



OPEN DATA INTERMEDIARIES IN THE AGRICULTURAL SECTOR IN GHANA



RESEARCH PAPER



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1 Introduction

BACKGROUND

Africa loses billions of dollars due to its inability to produce enough food and process its agricultural commodities. The immediate need for changing this situation is obvious. One way of improving food production in Africa is to connect farmers, food processors, food distributors and consumers more effectively. Such effective links could also generate employment in Africa. Since 80% of the food consumed in sub-Saharan Africa (and in Asia) is produced by smallholder farmers, the connectedness of these farmers is of crucial importance. That is, Africa's smallholder farmers need to be linked more effectively to the market and to the multiple actors that intervene in agricultural value chains.¹ Above all, farmers need to have access to information on the markets, processes, environmental conditions and value chains within which they operate. The awareness of the structure and properties of their economic, climatological and agronomic contexts may yield immediate and long-term benefits for African farmers, the markets in which they operate, and for the management of the environment on which they so depend. Open data holds the promise of unaltered and equal access to such information.

However, even though open data are in theory more easily accessed because they are publicly available, the reality of their flow to intended users, for whom they are essential, is far more complex. Barriers exist both on the side of data providers (Magalhaes, Roseira & Strover 2013) and on the side of data users (Canares 2014; Gurstein 2011; Janssen et al. 2012; Magalhaes et al. 2013). To overcome these barriers and to render the data flow more agile and efficient, intermediaries play a critical role in data ecosystems (Davies 2014; Roberts 2014; Van Schalkwyk et al. 2014).²

For the purpose of this study, we understood open data intermediaries to be agents who are located at any point in an open data supply chain – where such a chain is a data chain that at some stage (but not necessarily at all points in its length) incorporates an open dataset (Van Schalkwyk, Cañares, Chattapadhyay & Andrason

2016: 6). Open data intermediaries are thus bridging agents. They link two (or more) other agents to facilitate the use of open data at some point(s) in the chain. In other words, if there is an open dataset at the beginning, in the middle or at the end of a data chain – but not necessarily in the entire chain – a connecting actor who enables and/or eases the flow of data is an open data intermediary. Under this broad definition, open data intermediaries may open the data, close the data or simply transfer the data in the form which they received them from an agent located at a higher level, or in a form which they altered.

The role of open data intermediaries in the ecosystem broadly, and in the data supply chain specifically, is highly relevant – they may in fact be vital for enabling that data chain to be fluid and even for the very existence of data chains (Van Schalkwyk, Willmers & McNaughton 2016). Intermediaries increase the accessibility and utility of data. They also act as keystone species or decisive actors by introducing users to the data chain that otherwise lack the capacity or the means to access and interpret data directly. As a result, they expand the data network to new areas of the ecosystem or democratise the use and the effects of open data (Van Schalkwyk et al. 2014; Van Schalkwyk, Willmers & McNaughton 2016). Open data intermediaries typically contribute to the transparency of an ecosystem and its value chains, and increase trust among species present in that ecosystem and value chains. Being trusted sources of information, open data intermediaries stimulate positive relationships between various agents in data value chains. This trust (reinforced by transparency) introduced to the ecosystem may in turn contribute to breaking down the asymmetry of information in various ecosystems.³

It is important to note that intermediaries themselves have a profound impact on the properties of data, as they commonly manipulate the data received from other agents. That is, they may not only modify data that already exist by packaging them into a new, more accessible form, but they can generate entirely new data, adding to those already existing.

1 In this paper we understand a value chain as a complex system of inputs and outputs in which the interconnected consecutive activities are performed in order to deliver a broadly understood (i.e. material or immaterial) product (Porter 1985).

2 In this study we use ecosystem as a heuristic narrative that encapsulates the dynamics of open data systems (Gama & Lóscio 2014; Heimstädt et al. 2014a, 2014b; Van Schalkwyk et al. 2016). As in biology, an ecosystem is understood as a dynamic complex system of biotic and abiotic components.

3 It should be noted that not all intermediaries are trustworthy and/or equally trusted. For the issue of the importance of trust consult Davies (2014) and Davies and Perini (2016).

THE KNOWLEDGE LACUNA

There is an emerging body of empirical-based research that analyses the behaviour of open data intermediaries (Mayer-Schoenberger & Zappia 2011; Magalhaes et al. 2013; Dumpawar 2015). Empirical evidence that specifically focuses on the entrance of open data intermediaries into the ecosystem is even scarcer (Van Schalkwyk, Cañares, Chattapadhyay & Andrason 2016).

A study conducted by Van Schalkwyk, Cañares, Chattapadhyay and Andrason (2016) focused on open data intermediaries and their emergence analysed more than thirty cases from Africa and Asia. By employing Bourdieu's framework and the concept of capital, the authors demonstrated that the success of intermediaries in a data chain and in particular their entry into the ecosystem are related to the types of capital such intermediaries hold. The researchers concluded the following: since on the one hand a successful connection between open data suppliers and open data users necessitates various types of capital (i.e. economic, cultural, technical, social and symbolic capital),⁴ and on the other hand, both a single supplier or a single intermediary is unlikely to possess all types of capital required to ensure effective flow (and re-use) of data, multiple intermediaries – each specialised in in different types of capital – must intervene to establish an effective and sustainable link between data suppliers and data users (Van Schalkwyk, Cañares, Chattapadhyay & Andrason 2016).

The abovementioned research did not, however, provide an in-depth analysis of the different types of open data intermediaries that were included in the case studies. The study relied heavily on secondary evidence for its analysis, and its scope was coarse-grained and macroscopic. In other words, the case studies were not conceived or written for the purpose of studying the role, behaviour and emergence of intermediaries. It was only the broad conceptual framework shared by these reports and the intermediary research that made it possible for Van Schalkwyk, Cañares, Chattapadhyay and Andrason (2016) to deduce certain characteristics of open data intermediaries. Furthermore, given its synthetic nature, the study failed to micro-analyse the intermediaries by distinguishing their idiosyncrasies and dissimilarities. That is, atomic fine-grained divergences which may have important bearings not only on the specific intermediaries' performance but also on the broader theory of their emergence and behaviour were not accounted for.

4 For an explanation of these terms see Section 2.

RESEARCH QUESTION(S), RESEARCH SCOPE AND RESEARCH METHOD

The present study aims to reduce the scarcity of empirical fine-grained evidence concerning open data intermediaries and their emergences, in particular, their characteristics that enable them to enter an ecosystem and to thrive in it.

