

ICT Aid Flows From China to African Countries: A Communication Network Perspective

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The challenge in evaluating China's foreign aid has always been the unavailability of reliable data sets. This study constitutes the first analysis of the AidData data set from a communication network perspective. It examines China's development aid to Africa in the ICT sector from 2000 to 2014. Combining data mapping, network modeling, and regression, it uncovers general trends of aid allocation, central players, and collaboration patterns among aid agencies. The results demonstrate the variability in the distribution of China's foreign assistance to 44 African countries. In particular, African countries with less population, worse economic development, but higher oil rents are more likely to receive ICT aid from China. This study also finds that aid implementation is less likely to occur through collaboration within the same sector or between state-owned enterprises (SOEs) and private companies. This research reveals nuanced geometries of aid with "Chinese characteristics" that move beyond the extractive "Angola model" or the mutual benefits model. These findings provide implications on how Chinese telecommunication companies are shaping Africa's digital future.

Keywords: foreign aid, ICT, network analysis, China, Africa, telecommunication, ERGM, Belt and Road Initiative

China's relationship with the African continent has deepened in the past decades. In recent years, in particular with the launch of China's Belt and Road Initiative (BRI) in 2013, Chinese investments in Africa extend beyond traditional sectors such as transportation, mining, and energy to new sectors such as

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technology and telecommunications. Thussu, de Burgh, and Shi (2017) pointed out that in 2013, China contributed 4% to total global development assistance, half of which was directed to African countries, with a strong focus on creating infrastructure, including communication. This has prompted scholarly communities to ask, To what extent is China shaping Africa's digital future (Jiang, Li, Rønning, & Tjønneland, 2016)? How do donor interests and recipient needs shape China's investment in Africa (Workneh, 2016)?

This study focuses on China's foreign aid to Africa in the area of ICTs for two reasons. First, ICTs are indispensable for integrating underdeveloped nations into the global economic system (Vu, 2011), despite complex ramifications of global digital capitalist development, including widening digital divides on international, national, and subnational scales (Guillén & Suárez, 2005). Although the Internet's exact role remains ambiguous, mainstream scholarship has shown that ICTs contribute to more open international development (Reilly & Smith, 2013).

Second, a considerable amount of foreign aid has been used for ICT projects and is likely to be instrumental in facilitating an emergent multilateral world order of global digital capitalism (Schiller, 2014). But the foreign aid literature has mainly focused on contributions from the Organization for Economic Cooperation and Development (OECD) countries. The role played by new global powers such as Brazil, Russia, India, China, and South Africa remains underinvestigated (Pamment & Wilkins, 2016). China has become a major force shaping the evolving order of digital capitalism. The country's strategic focus on Internet-led communications development combines internal and external efforts to expand markets, with the BRI as a notable example.

This study examines China's ICT-related foreign aid to Africa in three related aspects. First, it investigates the allocation and evolution of ICT aid to uncover its geographical distribution. Second, it takes on a communication network perspective to uncover the collaboration patterns among organizations in China and Africa. Third, it examines roles main agencies play in aid implementation. This study moves beyond the simplistic presumption of "rogue aid," which is driven more by China's interests than Africa's needs (Naím, 2007), or China's official claim to achieve mutual benefits for donors and recipients (Dreher, Fuchs, Parks, Strange, & Tierney, 2018).

We analyze a data set curated by AidData.org that includes China's aid projects from 2000 to 2014 in 44 African countries. We first illustrate the general trends of the aid flow and what factors influence the allocation of the ICT aid. We then conduct network analysis to identify what drives the collaboration among agencies. We identify key funding and implementing agencies based on network positions, and discuss the top three subcommunities formed around main players. We collected additional archival data on aid projects to interpret and corroborate results from the quantitative analysis.

Foreign Aid With Chinese Characteristics

With a focus on Western countries, the existing literature on foreign aid has established development geometries of "the spaces, shapes and arrangements underlying the idea and practice of development" that only speak to a specific context (Shah & Wilkins, 2004, p. 395). The most well-cited definition of foreign aid is from the OECD, which describes two forms: official overseas development

assistance (ODA) and other official flows (OOF). ODA refers to grants or concessional loans to countries and territories on the Development Assistance Committee (DAC) List and to multilateral development institutions. ODA is administrated to promote economic development of recipient countries. OOF is provided to countries that are on the list of the DAC but that do not meet the criteria for eligibility for ODA, either because the aid is not primarily aimed at development or because it is not sufficiently concessional (i.e., having a grant element of less than 25%). Both ODA and OOF are government funded. The main difference is that ODA is often driven by donor countries' political wills, whereas OOF is more market based (Dreher et al., 2018). However, altruistic motives do not prevent donor countries from using foreign aid to serve their own strategic and political aims (Alesina & Dollar, 2000).

As a new power in the global governance structure, China's foreign aid practices are likely to differ from those of OECD countries (Wen, 2018). Understanding China's foreign aid requires new terminologies and interpretative frameworks that are not bounded to the current dominant geometry of development (Pamment & Wilkin, 2016). By extension, it demands new empirical investigation into shifts in the makeup of the donor community and unique motivations behind the aid projects.

China foreign aid tradition goes back to ad hoc transfers of goods to North Korea and development finance to socialist neighboring countries during Mao's era (Shen & Xia, 2012). China's foreign aid has been historically guided by the "five principles of peaceful coexistence" and the "eight principles" (Gu, Chen, & Zhang, 2014). These guidelines have been summarized into two key principles: mutual benefits and noninterference in the domestic affairs of sovereign governments (Dreher et al., 2018).

After China's reintegration with the global economy, foreign views of China's foreign aid diverge regarding intent and result. The West often perceives it negatively. Some argued that China's noninterference principle could conveniently favor undemocratic and corrupt governments (Bader, 2015; Kurlantzick, 2007). Others criticized China's resource extraction activities through aid. Some even characterize China's aid as "rogue aid,"² driven by political interests to secure natural resources rather than by recipients' needs (Naím, 2007). Through developing its own strategy, China has turned foreign aid into "both a key source and a key tool of China's influence" (Shield, 2013, pp. 155–156). The launching of BRI and the Asian Infrastructure Bank indicate China is taking a proactive role in foreign aid by diversifying its portfolios (Hameiri & Jones, 2018).

Conversely, some regard China as a valuable partner in development cooperation (Gu et al., 2014; Naím, 2007). From 2000 to 2013, China's aid increased almost sixfold, from approximately US\$300 million to US\$2 billion (Qian, 2015). A significant portion went to low-income developing countries, the African continent in particular (Amusa, Monkam, & Vieg, 2016). Although it is independent of recipient countries' institutional characteristics, such as democracy and governance, China's aid decision is no more shaped by political and commercial interests than that of other donors (Dreher & Fuchs, 2011).

² The concept of "rogue aid" was used to describe aid that cares little about the long-term well-being of the recipient (Naím, 2007). It has also been used to refer to aid from donors who are not part of the OECD's DAC. This type of aid is used to bolster "rogue states," and does not conform to the consensus around aid effectiveness and the good governance principles (Dreher, Nunnenkamp, & Thiele, 2011; Woods, 2008).

