-existing IDOs. Donors as a group face difficulties to keep their promises to uphold collective financing for
development, to enforce policy conditionality, and to coordinate bilateral aid activities. Consider the problem of collective aid finance. New targets could be defined following a so-called ‘multi-party escrow’ requiring \( n \) out of \( N \) countries to agree on a specific aid target. A multi-party escrow can also be used to ensure donors against under-compliance among their peer donors, specifying that aid dollars leave the national treasury only when \( n \) out of \( N \) other countries have paid their agreed share. These conditions can be coded easily as smart contracts. How do smart contract enforce donor commitments? Real-existing IDOs have limited possibilities for enforcement, with the suspension of voting rights often being the last resort. Arguably, enforcement is not possible without donors having staked real resources upon their contracts that they would lose if they were to renege on their promises. Thanks to the transparency of blockchain, empty promises could be more clearly identified. This would increase the effectiveness of peer pressure and naming-and-shaming by NGOs, leading (almost) all donors to put resources on the line. Similarly, as every participant in the blockchain network has the same information at any point in time, broken promises are immediately visible to everyone, making attempts to manipulate this information unsuccessful. For highly reluctant donor governments—the ones that refuse to stake—non-state actors with progressive development preferences could become literal ‘stakeholders’. Their contributions would not only make their own government’s promises more credible but generate additional private benefits to them—for example companies expecting greater market access overseas, implementing NGOs expecting net positive reflows of aid funds, and private donors motivated by warm glow.

An even more extensive transformation of multilateral aid governance would entail the establishment of a ‘development DAO’. A development DAO would address the problem of incomplete contracts by allowing stakeholders to reformulate key governance rules as deemed necessary. Consisting of all donors, recipients, and IDOs, the development DAO would be a decentralized entity governed by smart contracts (but now between all kinds of participants, not just donors–recipient pairs). The development DAO could change its own governance as deemed necessary by a (qualified) majority of participants. Members would collectively decide by (simple) majority on how the organization should allocate its funds. While the development DAO would be a permissioned blockchain, all its activities would be visible to anyone, thereby increasing the transparency of multilateral aid and improving its auditability. Moreover, breaking with current practice, the development DAO could formally embody the Paris Declaration principle of partnership-based development that includes all relevant stakeholders. Smart contracts would enable beneficiary communities to propose potential projects at low cost and find like-minded partners to implement these projects, with the DAO providing the overarching institutional framework. As the DAO resembles real-existing IDOs in its core functionality (or even goes beyond them in some ways), it questions the
relevance of such IDOs. However, IDOs would still be needed to perform critical roles as deliberation forums, agenda-setters, validators of real-world events, and capacity builders.

Summary and implications

In summary, blockchains hold most promise under three conditions. First, several institutions must share resources—money, information, or other assets—hitherto cleared through a central agency. In general, foreign aid is a cooperation-intensive issue area in which the contributions of several actors are required to achieve desirable outcomes; this makes blockchains theoretically attractive. Second, the currently-existing systems for such exchanges are slow, inefficient, or expensive. Indeed, the international community seems to be at a critical juncture in which international public bureaucracies no longer are the preferred institutional designs to address the challenges of the time—as evidenced by a growing number of transnational governance initiatives (Westerwinter 2017) and the growing attempts by donors to regain control over IDO policy-making through earmarked funding (Reinsberg, Michaelowa, and Eichenauer 2015). Third, blockchain-based governance of development cooperation is most efficient if all resources are digitally representable and the underlying aid contracts are complete. For real-world events, verification is key and hence the need for third-party judgment (or decentralized prediction markets) to bring the relevant data onto the blockchain.

5. Discussion and conclusion

Successful development often requires the input of several individuals to achieve a socially desirable outcome. However, development often fails because individuals may not be able to trust each other to the extent necessary to facilitate mutually beneficial exchange, leading to market failures. Market failure can be redeemed by a property rights regime enforced by the state as central authority (Levi 1988; North 1990; Olson 1965). Others have proposed decentralized solutions that provide incentives for sustained cooperative behavior (Ostrom 1990).