The main goal of the research is to study the emergence of intermediaries, the form of capital used by them to enter the ecosystem and its extent, and the intermediaries' effects on that ecosystem. This principal objective results in the following research questions:

1. What are the features – embodied in the open data intermediaries and/or present in the ecosystem – that enable these intermediaries to emerge, that is, to insert themselves into a value chain and the ecosystem?
2. What are the forms and extent of the capital that the open data intermediaries possess, and how do they manage these initial material and non-material assets for their survival in the ecosystem? In other words, how does their capital connect them with users and, subsequently, maintain their connection with others in value chains?
3. How do the open data intermediaries modify the data flow, value chain and the entire ecosystem which they enter? That is, what are the benefits to other agents present in the ecosystem, be they data suppliers, data recipients and indirectly related or even (at the beginning) unrelated actors.

The scope of the study is confined to open data intermediaries in developing countries, specifically in Ghana. The research is further narrowed to the interface of the agricultural and mobile-technology sectors, focusing on three recently established companies that combine open data with mobile-phone technology (and tools derived from or related to it) to convey information to users: farmers and/or other businesses. The three companies are Farmerline, Esoko and CocoaLink. All of them have proven to be successful in the open data ecosystem.

The choice of mobile-phone technologies is not accidental. Mobile-phone and smart-phone technologies are a new expanding tool in connecting users (especially farmers) with accurate and timely information and services. Technology can therefore play an important role in enabling connections between farmers and other

actors in value chains, thus constituting a vital factor in open data flow. As a result, it may contribute to counter some of the potential imbalances in the access to and possession of information that are almost inherent in initiatives dedicated to small-scale farmers in developing economies.

The three companies were also chosen to provide variations with respect to size, business model, target groups, reasons of creation, products offered, and data transmission and data generation models. The variability of parameters is intended to provide a qualitatively reliable sample which would enable us to discover macroscopic rules governing the emergence and survival of intermediaries and the effects caused by them in ecosystems, as well as the patterns in the use of different forms of capital.

The evidence was collected by analysing existing documentation discovered via desk research, by conducting research in situ in Ghana, and by interviewing the owners, founders or personnel of the three companies. Data was collated for all parameters in a single document to allow for easy identification of company characteristics and attributes that may serve as indicators of particular types of capital.

2 Theoretical framework

To analyse the emergence, survival and effects of open data intermediaries, elements of two theoretical frameworks were used: Bourdieu's social model (Bourdieu 1984, 1986) and theory of complex systems (Hooker 2011a).

We draw from Bourdieu's idea of capital to explain the various types of assets and properties associated with open data intermediaries. Capital will be understood as a set of possible advantages – that is, resources or properties that may yield benefits under certain conditions – characterising, positioning and differentiating agents in an ecosystem (Bourdieu 1984, 1986; Zhang 2010; Halford & Savage 2010).

In this study, we identify and explore configurations and the relative value of capitals in relation to three actors in the ecosystem: data owners, data users and resource owners. Intermediaries that connect multiple actors in the supply chain in order to connect data suppliers and data users need different types of capital. These types of

capital will vary in their value depending on the specific actor that they connect to.

There are, at least, five types of capital distinguished in the literature: economic, cultural, technical, social and symbolic capitals. Economic capital typically corresponds to monetary or financial assets and physical properties that have (or can be converted into) a monetary value. Economic capital is usually relatively overt, objective and easily measurable (where data is disclosed). Cultural capital makes reference to knowledge and experience embodied by agents: a person, a company understood as an amalgamation of individuals, or a company viewed as an individual itself. Cultural capital includes educational and professional background and credentials, diplomas, competencies, skills and qualifications. Certain aspects of cultural capital are easily measurable (e.g. diplomas and certificates), while others are too elusive to be quantified. Technical capital corresponds to technical knowledge, abilities and means of collecting, digitising, restructuring and translating data into information accessible to the data receptors. It can be measured in terms of educational degrees and/or technical expertise and skills acquired, as well as in terms of the technology and physical tools possessed. The former features relate it to cultural capital, the latter to economic capital. Social capital encompasses various types of institutionalised networks and personal or social connections. It is exemplified by circles of friends and acquaintances to which an individual is related, as well as by memberships and partnerships with which it is bestowed. Although overall it is less objective and measurable than the aforementioned forms of capital, certain aspects of it (such as official memberships and partnerships) are explicit and comparable. Lastly, symbolic capital includes any form of capital that fails to fall into the types introduced previously and/or is not regarded as such. This includes respect, reputation, recognition, fame, prestige, honor, attention, etc. (Bourdieu 1984, 1986, 1996: 148; Wacquant 2006; Zhang 2010).

Second, we will elucidate the behaviour of open data intermediaries from a broader perspective of complexity theory, focusing on their capitals' fuzziness and situatedness. Complexity theory is a theory of reality – all real-world systems are complex. That is, they display some or all of the following properties: they are open, situated, boundary-free and replete with unstable individuals; infinitely cardinal, uncontrollable and uncertain; dynamic, metastable and path dependent; nonlinear, sensitive to initial conditions, exponentially amplifiable and in regions chaotic; emergent, non-additive, non-modularisable, irreducible and organisationally intricate. They are

also self-organising and adaptive (Cilliers 1998, 2005; Schindwein & Ison 2007: 232; Wagensberg 2007: 12, 27, 56–62; Hooker 2011b: 20–21, 40; Bishop 2011: 112; Cilliers et al. 2013: 2–4).⁵ For the purpose of this study two properties will be of particular importance: fuzziness and situatedness.

Fuzziness means that a boundary between two individuals or an individual and the system in which it is embedded is problematic. In fact, a clear distinction between any two entities (and hence concepts) is pragmatic rather than real. In nature, rigid and permanent boundaries do not exist – we merely draw them according to our needs to simplify and explain complex problems. What does exist are smooth transition phases where individuals, categories, concepts and systems gradually transmute from one to another (Dimitrov 2002, 2003; Munné 2013:176–178).⁶ Situatedness implies that the behaviour of complex systems or the behaviour of their components depends not only on the parts of which they are composed but also on the whole(s) in which they are embedded. This means in turn that certain important properties of the system are dictated by its global situation and that some characteristics of a constituent derive from non-interiorised relations with other parts of the system. As far as the individual is concerned, it emerges and develops in response to the properties of the environment to the extreme that its own behaviour cannot be explained by micro-analysing the components of which it consists. Quite the reverse is true – an individual must include (some parts of) the system in which it exists (Hooker 2011a).