Ultimately, China's foreign aid is a statist project implemented by an array of state and nonstate actors, which creates nonunitary approaches and diverse outcomes (Kilby, 2017). First, the actual planning and implementation is hierarchical and to varying degrees is controlled by the central government. The main government agencies involved include the Ministry of Commerce (MOFCOM, the lead agency), the Ministry of Foreign Affairs (MOFA), the Ministry of Finance (MOF), the Export-Import Bank of China (EXIM), the China Development Bank, and the Agricultural Development Bank of China. The final approval must go through the State Council, followed by the allocation of funds from MOF to MOFCOM. To start the aid project, MOFCOM could initiate a bidding procedure for subcontracting or directly provide funds to the relevant department.

Second, SOEs play a significant role in the allocation of China's aid, guided by its "Going Global" strategy to invest in global markets, initiated in 2000. Some studies claim that SOEs are the primary source of investment, which makes China less sensitive to political risks related to foreign aid (Fijałkowski, 2011).

Third, the private sector also plays an increasingly active role in implementing aid, which has exacerbated the tension between political and economic goals (Sun, 2014). Private companies that win aid contracts (e.g., Huawei) are often large corporations with strong state ties (Zhang & Smith, 2017). The motivations behind the business sector's involvement in aid projects do not always align with the state's foreign policy, which creates challenges for state coordination and its image building overseas (Gu et al., 2014).

We posit that state agencies, SOEs, and large private actors with strong ties to the state together constitute Chinese state capital, a conceptual construct and a historical formation. They pursue their own competing goals through foreign aid, which range from achieving political security and diplomatic objectives to promoting economic security by forging international ties, expanding employment, and promoting corporate profits (Lee, 2017; Varrall, 2016). It is imperative to unpack the generic term "Chinese state capital" to understand how it is made up of competing and collaborating actors (Wen, 2018). Just as important, while striving to achieve their own political and economic needs, aid actors will likely open up interactive space to aid recipients and their local needs. We further postulate that once embedded within broader communication networks that encompass states and private actors, Chinese and African players, the construct of Chinese state capital becomes more flexible and less constrained by strict prior imperatives or pathways, whether political or economic.

China's Foreign Aid to Africa

The economic ties between China and Africa have been evolving since the 1980s with bilateral investment treaties (Ofodile, 2013). In 2000, the first China-Africa cooperation forum was held, with 44 African countries participating. Since then, the volume of trade between China and Africa grew 20-fold, from \$10 billion to \$280 billion in 2015 (Thussu et al., 2017). In 2016, China's exports to Africa were at US\$82.9 billion, whereas imports from the continent were at US\$54.3 billion (Sow, 2017). China has become a major investor and job creator in the continent (UNCTAD, 2019). The BRI initiative is partly intended to strengthen Sino-African ties. The intensity of Chinese investment in the Africa is a response to China's growth model.

Still, Chinese state capital offers a valuable alternative source of funding for African economies, which have been historically underserved by international investors (Cheung, de Haan, Qian, & Yu, 2012).

China became a major aid donor to Africa in the first decade of the 21st century (Grépin, Fan, Shen, & Chen, 2014). But there is little systematic research into the specific allocation of Chinese aid to the continent. China's first African aid recipient was Egypt, in 1956, followed by other nations as they became independent. Initially focused on socialist countries such as Ghana and Mali, China's aid later expanded to other countries to gain support for Beijing, facilitate trade and extraterritorial investment expansion (Strange et al., 2013). Consistent with the general trend of China's aid, SOEs are main donors in Africa particularly in the capital-intensive extraction sectors (e.g., oil and minerals) and construction sectors (Gill & Reilly, 2007).

The Western literature identifies several motives behind China's foreign aid to Africa: access to natural resources, access to African markets, gaining support for the "one China" policy, and looking for partners in international institutions (Hsueh & Nelson, 2013). The relative importance of these reasons may vary over time and across sectors. The most notorious characterization of China's aid to Africa is known as the "Angola model," named after the African country where low-interest Chinese loans were backed by oil and other extractive commodities (Tjønneland, 2015). The Angola model is prominent in traditional sectors such as mining, construction, agriculture, and transportation (Brautigam, 2009; Corkin, 2011). But when recipient countries lack the natural resources to provide guarantees, aid is likely predicated on the promise of local markets, which not only expose the Chinese donors to financial risks but also bring along new market players, alternative visions, and emergent relations.

Why Study ICT Aid?

ICT aid mainly targets recipient countries' telecommunication sectors, generally in two ways. The first aims to build telecoms' infrastructure by providing equipment. Telecoms' infrastructure represents an essential part of China's investment to improve ICT access and connectivity in Africa (Wen, 2018). The second type creates and extends value chains in the networked applications market—for example, to provide better e-commerce or e-education (Elder, Emdon, Fuchs, & Petrazzini, 2013). In ICT aid, traditional donors allocate relatively little assistance (Berthélemy, 2011), and literature shows emerging economies, such as China, take on a more active role (Amusa et al., 2016).

Studying China's ICT aid is likely to generate useful lessons. First, ICT aid is instrumental in the Chinese-style globalization, of which the digital economy is a significant driver (Shen, 2018). China's entry into the African telecom equipment market in the 1990s coincided with neoliberal telecom reforms in the continent. Huawei and ZTE have had considerable price advantages as well as state support in the form of foreign aid. They rose from periphery to dominant positions in the global telecom market in the past decades. Huawei is the number one supplier in the Middle Eastern and North African markets, the second largest one in South Africa, and shares 90% of the market with ZTE in Nigeria (Zao, 2013). The African and Middle East market contributed roughly 15% of Huawei and ZTE's revenue in 2011, trailing far behind the Asia-Pacific and developed Western markets. Their business expansion in relations with foreign aid could be indicative of the nature of China's state-capital relations overseas.

Second, examining the ICT sector moves beyond the conventional understanding of China's aid in traditional sectors. State and corporate actors have tolerated investment risk in ICT aid, which is shared between banks and small-to-medium-sized businesses in the telecommunication industry (Zao, 2013). As China expands and diversifies aid to Africa, the Angola model no longer adequately explains multiple actors' intents and dynamics, including but not limited to the pent-up need to expand outward-bound foreign direct investment in the face of chronic overcapacity and accumulation crisis (Sun, 2014). Thus, we first examine how the four motivations identified in the literature (Hsueh & Nelson, 2013) can explain the particular flows in the ICT sector.

RQ1: How do access to natural resources, telecommunication markets, diplomatic history, and internationalization of markets affect the allocation of China's ICT aid among various African countries?

The Communication Network Perspective

If the allocation of aid is driven primarily by foreign policy considerations (Dreher et al., 2018), the growing diversity of players may lead to conflicts between state aims and business goals (Gu et al., 2014). Diverse organizational actors exist to form interorganizational networks as aid implementation relies on the coordination of financial, administrative, and technical resources. We deploy the communication network³ perspective to analyze data on the exchange of resources and outline emergent aid geometries outside of the existing OECD models. Specifically, we rely on the conceptualization of emerging aid geometries in Pamment and Wilkins (2016).