Foreign aid is often considered to play an important role in promoting development—initially, by providing capital to boost investment in physical infrastructure, and subsequently, to help build institutions that “counteract the many perverse incentives likely to occur” in human interaction (Ostrom et al. 2002, 4). And yet, much as development, foreign aid itself is subject to collective action problems that limit its effectiveness.

The primary purpose of this paper is to cast light on how blockchain technology can be deployed to enhance the effectiveness of foreign aid provision and
delivery. Blockchain technology instills trust in anonymous interactions by distributing a shared ledger of all previous transactions across participants and by ensuring canonicity of the blockchain through a consensus mechanism.

While currently existing blockchain-based applications facilitate exchanges in anonymous environments—for example virtual currencies—this paper is the first to discuss potential applications in the semi-trusted environment where donor governments and recipient governments negotiate foreign aid contracts. Blockchain technology provides a platform to support smart contracts that make transactions unstoppable when pre-defined conditions are fulfilled (Diedrich 2016). This feature carries enormous value for foreign aid contracts, which are plagued by commitment problems. Using blockchain technology, donors would be less likely to renege on aid commitments, while recipients would be more likely to follow through with policy reforms. Blockchain technology may also remedy information problems, for example by facilitating prediction markets that can verify if predefined events have occurred.

The key contribution of this article is to combine the literature on blockchain technology and foreign aid. Many IDOs have launched blockchain-based pilot initiatives, but only recently policy experts have begun to think about when the use of blockchain is beneficial (Greenspan 2017; Nelson 2018; Pisa 2018). Surprisingly, blockchain-based solutions to collective action problems among states have not yet been discussed. While scholars have emphasized institutional deficiencies in the aid system—rather than lack of money—there is still little consensus on how to overcome such deficiencies because every institutional solution creates new challenges—notably because these solutions involve more centralization. In this regard, I demonstrate the potential benefits of blockchain technology, and smart contracts in particular, for enhancing aid effectiveness.

An important question touching beyond the issues discussed here is whether blockchains undermine real-existing IDOs. On the one hand, IDOs may not be significantly affected, but they will change their character. In particular, the transactional functions of IOs may become redundant because blockchains can enact transactions (subject to agreed conditionality) more cheaply. IDOs will continue to play a role in monitoring behavior and verifying results, even though competitive pressure from prediction markets challenges their dominant position. Other functions of IDOs will be strengthened, notably policy deliberation and technical assistance in the implementation of development policy. On the other hand, there may also be pressure on the classical model underlying multilateral aid in which donors collectively decide on a contract and delegate to IDOs, without much formal involvement of recipient countries. If states were to implement the far-reaching proposal of a development DAO, the real-existing IDOs would be challenged in their core governance roles. For obvious reasons, this transformation is less likely to occur.
Future research would need to address why blockchain solutions for aid governance are slow to break through. My preliminary analysis suggests that such breakthrough simply is a matter of time—given the undeniable benefits of blockchains to all actors involved. However, blockchain technology is no panacea—its benefits are greatest where they streamline the governance of complete contracts, notably the ones involving digital assets; but lowest where contracts are incomplete (unless states adopt a full-blown DAO). Finally, blockchain-based technology likely must prove its functionality before states are ready to adopt it. For instance, blockchain-based prediction markets are relatively new and their resilience to manipulation by actors with high stakes in prediction outcomes is yet unknown. In that regard, IDOs would be an ideal regulator for these markets to ensure their proper functioning. And yet, once blockchain-based aid governance has come to fruition, researchers should assess the extent to which the technology has made aid more effective compared to a business-as-usual case.
Notes

1 One example is www.ubackforgood.com (accessed February 2, 2018), which is limited to matching donors to charitable causes in the US.


3 Ethereum is a generalized blockchain with improved functionality as it operates two kinds of accounts—externally owned accounts held by participants, and contract accounts, which implement contracts autonomously on the blockchain.


5 He et al. (2016) provide a comprehensive overview of virtual currencies including a history of alternative currencies.


11 Irish Red Cross used a similar approach to assist refugees, distributing voucher cards stamped with a QR code (Wellisz 2018).


14 For a detailed description, see www.augur.net (accessed October 30, 2017).
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