The concepts of fuzziness and situatedness can be translated onto a framework of capitals in the following manner. Forms of capital and their measure constitute fuzzy concepts. First, any type of capital discussed in this section is not unitary but rather composed of multiple sub-types. If a relatively fine-grained level of analysis is adopted, one sub-type may in fact belong to two major forms of capital (e.g. tools possessed by a company can be viewed as constituting its economic and technical capitals; certificates in the form of formal qualifications can be understood as shaping both educational capital and

technical capital). Moreover, a component contributing to a major form of capital can have important bearings on another major form of capital. As a result, capitals partially overlap so that sometimes the exact classification of an aspect of capital may not be straightforward or it can be categorised as belonging to two forms of capital. Forms of capital transmute from one type to another in a scalar manner though fuzzy transition phases. Second, the sub-types of capitals that deliver major forms of capital are qualitatively dissimilar. The measurability of such components of capitals varies from more objective and easily quantifiable (e.g. monetary assets) to more subjective and non-quantifiable (e.g. fame). As a result, the overall measure of a form of capital that is possessed by an individual can only be approximate. Consequently, capitals will be understood as elastic terms and their quantification as rounded, and not as discreet categories with precise numerical values.

Capital is not only fuzzy but is also situated. The advantage of capital is not intrinsic. Rather, its beneficial effects emerge in relation to an ecosystem in which it is used, or even to a fragment of it. The exact value of a capital possessed by an actor depends on the environmental factors in which both the capital and its possessor are embedded. As a result, a type of capital that is highly advantageous in one area of the ecosystem may fail to have value in other areas, or may even be valueless. This situatedness of capital means that different forms of capital can (and in fact should) be converted and/or exchanged (Halford & Savage 2010: 944–945). Due to this convertibility and transferability, capital can flow between agents from one part of an ecosystem to another, having an important effect on these agents' behaviour and/or the ecosystem's structure.

3 Findings

Even though operating within the same larger ecosystem – open data intermediacy via mobile technology in the Ghanaian agricultural sector – the three entities selected for the purpose of this research differ at a more atomic level of description.

Farmerline

Farmerline is a private, for-profit company established in 2013 by two young entrepreneurs: Alloysius Attah and Emmanuel Owusu Addai. From the beginning, the

5 As far as its modelling is concerned, a complex system is typically incompressible, model-specific and model-pluralistic (Hooker 2011a, Cilliers et al. 2013). For a concise explanation of these terms see Andrason 2016. On complexity and its measures, such as Kolmogorov complexity (also known as algorithmic, descriptive or programme-size entropy) or Gell-Mann complexity (also denominated as effective complexity), see Gell-Mann (1995), Gell-Mann & Lloyd (1996, 2004), Gell-Mann & Tsallis (2004), Li & Vitányi (2008) and Esquivel et al. (2010).

6 On fuzziness, fuzzy logic (a mathematical convention to treat fuzziness), and fuzziology (the study of fuzziness in complexity and/or human life) see Zadeh (1973), Zadeh and Yager (1987), Klir (1992), Dimitrov (2002: 10–15, 18–19; 2003), Dimitrov and Hodge (2002), Dimitrov and Korotkich (2002), and Siagian (2003).

main office has been based in Kumasi, one of the main urban areas in Ghana, situated 250km northwest from the capital city of Accra. Farmerline does also have a business development office in Accra.

The company principally targets individual farmers, although it has gradually expanded to accommodate businesses as well. At the time of its establishment, the founders had relatively little experience in open data; their familiarity with the mobile sector and associated technologies was more extensive. Attah had earlier been involved in a photo-video production company and a web-mobile startup. Addai had worked as consultant and developer on certain national projects and in the web-mobile company with Attah. Both founders initially operated within a personal and national network of connections. This local orientation of their networks, which played a relevant role in an adequate positioning of Farmerline within the Ghanaian context, has its roots in the social provenance of the founders. Attah was originally a small-scale farmer and had himself experienced the challenges of small-scale farming in rural Ghana.

As for their educational background and professional qualifications, Attah concluded college education while Addai holds a bachelors and a masters degree in engineering from Kwame Nkrumah University of Science and Technology (KNUST) (Ghana). This accounts for Addai's main responsibility in Farmerline: he is responsible for the technological side of production, such as writing algorithms and developing applications.

In its initial phase, Farmerline secured some funding from external organisations: Echoing Green, Indigo Trust, European Union Commission and NWO (Netherlands).

Farmerline was established for two main reasons: one was personal and the other was ecosystem-driven. On the one hand, given their social background, the founders wanted to contribute to the community that had previously supported them. On the other hand, an ecological niche emerged, ready to absorb a new type of business. To be exact, farmers in Ghana for a long time lacked access to information about farming techniques and market prices even though such information existed. The government had tried to address this issue by providing agricultural extension officers who would train smallholder farmers in agrarian and business practices. However, as the number of agents was highly limited (there was one agent for every 2 000 farmers served) and illiteracy was high, government's intervention was largely unsuccessful. Moreover, a relatively extensive mobile phone network existed in rural Ghana – almost 70% of the population

had access to mobile phone technology at the time. Thus, Farmerline was created to bridge the existing gap by connecting farmers with government-held information by using mobile-phone technology.

Since the establishment of Farmerline, its primary target market consisted of smallholder farmers. A secondary group of customers include low-income illiterate communities, farmer-based organisations, NGOs and data collection organisations. The main objective of the company is to help farmers to increase their yields, productivity and profit by means of mobile-phone information and for farmers to develop sustainable businesses. Farmerline's general offering includes sending messages with agrarian, economic and financial information, and providing web platforms and mobile applications to disseminate and collect agricultural data. The specific products offered by Farmerline are both mobile and non-mobile. The former are of two main types: those directed to farmers, and those directed to organisations and businesses. Products offered to individual farmers are twofold. One consists of voice messages and SMS, both related to four classes of content: farming practices, weather forecasts, market prices and financial tips. The messaging system is offered in 12 local languages (Dagbani, Mampruli, Twi, Kusaal, Frafra, Sissali, Dagaari, Wali, Ewe, Ga, Fante and Hausa) and in English. The second product consists of a support line that farmers may call and receive expert advice on various issues. For businesses, Farmerline principally offers mobile and software (Android) products. These products enable farmer-based companies, organisations, NGOs, government, mobile network operators and agricultural businesses to administer, monitor and trace their projects, to collect any type of data related to the impact of their interventions, and to communicate with farmers and other agents in the supply chain. The non-mobile products principally involve training and sensitisation workshops for farmers.