Encompassing both aid donors and implementing agencies, a communication network perspective helps to uncover how network power is constructed through the exchange of resources among stakeholders. Castells (2009) defines power as "the relational capacity that enables a social actor to influence asymmetrically the decisions of other social actor(s) in ways that favor the empowered actor's will, interests, and values" (p. 10). In a network society, traditional forms of power originating from monetary, political, and military sources become contingent on network power from three sources: an actor's ability to organize the network, an actor's ability to define the goals and norms of a network, and an actor's ability to connect separated networks (Castells, 2009). As deployed here, this approach examines the different network positions agencies occupy in the aid implementation network, the cliques formed around key agencies, and the relational dynamics. We propose the following research questions:

RQ2: What organizations and sectors are more likely to be central players in the implementation of China's ICT aid to Africa?

RQ3: What factors drive the collaboration among agencies in the implementation of China's ICT aid to Africa?

³ Communication networks are "created by the flow of messages among communicators through time and space," with the concept "message" including broadly tangible resources, and information that can be exchanged among different players (Monge & Contractor, 2003, p. 3).

Method

We collected data on Chinese aid to Africa from AidData.org. AidData included three types of aid: ODA, OOF, and vague official finance (VOF; i.e., aid that is clearly official finance implemented by the government, but lacks sufficient information to assign to either ODA or OOF). The bulk of data came from the most recent complete data set, which captures aid activities from 2000 and 2012. A new wave of data was released in the fall of 2018, covering the period up to 2014. This latter data set had a number of issues.⁴ After consulting with AidData personnel, we identified 18 additional ICT aid projects implemented between 2013 and 2014, which were added to the first data set.

Our final data set includes 173 ICT aid projects—104 on telecommunication, 65 on media, one on both, and three other projects that did not belong to either category. Sixty-two were ODA, 12 were OOF, and 99 were VOF. The following five countries received the most projects: Zimbabwe ($n = 18$), Nigeria ($n = 12$), Zambia ($n = 9$), Tanzania ($n = 9$), and Ghana ($n = 9$). The five countries that received the highest aid amount (in U.S. dollars) were Nigeria (\$1.65 billion), Zimbabwe (\$822.2 million), Ethiopia (\$822 million, with one project), Tanzania (\$688 million), and Côte d'Ivoire (\$402 million, with two projects).

A total of 125 agencies from 44 countries participated in ICT aid projects. Of those, 57% were SOEs ($n = 71$), 22% were private companies ($n = 28$), and 21% were government agencies ($n = 26$). Two-mode project-to-agency network ties⁵ were coded ($n = 508$) and converted into one-mode agency-to-agency collaboration network ties ($n = 2,510$).

We conducted three types of analysis. First, we collected 2014 country-level data from the World Bank Development Indicator, the International Telecommunication Union, and MOFA. These variables were included in regression models to test their influence on Chinese ICT aid distribution, which was captured by the amount and the number of projects. Second, we used the exponential random graph model (ERGM) to examine what agencies tended to collaborate with whom, by estimating the probability of tie formation among dyadic nodes (Robins, Pattison, Kalish, & Lusher, 2007). Third, we conducted network community detection analysis following the Louvain algorithm (Blondel et al., 2008), which searches for a partition of all nodes into distinct sets to maximize network modularity. The Louvain method defines a community as a group of nodes that interact more frequently with each other. Its partitioning algorithm can reliably reveal closely connected clusters of agencies in our data set. We discussed top three subcommunities. In addition, we collected archival data about China's aid to Africa and main agencies from the following sources: MOCMOF, World Bank, and the Forum on China–Africa Cooperation, news reports, and think tank reports. These qualitative data are incorporated in the discussion to elaborate main results.

⁴ AidData informed us that data cleaning for research use is still on-going. We reviewed the new data set carefully and identified duplicate projects and other errors.

⁵ Two-mode networks describe activities between dissimilar units and one-mode networks describe activities among similar units (Borgatti, 2009). In this study, ties created between projects and agencies are two-mode, and collaboration ties between agencies are one-mode.

Regression and ERGM were conducted in R. ERGM tests the fit of hypothesized parameters and estimates a general model based on simulations of the observed data. The model fits the data when all parameters have $t < 0.10$, and specific parameters are significant when the values are within 1.96 standard errors of the parameters (Robins et al., 2007). Gephi was used to generate network visualizations and community detection results.

Results

Chinese Foreign Aid Footprints in Africa and Major Recipient Countries

From 2000 to 2014, the aid flow from China to Africa grew exponentially. The majority of the aid was allocated to traditional “pillar industry”: about 40% to industry, mining, and construction; 15% to energy generation and supply. ICT aid projects consistently remained a small portion of the overall aid, ranging from a 2000 low of 0.22% to a 2002 high of 20.64%. The total amount of ICT aid added up to US\$7.13 billion (about 3.1% of the US\$288 billion total).

The number of ICT aid projects fluctuated over the years (see Figure 1). Big packages drove peaks in 2004, 2006, and 2008. This included a 2006 Ethiopian project for US\$822 million, where Ethiopia Telecommunications Corporation, Huawei, ZTE, and China International Telecommunication Construction Corporation (CITCC) worked together to boost mobile users in Ethiopia. By far the largest project in the data set, this contrasts with the general situation that Ethiopia was a peripheral destination for foreign direct investment (FDI) from China, receiving 1% between 2003 and 2007 (Renard, 2011).

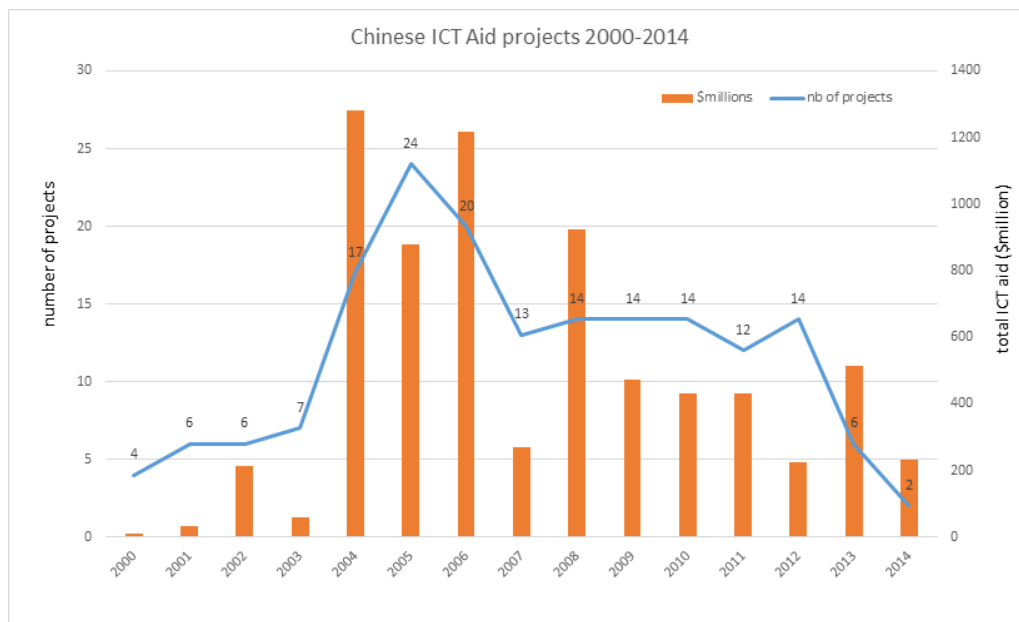


Figure 1. The evolution of Chinese ICT aid to Africa, 2000–14.