Currently, Farmerline is relatively small in terms of its staff complement. It employs the two company founders and a team of 19 staff, five of whom are women. As a result, the company preserves its original person-oriented and direct character. The principal range of activities of Farmerline has also remained as it was, namely national. The company has reached 5 000 Ghanaian farmers of whom many are women. Nevertheless, since the creation of Farmerline, the network of its connections has increased, currently extending beyond the borders of Ghana. Farmerline has collaborated with both international NGOs and international food companies (e.g. Hershey, Ecom and Armajaro). It has also participated in the Global Open

Data for Agriculture and Nutrition network (GODAN) and in the Business Call to Action (BCtA). The latter partnership, promoted by the Dutch, Swedish, UK, USA governmental agencies and the United Nations, exposed Farmerline to a hundred other member-companies. Recently, Farmerline engaged in a partnership with a Dutch NGO, Trans-African Hydro-Meteorological Observatory (TAHMO) and with KNUST and Delft University of Technology. The purpose of this is partnership to set up weather stations across Ghana. Through partnerships in Nigeria, Sierra Leone, Cameroon and Malawi, Farmerline is estimated to have reached 200 000 farmers.

As far as the character of the data used by Farmerline is concerned, some of the data are open data. Open data is sourced from the government's meteorological services (GMET) and from the ministry of food and agriculture. However, these open data are combined with data collected by Farmerline. To be exact, with respect to market and weather data, the company's own agents collect weekly market prices. Farmerline also deploys weather stations in partnership with the GMET and TAHMO. It purchases weather forecast data from other non-open sources. Agricultural advice information for farmers is sourced mainly from open sources such as KNUST, and its Aquafish Innovation Lab funded by the US Agency for International Development (USAID), as well as from the ministry of food and agriculture. However, again, Farmerline actively contributes to the preparation of this type of information. Financial advice is mainly generated by Farmerline and is sourced from microfinance institutions. Given the active contribution of Farmerline to data chain and to data collection and preparation, the company charges limited fees. Farmers pay a small subscription fee to access Farmerline's services.⁷

The overall activity of Farmerline increases farmers' connectivity. On the one hand, it connects farmers to markets and to farming and trade-related information. On the other hand, it connects businesses and other organisations to farmers. The system is easy to use, which is relevant for farmers, although its complexity increases with more advanced tools and features.

As its primary result, Farmerline reports that the yields and, hence, the incomes of farmers have increased. According to the company, this increase in the income of farmers amounts to an average of 55.6%. However, the

monitoring and evaluation of the results are not consistent as only sporadic field tests and internal assessments are reported. Moreover, the system of interactive voice response (IVR) offered by Farmerline has proved successful in rapid assessment needs, for instance in case of a disaster or epidemics. In light of its success, Farmerline was awarded the title of Echoing Green Global Fellows in 2014.

Farmerline also faces certain challenges. According to the company, one of the them is local scepticism, especially patent at the beginning of its activities. Moreover, the helpline and IVR service have not been widely adopted, as it is both relatively expensive and complex for farmers (the menus and application are complicated) when compared to receiving voice messages. Other types of challenges include human resourcing. Hiring of skilled staff and, especially, of talented programmers is difficult. Farmerline struggles to attract specialists, as it cannot compete with large technological companies on experts' salaries.

As for the future plans, Farmerline aspires to reach 500 000 farmers in West Africa through BCtA by 2019 and to empower two million farmers by 2024 by expanding across Africa, Asia and Latin America. Given the usefulness of its IVR and voice surveys in cases of disasters and emergencies, Farmerline also plans to create new tools that can support health workers in Africa, both in emergencies and in educational health programmes.

Esoko

Esoko is a for-profit company that, even though private, maintains close relationships with the public sector. Managed from its main office in the capital city of Accra, Esoko is principally directed at businesses (being an example of a business-to-business [B2B] model), while individual farmers constitute a secondary market.

The origin of Esoko may be traced to TradeNet, a company that was created in 2004 in Uganda in partnership with FoodNet and under the stimulus of the Food and Agriculture Organization of the UN (FAO). In 2005, TradeNet entered into the MISTOWA project funded by USAID and expanded to ten countries in Africa. Esoko emerged from TradeNet in 2009 with the aim of providing a richer product than the market prices in which TradeNet had specialised. For this purpose, a new platform with a broader set of tools was developed. A change in product meant organisational change and, ultimately, a new name.

⁷ There are cases where private businesses or other organisations cover that fee, rendering the service free for farmers. It should be noted that farmers can subscribe via a code or pay directly via mobile money.

The founder and the first CEO of Esoko was Mark Davies. Other investors, who provided the bulk of the capital, were the International Finance Corporation, the Soros Economic Development Fund, Lundin Foundation, and Acumen. Currently, Esoko also generates its own income. At the time of the establishment of Esoko, the prior experience of its founders was relatively good as was their network of connections. This network was mainly corporate and both of a national and international extent.

TradeNet emerged as a result of an ecological niche created in the agrarian ecosystem in Uganda. That is, information concerning market prices existed but farmers had no access to the information. TradeNet aspired to bridge this gap by connecting farmers to the available data by means of mobile-phone technology, namely SMS. Esoko explored a similar ecological niche in Ghana. On the one hand, Ghanaian farmers sought information concerning market prices and weather (in particular data on rainfall). As they found themselves unable to acquire this information, they traded their produce at low prices and were vulnerable to climate variations. On the other hand, the information required by farmers existed at a governmental level. Nevertheless, the extension agents employed by the government to convey this information to farmers were inefficient and costly. Consequently, Esoko emerged to bridge the gap by connecting farmers to the available information. However, as the acquisition of individual farmers is expensive, the company principally focuses on businesses and projects that already have access to farmers.

Esoko's main target group includes businesses (agri-businesses, NGOs, governments or mobile operators), although the company also seeks to serve smallholder individual farmers. The principal and ultimate objective of Esoko has in fact been to empower smallholder farmers and render their agriculture business more profitable. To accomplish this, two more specific goals have been formulated. On the one hand, Esoko aims to provide a communication platform whereby such smallholder farmers could easily and successfully be reached. On the other hand, it seeks to offer information and communication service for agricultural markets.

The range of products offered by Esoko principally concerns mobile technology, although non-mobile products are also provided. The extent of mobile products for its B2B market is relatively broad and rich, including marketing products, monitoring and evaluation products, as well as goods sourcing products (e.g. bulk messaging, SMS polling, call centre monitoring and call surveys). It also develops Android-based applications for surveys,

marketing and monitoring. The main offering of Esoko to farmers includes automated alerts containing agrarian and economic information sent to farmers on their cell phones in the format of SMS and voice messages. The products offered directly to farmers are the following: text and voice messages on market prices (58 commodities in 42 markets countrywide, collected at markets daily), weather forecasts, bids and crop production protocols. It also developed the first call centre (Helpline) for farmers in Ghana to improve communication and the usability of the provided information. The messaging and call centre operate in 12 local languages and English: Dagbani, Mampruli, Twi, Kusaal, Frafra, Sissali, Dagaari, Wali, Ewe, Ga, Fante and Hausa. The non-mobile products include deployment support for surveys in the field (e.g. the deployment of the company's own agents), strategic planning and field training to business clients and farmers.

Currently, there are two main branches of Esoko in Africa, in Ghana and Kenya. Even though the offices in Ghana and Kenya function under the name Esoko and provide similar products, they constitute two distinct operations managing the two respective markets. In addition, they are resellers and offices in Mauritius, Malawi, Uganda, Mozambique and Benin.⁸ Overall, Esoko has separate directors and/or representatives in seven countries. In Ghana, Esoko employs 90 people, which ensures its semi-personal and semi-corporate character.⁹ The country director in Ghana, responsible for raising funds and building the Esoko network in that country, is Daniel Asare-kyei.¹⁰ Currently, Esoko is partnered with the Ghanaian ministry of food and agriculture, which provides external technical experts to support the call centre and e-programs, as well as with the Centre for Agriculture and BioSciences International (CABI), the Council for Scientific and Industrial Research (CSIR) and the International Fertilizer Development Center (IFDC). This means that the network of the Ghanaian branch has considerably increased since the establishment of Esoko, especially at a national level. Esoko is claimed to have reached 350 000 farmers in ten countries across Africa. It has sent 9.5 million messages on one million prices in 170 markets collected by 150 field agents. In 2014, Esoko operated 29 344 calls in Ghana, of which 40% were related to weather data.

Although a portion of the data sources by Esoko is open (being directly sourced from the government), Esoko

8 International headquarters are located in Mauritius and in Kenya.

9 In all the countries where it operates, Esoko provides employment to more than 200 people.

10 The current CEO of the company is Hillary Miller-Wise.

Ghana collects its own data. Esoko actively collects data from farmers which may be of interest to agencies and businesses engaged in the agri-sector. Overall, data sourcing is structurally complex, and its open (provided by the state) and private (generated by Esoko) sub-types closely intermeshed. To be exact, even though agricultural data are obtained from government and from CABI, the data are extensively curated by Esoko. Curation includes the structuring of the data, its packaging and the translation into local languages. Esoko also deploys its own agents in the field to collect price data in about 50 markets in Ghana, albeit that some of these agents are in fact employees of the ministry of food and agriculture.¹¹ Esoko also collects other data related to the farmers such as their interests, agronomic profile and personal information (e.g. gender, age). These data are not publicly open and are only made available to clients as part of a value-added service. Given that Esoko actively contributes to generating data, which is a costly process, it charges for most of its services. However, the cost for individual farmers is relatively small, as each call to the call centre service is at the regular call rate.

Esoko improves various types of connections in the ecosystem. It enhances the connection between businesses that group farmers and the various types of information, between businesses and farmers, and between farmers and experts. The mobile system offered by the company is relatively sophisticated, although its sophistication can be adjusted to the needs of a business (typically more complex) or a farmer (usually less complex).

According to an external evaluation conducted by the French organisation, National Institute for Agriculture Research (NIAR), northern Ghanaian farmers who are clients of Esoko increased their revenues by 10%. Research conducted by New York University (NYU) confirmed this correlation between increased market price information and revenues. Additionally, certain secondary results have been noted, which can be encompassed under the notion of an ecosystem change. Most importantly, the presence of Esoko in Ghana has contributed to the increase in trust and transparency between farmers and traders. On the one hand, it empowered farmers by enabling them to better negotiate their prices, to discover new markets and to identify new market segments. On the other hand, it led the buyers, who now know that the farmers have access to the correct market information, to adopt a new bargaining and trading strategy. The

performance and results of Esoko have been monitored by external agents, such as the NIAR in France. Esoko is in fact looking for further research partners to engage in studies on its own impact on farmers' revenues and businesses' efficiencies.

Despite its success, Esoko faces three main challenges. They concern deployment costs, infrastructure reliability and information quality. As far as costs are concerned, the deployment constitutes the main bulk of expenses (95%) while the actual technology component only incurs a marginal cost (5%). From a technological perspective, access to the mobile network infrastructure is at times difficult as is access to electricity. Lastly, some of the information provided by Esoko remains difficult for farmers to interpret.

In the future, Esoko envisages engaging with the public sector in a broader range of initiatives. For instance, it plans to provide technology to the ministry of food and agriculture in Ghana to collect market prices.

CocoaLink

Based in the Ghanaian capital Accra, CocoaLink is a public-private partnership, which, at least originally, had a non-for-profit character and was specifically directed towards individual customers.

CocoaLink was formed in 2010 with funding provided by Hershey and the World Cocoa Foundation. The two principal founders of CocoaLink are well-established entities in the agriculture and trade sectors. Hershey is the leading manufacturer of chocolate and other cocoa-based products in the world with 15 000 employees and revenues exceeding USD 7 billion. The World Cocoa Foundation consists of over one hundred companies and comprises 80% of the global corporate market. Additional funds for the establishment of CocoaLink came from other organisations and corporate business (all well-known globally and active in international cocoa and food markets and the mobile phone sector). These included USAID Feed the Future, member companies of the World Cocoa Foundation, Bill and Melinda Gates Foundation, Orange, and Grameen. Additionally, DreamOval, was contracted to implement the technology side of the company. Total start-up funding was USD 1 million.