ICT aid, while proportionally small, is crucial for extending China's corporate footprint beyond first-tier African countries. Up until 2014, more than 50% of China's foreign aid in Africa was concentrated in Cote d'Ivoire, Zambia, Cameroon, Nigeria, Tanzania, Ghana, and Angola. By contrast, ICT aid projects covered a broad set of countries—44 countries in the continent received Chinese ICT aid between 2000 and 2014. Although about half of that total ICT aid is not directly characterized in our data set, the remaining half is dominated by direct aid (70.32%, including technical assistance, grants, in-kind grants, monetary grants, and scholarships), followed by loans and loan-related aid (29.48%, including export credits, loans, loan guarantees, and strategic/supplier credit). FDI accounts for a very small 0.20%.

Still, three countries (Nigeria, Ethiopia, and Zimbabwe) received 50% of total communication aid⁶ over that period, and the top 10 ICT aid recipients accounted for 80% of the total (see Figure 2). Though Ethiopia only received one aid project (the one in 2006), the other two major recipient countries, Nigeria and Zimbabwe, had a consistent flow of aid over the study period. The earliest project to Nigeria was in 2002, and in general it received new aid projects every two years. The first aid project to Zimbabwe was initiated in 2004, and it continued to receive aid almost every year thereafter.

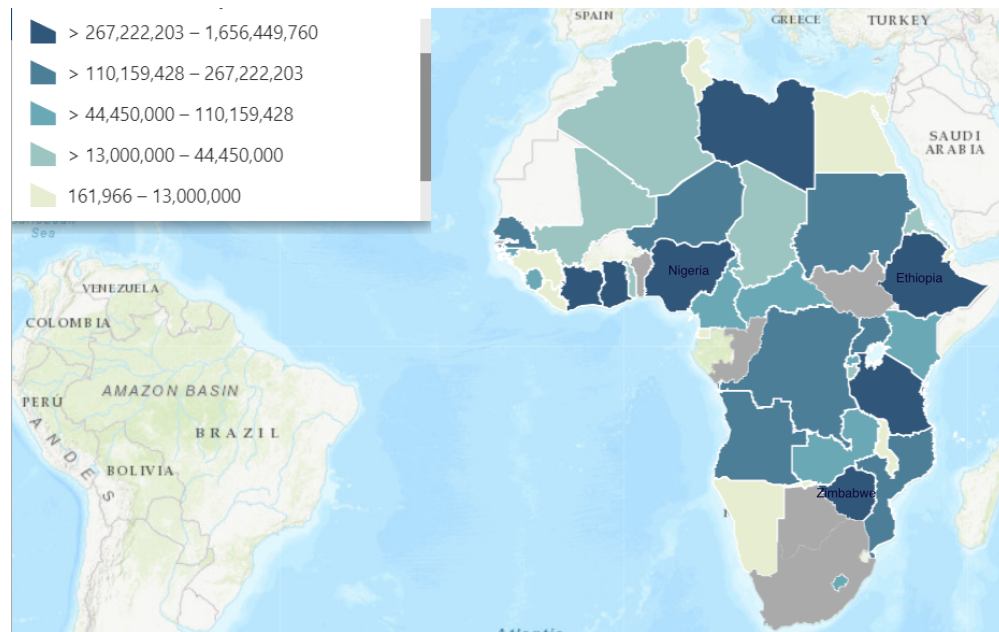


Figure 2. Chinese ICT aid received by country, 2000–14.

⁶ Many projects spanned across multiple years, but were only accounted for in the first year. Additional data are needed to identify projects' life cycle and to provide a more accurate account of annual aid flows.

Factors Influencing Flow of China's Aid to Africa

RQ1 examined the four major motives from Hsueh and Nelson (2013). Two variables were measured to capture the surplus value of natural resources: oil rents and total natural resource rents. Oil rents are the difference between the value of crude oil production at world prices and total costs of production, and natural resources rents are the sum of oil rents, natural gas rents, coal rents, mineral rents, and forest rents (World Bank, 2019). Five variables were included to measure telecommunication market size: fixed phone subscription, fixed broadband subscription, mobile subscription, Internet users, and population. Diplomatic history was measured as the number of years having an official diplomatic relationship with China. FDI per capita⁷ captures the level of international investment in the form of controlling ownership.

Two models were conducted. The first model used the amount of ICT aid as the dependent variable (DV), and the second model used the number of ICT aid projects as the DV. Model 1 was significant, $R^2 = .41$, $F(4, 33) = 2.28$, $p = .04$. Three independent variables (IVs) were significant: population ($\beta = -.51$, $p = .03$), GDP per capita ($\beta = -.65$, $p = .004$), and oil rents ($\beta = .64$, $p = .01$). Diplomatic history, telecom market size, and FDI inflow had no effect. The findings suggest that after controlling other factors, less populous countries with worse economic conditions and higher oil rents tended to receive more aid from China. Model 2 was not significant, suggesting all these IVs were not related to how many aid projects received (see Table 1 for model summary).

Table 1. Models Predicting Aid Flow.

Independent variable	Model 1: Aid amount	Model 2: Aid projects
Population (logged)	-.51 (-2.27)*	-.30 (-1.14)
FDI per capita	.09 (.59)	-.05 (-.28)
GDP per capita	-.65 (-3.12)**	-.39 (-1.58)
Diplomatic history	.28 (.18)	-.15 (-.87)
Oil rents	.64 (2.80)**	.34 (1.26)
Natural resources rents	.04 (.17)	.14 (.57)
Fixed phone	.46 (.75)	.49 (.69)
Mobile	.28 (1.21)	.04 (.15)
Internet users	.22 (1.06)	.11 (.44)

Note: ** indicates $p < .01$, and * indicates $p < .05$.

Comparing Chinese ICT aid to African countries' mobile subscriptions in 2014 suggested a general correlation (see Figure 3). However, the regression results show the size of a national telecommunication market does not significantly correlate with aid amount. This indicates state finance behind ICT aid might be independent of profit-seeking motives.

⁷ FDI per capita was chosen to account for a country's economic development. Before the regression model, a correlation test between FDI per capita and aid amount was conducted which was not significant ($.20$, $p = .22$).