During the two first years after its establishment (i.e. from 2011 to 2013), CocoaLink operated in a pilot phase. In 2015, the company was handed over to the Ghana Cocoa Board (COCOBOD), who provided further funds,

¹¹ These data are validated by the Council for Scientific and Industrial Research (CSIR).

although the original funding partners continue to provide technical and network support. At the time of its launch, the company had access to a highly experienced body of personnel. Its original network of connections was also highly extended, including both national and international connections, principally of a corporate and institutional character.

The main reason behind the creation of CocoaLink was the deteriorating or, at least, questionable image of Hershey. For a time, Hershey had been the target of human rights groups and activists who argued that Hershey showed a lack of commitment to fair trade and to combatting child labour in West Africa. CocoaLink was therefore a vehicle for improving the company's reputation by making explicit the willingness of Hershey to encourage and respect cocoa fair trade and giving assurances to protect children against exploitation by providing them with access to education. However, CocoaLink's emergence is also attributable to its exploration of an ecological niche that emerged in Ghana and widely in Africa. On the one hand, while farmers lacked information that could improve the quality and quantity of their crops, this information related to cocoa farming and education was widely available. Inopportunately, the scarcity and cost of extension officers and extension services, who were introduced by the government to reach cocoa farmers, rendered the process of linking cocoa farmers with the information inefficient. On the other hand, an extensive mobile phone network existed in Ghana with 85% of its territory covered by mobile operators. This equaled 65% of rural residents. CocoaLink was launched to improve the data flow by conducting the existent information through new, albeit also existent, channels, by which the image of Hershey would be enhanced.

The choice of Ghana as the site for Hershey's project was dictated by the fact that this country is the world's second-biggest cocoa producer. There are approximately 700 000 cocoa farmers in Ghana and cocoa is the largest cash crop in the country. The positive experience of previous research on farming and educational information flow in Ghana further encouraged the location of CocoaLink in this country. To be exact, CocoaLink built on the success of the World Cocoa Foundation's education and literacy programmes in Ghana and on COCOBOD research.

The principal target group of CocoaLink are cocoa, rural, smallholder farmers. As its main objective, the company considers the improvement of incomes and livelihoods of farmers by giving them access to agrarian, social and marketing facts and knowledge. Therefore, the general offer consists both of providing farmers with adequate

information and of enabling them to actively seek and/or exchange the information. All of this packaged in the form of accessible mobile-phone services and technology. The products offered by CocoaLink are mobile, non-mobile and mixed.¹² The mobile products offered to individual farmers include the following: SMS and voice messages on fair trade, farming practices, farm safety, child labour, crop disease prevention, post-harvest production and marketing. Farmers can also share acquired information with industry experts and ask questions, as well as exchange experience with other farmers. All these mobile-phone products are provided both in English and in a local language. Non-mobile assistance is also specifically directed to farmers and includes: education training (specifically with respect to literacy and numeracy) and skills training. To ensure the programmes' success each community has access to local trainers. Such trainers, chosen by the communities themselves, serve as direct links between farmers and the CocoaLink network. They are usually recruited from governmental extension agents and/or persons who have already been engaged in literacy education projects. Now, these persons additionally teach how to use mobile-phone technology. Lastly, a mixed product offered by CocoaLink complements non-mobile training provided by agricultural extension agents with mobile phone messages sent weekly.

The overall size of CocoaLink and its funders is large. This renders the character of the company rather impersonal. Currently, CocoaLink collaborates with Hershey and, through its network, with various companies such as Barry Callebaut, Bloomer, Cadbury Ghana, Cargill Ghana, Nestle, Olam and Transmar. Other CocoaLink supporters and partners are Agencie Nationale d'Appui au Developpement Rural (ANADER), World Education and International Cocoa Initiative, the Grameen Foundation, World Education, CENCOSAD and DreamOval. Its training program receives assistance from US Peace Corps volunteers working in Ghana. The worldwide relationships render CocoaLink's network highly extended and international, mainly corporate and governmental. However, the collaboration with COCOBOD and Peace Corps Ghana also ensures the extension of its national network. In Ghana, CocoaLink has reached 50 000 farmers (of whom 35% are women) in 550 rural communities located especially in the western part of the country. The company has recently launched additional programmes in Cote d'Ivoire.

12 The last category combines mobile and non-mobile aspects.

The data required by CocoaLink is principally sourced from open resources provided by the government. Therefore, the service is free, both with regards to registration and messaging. Registration is relatively easy and may be accomplished by farmers through an extension agent, a request extension support using a mobile application, or via SMS short code.

Overall, farmers benefit from participating in CocoaLink programmes by being connected to relevant information, to other farmers to whom they can share their own experiences, and with experts from whom they can receive more specific knowledge and assessment. Generally, the service is easy to use for farmers, even among those unfamiliar with mobile technology.

The results from 2014 demonstrated that farmers had increased their yields by 45.6% in three years. This has been linked to the improvement of farmers' literacy, an increase in their general knowledge of cocoa production, and their familiarity with adequate and safe agricultural practices. These improvements seem, at least in part, to have stemmed from various types of training offered by CocoaLink.¹³ The company also reported an increase of farmers' trust in the information from government. According to a survey, farmers viewed the information provided to them as trustworthy and practical. The impact of CocoaLink and the progress of its training and literacy-numeracy programmes are monitored by professional evaluations (e.g. by World Education) and surveys performed by trainers in local communities.

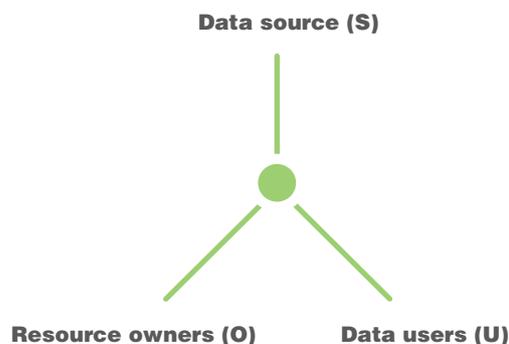
According to CocoaLink, the main challenge faced is the possible inefficacy of SMS due to low levels of literacy among farmers (that is, they cannot read the messages delivered to them). Therefore, CocoaLink envisages developing platforms and programmes that give preference to voice messages over text messages. In particular, the company aims to set up a call centre where farmers would be able to conduct live chats with cocoa agronomy experts and make conference calls with extension agents. Moreover, further community support programmes, including literacy training, are planned. All these objectives are to ensure the fulfilment of Hershey's goal to increase the use of certified cocoa from 18% to 100% by 2020.