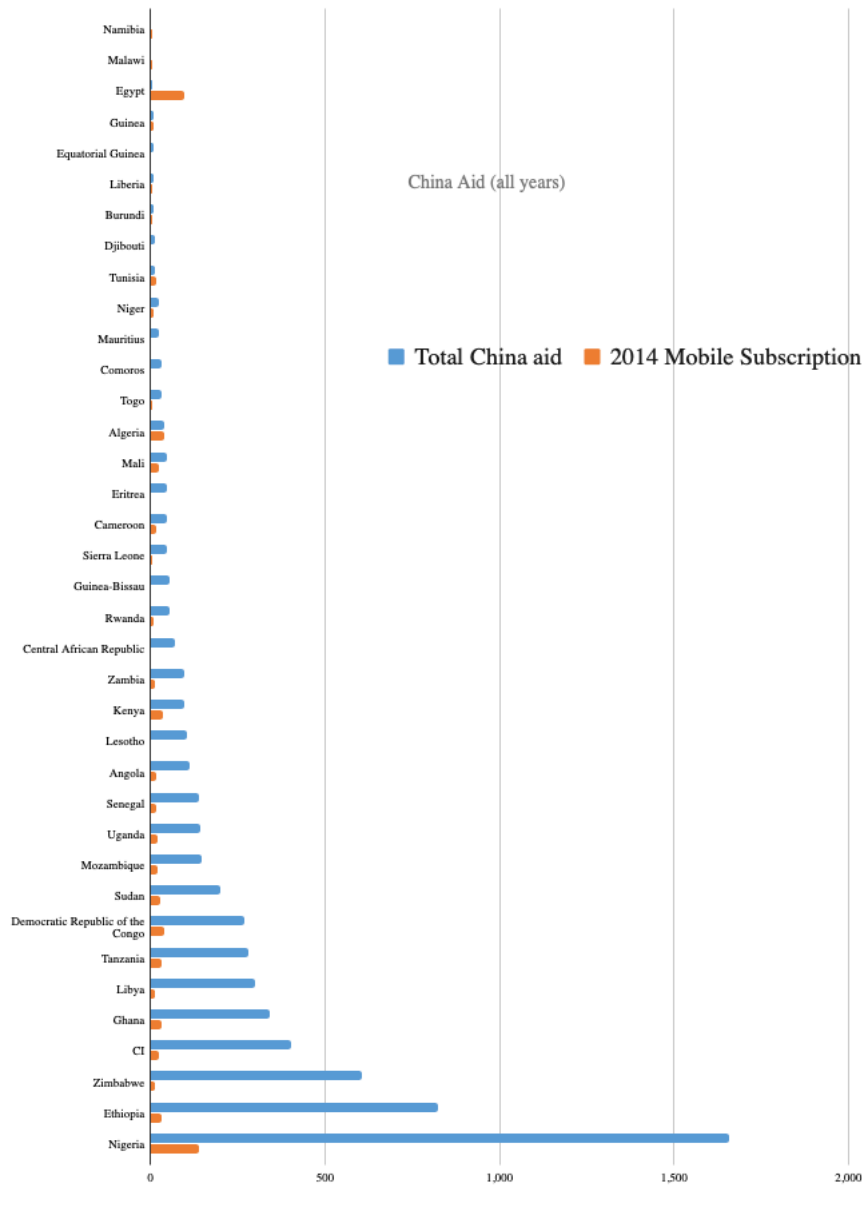


Figure 3. China ICT aid and mobile market by countries.

A number of first-tier countries by mobile subscribers (Egypt, Algeria, Kenya, Mali, Tunisia, and Guinea) received limited aid. Given that Huawei has dominated the Middle Eastern and North African markets and also is an important vendor in South Africa, foreign aid proves not to be a prerequisite for

market entry or success. In 2011, extraterritorial investment by both Huawei and ZTE was mostly self-financed, with financing from external sources accounting for only 7.6% of Huawei's investment capital and 24.8% of ZTE's (Ministry of Commerce, 2013, p. 7). In these important national markets, Chinese firms have reacted to business opportunities with or without state financial support. Conversely, the flow of foreign aid outside of the first tier indicates the Chinese state with its financial tools acts as a critical mediator for extraterritorial corporate expansion, especially in less developed markets.

Major Players in Chinese ICT Aid to Africa

Huawei ($n = 34$) and ZTE ($n = 23$) were the top two implementing agencies. The top three funding agencies were EXIM (40 projects), Huawei (37 projects), and ZTE (26 projects). By aid amount, EXIM had the largest share that totaled USD\$3,033,452,557, roughly 40% of the total ICT aid. ZTE had a share of USD\$2,047,737,756 USD (30% of the total ICT aid). Huawei's share totaled at USC\$1,160,415,232 (15% of the total ICT aid). To identify collaboration patterns among agencies, we constructed a project-donor affiliation network to capture links between agencies and projects.

To answer RQ2, Figure 4⁸ shows that central nodes were from two industries: media and telecommunication. The number of connections indicates the degree to which they possess network power in aid implementing. Reflecting the statist nature of China's global media presence, main media actors include state-owned media agencies, such as Xinhua News Agency, CCTV International,⁹ China Radio International, Zimbabwe broadcasting holdings, and Mauritius Broadcasting Corp, together with private companies such as Beijing Construction Engineering Group and StarTimes. In the telecom sector, the main actors were leading telecoms providers (Huawei, ZTE, Alcatel-Lucent Shanghai Bell, Star Communication Network Technology, and NetOne), and a few financial institutions. Central nodes were diverse, indicating a decentralized and more corporate-driven approach in network infrastructure investment.

⁸ Agency was in blue and project was in yellow. Central agencies connected to many projects were labeled with names.

⁹ CCTV international has been rebranded as "China Global Television Network" (CGTN). CCTV Africa was the African bureau and transmitted from Nairobi.

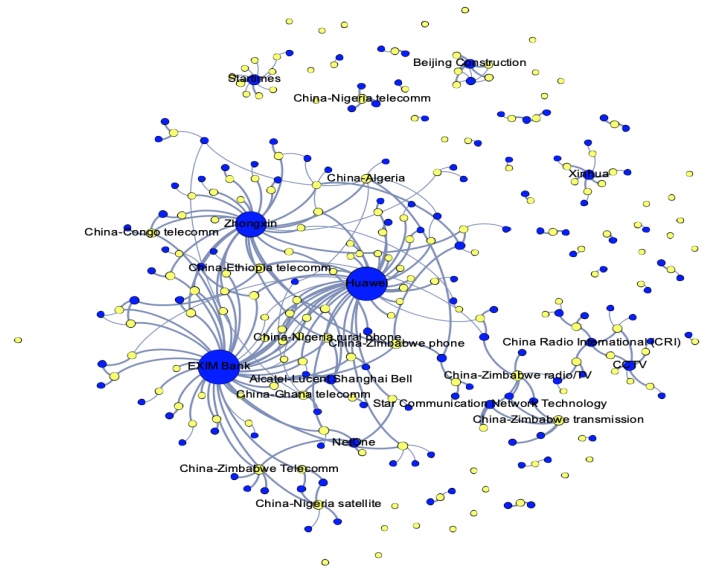


Figure 4. Project-agency affiliation network.

Actors in the network have unique collaboration patterns. Some key private sector actors were scattered around and formed their own cliques of projects, such as StarTimes and Beijing Construction, representing different industries. ZTE and Huawei collaborated on several projects; however, they formed their own cliques. The limited involvement of African stakeholders is notable.

Who Collaborates With Whom?

The agency-agency network captures how agencies collaborate to implement aid projects. A tie between two agencies indicates that both are identified in the database as affiliated actors for one project. The unidirectional network was sparse (density = 0.03) and centralized (31%). On average, one agency had 6.24 ties and was connected to 3.12 other unique agencies. The network has a higher average clustering coefficient (.81).