4 Discussion

EMERGENCE: OPPORTUNE NICHES

The most consistent reason for the emergence of the intermediaries analysed in this study was the crystallisation of a niche in the agro-ecosystem in Ghana. That is, at a point in time, three, initially independent, factors conflated: a) rural small-scale farmers needed certain types of information; b) government open data were available but not easily accessible and delivery via extension officers was highly inefficient; and c) mobile-phone technology became inexpensive and widespread. In other words, the niche emerges at the point where the data users, the data source and resource owners intersect (see Figure 1). Open data was clearly a necessary enabling condition in creating a niche in the ecosystem. The intermediaries explored and populated this broad niche. They bridged the gap existing between the potential receptors of the data with the data providers (i.e. the farmers with the information hold by the government) by using the channel that was likewise already accessible. The niche also emerged from the inefficiency of the government's own attempts to convey the available information via more traditional conduits, such as extension officers, and high levels of illiteracy among the rural population.¹⁴

Figure 1: The structure of the niche



Although the three companies occupied similar niches, they did not enter into direct competition for resources and/or space in the ecosystem. This can be explained by the fact that at a more microscopic level of description, their precise niches are not identical. In other words, even though the three niches are certainly located in adjacent parts of the ecosystem, they do not coincide, differing as follows:

¹³ For example, 88% of targeted farmers received some sort of training, 65% of them received basic literacy training and the same number was trained in bookkeeping.

¹⁴ This latter factor resulted in the success of voice messages.

- The main type of information that was required by the users and/or available from the side of suppliers: principally market prices (Farmerline), both market prices and weather forecast information (Esoko), and farming practices (CocoaLink);
- The principal types of the data users: farmers and, to a lesser extent, businesses (Farmerline), businesses and, to a lesser extent, farmers (Esoko), and farmers exclusively (CocoaLink);
- The geographic location: Kumasi region, northwest of Accra (Farmerline), Esoko (all Ghanaian territory albeit mostly the rural areas spreading from the capital) and Western Ghana (CocoaLink);
- Sectors in which they operate: non-specific (Farmerline and Esoko) and cocoa specific (CocoaLink).

In the case of Farmerline and CocoaLink, their emergence was also related to two other, less tangible, reasons: personal motivation and image enhancement. To be exact, the founders and/or owners of Farmerline wanted to contribute to the rural community from which they had come and which had supported them. In contrast, the main funder of CocoaLink, Hershey, wanted to improve its own image in the eyes of human rights groups and general public with respect to child protection, fair trade and sustainable farming.

Furthermore, the motivations that underlie the geographic establishment of the three intermediaries in Ghana were different. The choice of Ghana was 'passive' in the case of Farmerline (the founder happened to live in that country), slightly more active in the case of Esoko (the company separated from the Ugandan ecosystem), and the most active in the case of CocoaLink, which was actively looking for a place to start the campaign to enhance its image. In this last instance, Ghana was chosen because it is one of the leading cocoa producers in the world and because cocoa corresponds to the largest cash crop in this country. This choice was also motivated by the positive experience of previous research on the farming information flow and educational programmes.

It is evident that reasons for the emergence of three of the intermediaries are interwoven and related to each other. That is, they do not form a linear series that can yield a coherent unidirectional line. Rather, they combine into a network where each chain is connected to many other chains – it both prompts them and is derived from them.

Overall, as several similar, but yet different, niches are

available in the ecosystem, a potential intermediary has to select one in which it would like to settle. The intermediary can fill out the niche directly if it is highly adapted to it. However, it can also modify its own characteristics so that its fitness to the existing niche would be more effective. This increase of fitness may take place before entering the ecosystem, or it may develop gradually during the intermediary's ingress. In the latter situation, the intermediary would behave as if it were progressively tuning into the niche. This tuning or a more affective adaptation can be seen in the following fact: all the intermediaries began with SMS messaging, but gradually developed and focused on voice messages (because of the illiteracy problems) and/or on call centres (because of the problem with interpreting the data even if sophisticatedly packaged).

The evidence also shows that intermediaries implement capitals focused on resource opportunities before shifting their focus to users, that is before deploying and acquiring capitals in order to connect to users without which their continued presence in the ecosystem becomes tenuous. We now turn to a more detailed discussion of capital configurations.

CAPITAL

While the existence of a niche may explain why Esoko, Farmerline and CocoaLink entered into the ecosystem, it does not account for why these three intermediaries were able to exploit this niche when other intermediaries did not. One possible explanation is offered by using the concept of capital. The evidence shows that Esoko, Farmerline and CocoaLink differ in the extent of the five forms of capital they possess. That is, even though the three companies have access to all the forms of capital, the degree of this access, at least in absolute terms, is dissimilar.

With respect to economic capital available, it was the highest in the case of CocoaLink, lower for Esoko, and the lowest for Farmerline. To be exact, CocoaLink was funded with over USD 1 million, mainly provided by its principal funder, Hershey. Additionally, if the value in economic terms of the other funders is considered (e.g. World Cocoa Foundation, USAID Feed the Future, Bill and Melinda Gates Foundation, and Orange) the original (direct and/or indirect) economic capital of CocoaLink was remarkable. Esoko's economic capital is lower, albeit, if direct and indirect sources are considered, still relatively good, as the investors who provided the bulk of the capital were financially robust organisations (e.g. International Finance Corporation, Soros Economic

Development Fund, Lundin Foundation, Acumen, Jim Forster Foundation). This strong economic foundation of Esoko can also be recognised in its expansion or presence (via partnerships) in many other African countries. Lastly, Farmerline exhibited the lowest amount of economic capital in relative terms at the time of emergence, funding being provided by a few external organisms and by the owners themselves. This accounts for the small size of the company and its non-corporate character.