As shown in Figure 5,¹⁰ EXIM, ZTE, and Huawei are the most central agencies, given their active roles in providing financial resources and implementing projects. Agencies tended to cluster around countries: the top left was Nigeria, the center and the lower right was Zimbabwe, and the lower center was Cameroon. ERGM was conducted as follows. First, the baseline model included edges and the geometrically weighted edgewise shared partner (GWESP). Second, Model 2 was constructed by adding organizational types to the baseline. The goal was to discover what sectors were more likely to collaborate with each other. We constructed Model 3 by adding SOCs to the baseline model to test whether they are

¹⁰ Agencies were colored based on organizational type: red = SOEs; blue = private companies; orange = government agencies; and green = others. Bigger agencies indicate more connection, labeled with names.

more likely to implement aid projects than are other types of organizations. Two country variables were added as control variables to see whether agencies from the same country, and particularly from China, were more likely to collaborate.

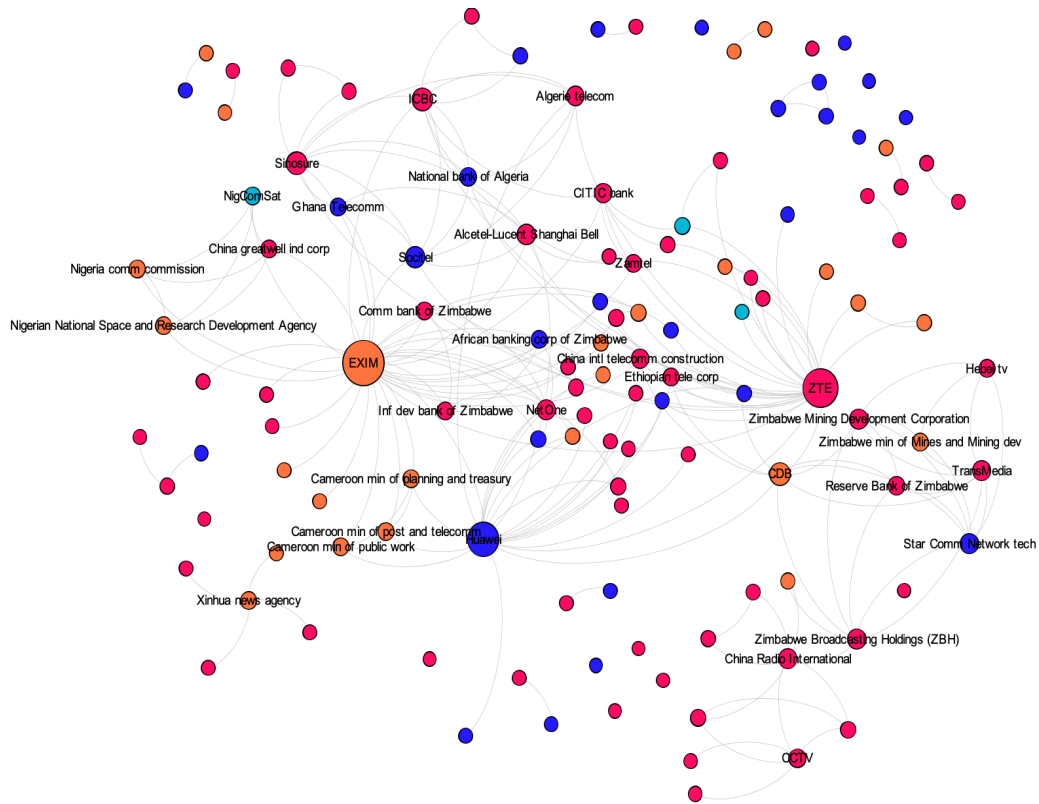


Figure 5. Agency-agency collaboration network.

To answer RQ3, ERGM results show that the foreign aid collaboration network had a strong tendency toward transitivity: An agency is more likely to collaborate with partners' partners (Model 1, Estimate = 2.35, $SE = .17$, $p < .0001$). Sector homophily effect was not significant, suggesting agencies in the same sector tend to view each other as competitors. Compared with other pairs, SOEs were less likely to collaborate with the private sector (Model 2, Estimate = $-.52$, $SE = .17$, $p = .002$). In Model 3, the effect of country homophily was not significant, suggesting agencies from the same country were not more likely to collaborate. Same effect was found for Chinese agencies, suggesting a typical project would have one Chinese funding agency and one African implementing agency from a different sector (see model summary in Table 2).

Table 2. Summary of ERGMs.

Parameters	Model 1	Model 2	Model 3
Edges	-5.77 (.20)**	-5.60 (.21)**	-5.85 (.24)**
GWESP	2.35 (.17)**	2.34 (.17)**	2.43 (.18)**
Government-government		.11 (.22)	
Government-SOE		-.17 (.14)	
Government-private		-.29 (.24)	
SOE-private		-.52 (.17)*	
Private-private		.28(.20)	
Country homophily			.21 (.20)
China-China			-.07 (.15)
SOC			.05 (.08)
	AIC = 1,449	AIC = 1,450	AIC = 1,459
	BIC = 1,463	BIC = 1,499	BIC = 1,494

Note: ** indicates $p < .001$, and * indicates $p < .01$.

To further explain collaboration patterns among agencies (RQ3), we conducted modularity analysis. All the 125 agencies can be grouped into 31 subcommunities (resolution = .61). We discuss the top three communities¹¹ by memberships (see Table 3), as the results display some distinctive patterns.

The largest subcommunity had 19 agencies from nine countries, among which the most active agencies were EXIM and NetOne, a telecommunication SOE in Zimbabwe. Other major agencies included three banks in Zimbabwe (two SOEs and one private); one private bank in South Africa; government agencies in Sierra Leone, Nigeria, Ghana, and Eritrea; SOEs in Nigeria, Djibouti, and China; and one private company in Angola. This subcommunity contains major aid-recipient countries from the data set. Main agencies were state institutions including banks, infrastructure companies, telecom companies, and government agencies.

The second largest subcommunity has 18 agencies from 13 countries, making it the most geographically diverse cluster. ZTE is a well-connected agency, central to this subcommunity. Two state banks and one Chinese ministry belong to this community. The rest are African agencies, including governmental, banking, and industrial institutions in electricity supply and telecommunications. Major players are based in the southern and northern parts of the continent.

The third largest subcommunity has 17 agencies from 11 countries. The most notable are Huawei, connecting with nine SOEs, mostly African ones, in the areas of telecommunication and infrastructure construction. Two private companies from Mali and Nigeria are included. The rest are government entities overseeing telecom, finance, and planning. Major players are based in the central, eastern, and western parts of the continent, with a strong focus on telecom infrastructure.

¹¹ The number of members in the other subcommunities dropped dramatically, with the fourth largest having 12 agencies, fifth largest having eight, and sixth largest having five. The rest ranged from five to one.

Table 3. Top Three Subcommunities.

Agencies	Subgraph
1 Chinese government agency: EXIM	
4 SOEs in China: Great Wall Industry Corp.; International Telecommunication Construction Corp., China Communications Service International, and China National Electric Import & Export Corp.	
3 SOEs in Zimbabwe: NetOne, Commercial Bank of Zimbabwe Holdings, and Infrastructural Development Bank of Zimbabwe	
1 SOE in Nigeria: Kaduna State Media Corp.	
1 SOE in Djibouti: Djibouti Telecom	
3 Private companies: African Banking Corp. of Zimbabwe, Standard Bank of South Africa, and Munda Startel in Angola	
6 government agencies in Africa: Ministry of Finance and Economic Development in Sierra Leone, Nigerian Communications Commission, Nigerian National Space and Research Development Agency, NigComSat in Nigeria, Ghana Ministry of Communications, and Ministry of ICT in Eritrea	

3 Chinese SOEs: ZTE, China CITIC Bank, and Bank of China

China Ministry of Communications

5 other government agencies: UN, National Telecom Institute in Egypt, Congolese Office Congress of Post and Telecom Democratic Republic of Congo, Chad Ministry of Communications, and Algerian Ministry of Post and IT

3 private companies: Econet Wireless Zimbabwe, Libya Telecom and Technology, and Econet Telecom Lesotho

6 SOEs in Africa: Zambia Electricity Supply, Zamtel in Zambia, Nigerien Telecom Society, ABN AMRO Bank in the Netherlands, Telkom Kenya, and Congo-Chine Telecoms

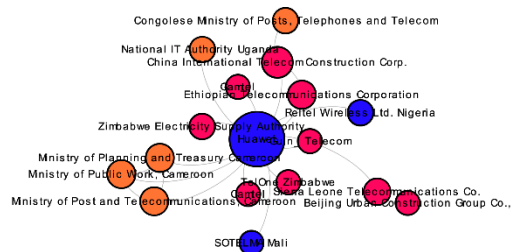
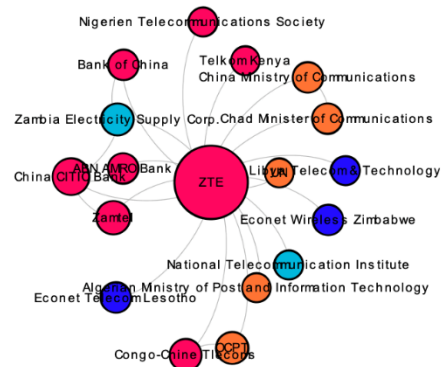
Huawei

2 Chinese SOEs: CITCC, and Beijing Urban Construction Group

5 government agencies: National IT authority Uganda; Congolese Ministry of Posts, Telephones and Telecom; Ministry of Planning and Treasury Cameroon; Ministry of Post and Telecom Cameroon; and Ministry of Public Work Cameroon

2 private companies in Africa: SOTELMA Mali, and Reltel Wireless in Nigeria

7 SOEs in Africa: Zimbabwe Electricity Supply Authority, TelOne Zimbabwe, Sierra Leone Telecom, Guinetel in Guinea Bissau, Gamtel in Gambia, Ethiopian Telecom Corp., and Camtel in Cameroon



Discussion

The aim of this article was to identify general patterns of China's ICT aid to Africa. This effort is worthwhile for two reasons. First, no such systematic analysis exists in the literature. Second, this study leverages the construct of Chinese state capital as embedded within communication networks to outline major spatial and relational features of China's ICT aid, providing insights into the global construction of China's digital capitalism. We summarize important patterns of aid flow, including the main recipients that do not fall into the traditional Angola model, and the diverse players in providing and implementing the aid that challenge the old geometries dominated by OECD countries. We also draw from archival data to elaborate these findings.

Beyond the Angola Model

ICT aid constituted a very small portion of the total Chinese aid to Africa. Yet Chinese agencies have directed ICT aid to a remarkably large number of African countries, which together are home to 92% of the African population. The presence of Chinese vendors beyond traditional first-tier nations, and independent of Huawei and ZTE's self-financed market expansion, will provide Chinese equipment vendors market footholds in the longer run, even if it does not necessarily dovetail with short-term corporate priorities. Our analysis revealed Huawei and ZTE initiated and mediated financing from China to Africa, in many cases shielding from taking full debt-related liability through the participation of Chinese banks. At this stage, this widespread geographical footprint appears to be strategic positioning for the future, even if in terms of absolute amounts, Chinese ICT aid has unmistakably concentrated on three countries—Ethiopia, Nigeria, and Zimbabwe. We look at these three countries in turn.

Ethiopia, the second most populous African country, yet a still undeveloped telecom market, received the single largest ICT aid project. As Chinese vendors seek long-term returns in Africa through in-depth engagement that differs from the strategies of their European counterparts (Wen, 2018), it is reasonable to infer that this project was partly motivated by the desire to engage and access a potentially huge market. Furthermore, Ethiopia, home to the African Union headquarters, is important to Sino-African diplomatic relations. China's prominent role in developing Ethiopia's telecom backbone may prove an astute political strategy. Clearly however, Ethiopia's prominent position in receiving Chinese ICT aid does not follow the Angola model.

The second biggest project was a \$500 million loan to Nigeria in 2008. Nigeria has considerable oil reserves and could fit the Angola model. But there is more to the story. Nigeria is the largest mobile market on the continent and has been Huawei's largest African client in the past 10 years. With sustained aid over 15 years, Nigeria received a total of 12 aid projects. The most populous country in Africa, Nigeria has had strong economic ties with China, as indicated by its reception of a high level of FDI and by its 34% share of confirmed Chinese infrastructure financing in sub-Saharan Africa between 2001 and 2007 (Renard, 2011). Nigeria is also important because its telecom market is highly competitive, a situation where Chinese vendors tend to do better. Recent statistics showed that Huawei and ZTE have shared 90% of the Nigerian equipment market (Zao, 2013).

Eighteen projects were allocated to Zimbabwe, a smaller national market compared with Nigeria. Zimbabwe was not a big recipient of Chinese infrastructure financing up until 2007. ICT was somewhat of an exception. In Zimbabwe, Huawei not only created a joint venture with state-owned landline operator TelOne but also invested directly in mobile operator NetOne. The opportunity to control a share of the market is a possible incentive. Here again, the specific details of these deals suggest strategic motivations that go beyond the purely extractive motives of the Angola model.

As Nigeria and Zimbabwe were respectively the third and the seventh largest recipients of China's FDI up to 2014 (Ministry of Commerce, 2015), and as Ethiopia moved into the top 10 African countries for Chinese FDI by 2016 (Ministry of Commerce, 2017), these findings indicate ICT aid spearheads China's capital expansion.

Another key finding is that beyond the first-tier national telecom markets where Chinese corporate powers have gained a strong foothold through corporate initiatives, the size of a national market alone is not correlated with the allocation of ICT aid. Instead, higher amounts of ICT aid tend to flow to countries with lower GDP per capita, less population, and higher oil rents. This suggests China's ICT aid is partially driven by the original goal of foreign aid defined by OECD (i.e., assisting the recipient's development). However, Chinese ICT aid likely is not completely disconnected from strategic resource considerations, as evidenced by the significant effect of oil rents on aid allocation.

Taking all these findings about the ICT aid flow, we argue that China's ICT aid does not exclusively follow the Angola model, where aid would mainly be exchanged for natural resources. The real story is more complex, and the multiple patterns uncovered indicate multiple interactions between the Chinese state and corporations, including a mixture of local, corporate, national, and international strategies and priorities. The patterns of Chinese ICT aid reflect a diverse project portfolio with goals ranging from cultivating diplomatic goodwill to promoting infrastructure development to bolster market growth, from developing good relations with countries rich in natural resources to selling telecoms equipment, from locking in market opportunity to instituting network power.

Diverse Players and the New Aid Geometries

Our analysis reveals new aid geometries that challenge the one dominated by traditional donors from the OECD community. To begin with, a few Chinese agencies possess network power in implementing ICT aid. This suggests that the ensemble of Chinese state capital that comprises state banks and industry heavyweights aims to exert substantial influence over Africa's digital future. The two largest Chinese industrial actors (Huawei and ZTE), along with China's central financing organization EXIM, play the most central role. Evidence for this claim includes the number of projects these three actors participated in or implemented, and the number of agencies they collaborated with. Second, Chinese players in the ICT aid space are diverse, consistent with the new geometries identified by Pamment and Wilkins (2016), which captures the openness to more diverse contributors. For example, private companies from the shipping and media industries occupied their niche in those giants' shadow by focusing on smaller aid projects, largely independent from telecommunications aid projects.

The overall aid network itself is transitive, with agencies more likely to form alliances with partners' partners. Agencies from the same sector or country tend to view each other as competitors, proving more likely to seek partners elsewhere. This type of competition appears to be most intense among SOEs. SOEs, particularly Chinese ones, are the main driving force in aid implementation, in contrast to private companies such as Huawei. Our network analysis detected distinct state-centric operational clusters, which included both Chinese and African SOEs as the core agencies. The most likely pattern of aid implementation tied one Chinese funding agency (government agency or SOE) to an African agency from a different sector.

The three most connected subcommunities, respectively, centered on ZTE, Huawei, and EXIM. EXIM collaborates with various institutions, notably from major recipient countries like Nigeria, Ghana, Zimbabwe, and Angola, and relatively less with ZTE and Huawei, confirming the crucial role of the state in securing public financing for aid. Rising from the periphery to partial dominance in the African continent, Huawei and ZTE achieved a degree of independence from EXIM through their ability to provide vendor financing, even though they also rely on other funding sources.

ZTE and Huawei formed their own subcommunities with separate ties to unique collaborators. As shown in Table 3, ZTE focused its footprint on the southern and northern parts of the continent, working with telecom government agencies, private telecom companies, and SOEs. Huawei focused investment in telecom infrastructure in the central, eastern, and western parts of Africa, likewise forming alliances with government agencies overseeing telecom, finance, and planning, and other local telecom companies, state-owned or private. This networking strategy partly protects Huawei and ZTE from political and other risks related to foreign aid while it opens up an interactive space to aid recipients and their local needs.

Although it is not surprising to find three major actors at the center of the network, there is relatively less overlap among their respective subcommunities. A number of underlying dynamics might be at work. First, both having large war chests, Huawei and ZTE have less of a need to rely on Chinese State finance, possibly explaining their looser ties with EXIM. Second, smaller Chinese industrial players cluster around EXIM, likely to secure financing. Third, the separation between ZTE and Huawei's respective subcommunities, and the limited overlap of their geographic aid footprints suggest that these two global competitors stay out of each other's way in Africa, preferring a partition of the field rather than direct confrontation. Further research will be needed to confirm these indications and elaborate on their causes, but our network analysis already suggests complex interaction patterns are at play, patterns that belie both the traditional view of monolithic Chinese state capital and the old assumption that Chinese aid to Africa is purely extractive along the Angola model.

Conclusion

The literature on aid has been guided by a Western view about who the main donors are and what motivates the aid flow. In response to a call for discovering new geometries of aid, this study takes a unique communication network perspective to focus on an emerging donor, China, and on the ICT sector. It uncovers new aid geometries driven by the Chinese state capital, which consists of competing and collaborating actors such as SOEs and government agencies. The new aid patterns revealed in this study indicate that China's ICT aid approach might disrupt to the old geometries dominated by OECD countries.

Findings revealed a nuanced picture of aid flow, which moves beyond the traditional Western characterization of an extractive Angola model, or the mutual benefits model China officially acknowledges. ICT aid flows out to a broad portfolio of countries, but with unique strategies determining who received more aid. It is unclear from this data set who initiates aid flows, whether the funding agency or equipment vendors, or how much state-business interactions might extend to local aspirations and emergent social relations. However, our analysis suggests the intents and results of aid projects vary, ranging from redressing infrastructure deficit to opening new markets for Chinese equipment, from supporting resource-extracting businesses to buttressing local politicians. Networked with diverse players, including state and local government agencies, private companies from media and telecom industries, and SOEs, main players such as EXIM, ZTE, and Huawei have carved their own niches in different regions to establish network power, individually and collectively. The diverse local partners they collaborate with suggest that as China manages an ever-increasing pool of financial aid, it has likely revised its traditional approach, in ways that both share more aspirational opportunity with, and offload more risk to, local stakeholders.

This research's contribution to the study of international aid is twofold. First, it moves beyond the existing aid geometries defined by OECD to identify unique patterns of aid from emerging players such as China. Our findings uncovered categories of actors that are not present in other countries and articulated the roles they played in forming alliances to implement aid. Second, this study introduced network analysis as a new methodology into the literature to analyze the relational dynamics and network power among agencies.

Being a multimethod preliminary examination of a yet-unexplored data set, this study has several limitations. First, it focuses solely on ICT aid, which constitutes a small proportion of total aid. The allocation and collaboration patterns should not be generalized to other, more traditional sectors, which may be more constrained by government regulation and less by market forces. Second, unlike the tight alignment of Chinese state and corporate interests most Western literature presupposes, we expected differentiated, multifaceted, and contingent state-business interplay in the transnational context. Although we found some support for these expectations, a systematic exploration of various patterns of state-business alliances in different national and sectoral contexts was beyond the scope of this article. Third, we analyzed secondary data collected by AidData, which is still being cleaned up for research use. As more detail is added to this data set, we expect it will support a stronger research agenda.

One potential area of research is to analyze the longitudinal data to uncover whether ICT aid received each year was related to mobile and Internet penetration. This could provide further explanation as to why the aggregated data in this study found no significant correlation between market size and ICT aid. Furthermore, aid players are motivated by different incentives. We call for future research to rely on archival publications and sales data from telecommunication companies such as ZTE and Huawei to examine investment criteria in Africa. We also call for future research to investigate both their aid and commercial activities, and their unique strategies in working with state actors.

Given our findings and the increasing Chinese investment in Africa since the inception of the BRI, another promising direction for further analysis will come from the combination of the two lines of inquiry we started in this article (i.e., the interplay between donor interests and recipient needs). For example, how

is the allocation of aid in different sectors (such as mining, energy, transportation, and ICTs) affected by the state–capital relationship, convergence of interest among players, and the market structure of each sector? Furthermore, the literature on foreign aid could benefit from the investigation into how the implementation of different aid types might be related. For example, is there a sequencing effect between infrastructure (e.g., roads, railways, and power supplies) and ICT aid? Are these aid types complementing each other? Our article lays out a partial foundation in the ICT sector for such analysis, to be complemented by analysis of other sectors.

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