With respect to cultural capital, the following can be noted. If considered in absolute terms, its degree is significantly higher for CocoaLink and Esoko than for Farmerline. To begin with, Farmerline's cultural capital draws from the educational and professional background of its two owners. As far as education is concerned, one of the founders has a college education, while the other held a university masters degree in engineering at the time Farmerline was launched. Their expertise at the interface of open data and mobile-phone technology was relatively limited. Although both had worked or directed small business in the mobile sector, this lasted for a short time and the businesses were themselves small. If the cultural capital of the employees is included, the limitations persist. As stated by Farmerline itself, hiring of skilled staff and, especially, of well-educated and experienced programmers is difficult. As Farmerline is unable to compete with larger technological companies, it struggles to attract such specialists. However, the access to cultural capital has recently increased through various partnerships: Trans-African Hydro-Meteorological Observatory, KNUST and Delft University of Technology. Furthermore, the cultural capital is counterbalanced by the linguistic capacities of the team, as the messages are delivered or translated into 12 local languages and English.

Esoko exhibits a higher extent of cultural capital than Farmerline. Presently, farmers can have access to external experts through Farmerline's call centre. In this case, the capital draws less from individuals (e.g. the founder Mark Davies, and/or current local director Daniel Asare-Kyei) but more from the company understood as a conglomerate of individuals or a partner of other companies. To be exact, the cultural capital of Esoko builds on the experience and capacity of TradeNet and external agents, such as universities (NYU) and research institutes (France's NIAR). Additionally, the cultural capital of Esoko has recently been expanded due to the access of experts provided by partnership with the Ghanaian ministry of food and agriculture, the CABI, and the French Council for Scientific and Industrial

Research.¹⁵ As was the case of Farmerline, the linguistic sub-type of cultural capital is high as besides English, 12 local languages are represented in the services offered by Esoko. Lastly, as CocoaLink has a strong corporate origin, its cultural capital can be viewed as a summation of the education and experience of individuals and of the founding (or funding) companies: Hershey and the World Cocoa Foundation. The cultural capacity of both organisations is impressive. For instance, only Hershey, leading manufacturer of chocolate and other cocoa-based products in the world, employs an excellent team of agrarian and financial experts. The cultural capital of CocoaLink also builds on the Ghanaian Cocoa Research Institute and its research expertise. Moreover, since CocoaLink was in 2015 handed over to COCOBOD with its own group of specialists, well-educated and experienced in the Ghanaian reality, the extent of its cultural capital further increased. Nowadays, CocoaLink has additional access to the knowledge and experience of many other companies and institutes, such as the Agencie Nationale d'Appui au Developpement Rural (ANADER), World Education, International Cocoa Initiative and Peace Corps (with its own network of well-educated young American volunteers), which coordinates some of CocoaLink's training programmes. This high degree of educational capital, explains the focus CocoaLink gives to educational information, literary and numeracy.

Technical capital is closely related to cultural capital. Overall, Esoko and CocoaLink exhibit a greater extent of technical capital than Farmerline. To be exact, Esoko inherited the good experience of TradeNet and has itself been able to deliver text and voice messages across an impressive range of topics. For instance, it monitors and collects information concerning 58 commodities in 42 markets countrywide. It has also developed the first call centre or a helpline for farmers in Ghana. The mobile system offered by the company is relatively sophisticated although this sophistication can be adjusted to the requirements of businesses and the abilities of farmers. Esoko's technical capital also surfaces in its high contribution to the curation of data, their structuring, packaging and translation and its deployment capacities (e.g. the company's own agents who collect data in the field).

In a similar vein, at the time of launching, CocoaLink had wide access to technology, especially through funders, partners or contractors such as Orange and

¹⁵ Of course, the access to the cultural capital of other organisations via partnerships is also evidence of social capital. Therefore, this sub-type of cultural capital can be understood as secondary and/or 'acquired'.

DreamOval. The mobile products offered by CocoaLink show the high extent of technical capital possessed by the company. However, as CocoaLink focuses on the educational side of information (not necessarily on the diversity of its digital channeling), its mobile offering seems to be poorer than in the case of Esoko. In contrast to Esoko and CocoaLink, the extent of Farmerline's direct technical capital was more reduced. As already explained, the company's technical expertise principally drew from the masters degree in engineering held by one of its founders.

Overall, even though the two founders had some experience in the application of mobile technologies to open data, its range was significantly less extensive than in the case of the other companies analysed in this study. The limitation of technical capital also stems from the smaller extent of economic and educational capital, mentioned above. However, despite these limitations, the technological side of products offered by Farmerline (voice call messages, SMS and a support-line for farmers, as well as various software products for businesses) is relatively impressive, being of a similar complexity to that provided by Esoko. Furthermore, the extent of Farmerline's technical capital has increased during the life of the company as more sophisticated products have been developed.

As social capital is less uniform, its analysis seems to be more complex. At the time of launching, Farmerline operated within a personal and national network of connections. This more local orientation does not need to be regarded as its weakness. Instead, it might have played a relevant role in an adequate understanding of Ghanaian reality and a correct placement of Farmerline in the ecosystem. Nevertheless, Farmerline's local and personal network gradually expanded. Farmerline has established more enduring collaborations with national and international companies, NGOs and research centres. It also entered into a new and extensive set of connections through its participation in the Global Open Data for Agriculture and Nutrition network and the Business Call to Action initiative. Farmerline has also gained access to other African ecosystems through partnerships in Nigeria, Sierra Leone, Cameroon and Malawi. This, however, has not altered the basic profile of the company as its primary focus remains national.

Esoko's social capital is relatively high. At the time of launching, its network of connections was extended. It was mainly corporate, both of a national and international range. A part of these connections was inherited from

TradeNet's links.¹⁶ The effect of this may be still seen in the branching of the mother company into two independent (but connected) operations in Africa (the Ghanaian branch and the Kenyan branch) and its presence in five other African countries (i.e. Mauritius, Malawi, Uganda, Mozambique and Benin).¹⁷ Esoko's international and national network of connections have further expanded. In Ghana, Esoko's reach extended to the governmental (ministry of food and agriculture) and to research agencies (CABI). Internationally, it established relationships with the Council for Scientific and Industrial Research in France.

As far as CocoaLink is concerned, this company operated in a large network of connections granted directly or indirectly through its funders such as Hershey and the World Cocoa Foundation. At the time of launching, CocoaLink's network included national and international connections, principally of a corporate, governmental and institutional character. In contrast, the company lacked more personal grassroots relationships with its target group (i.e. farmers). This, however, seems to have been successfully overcome by indirect links and, especially, by handing the company to COCOBOD, which had its own elaborated national network.¹⁸ The overall global seize of CocoaLink – and its funders – is overwhelming, which makes it rather impersonal. This impersonality has also been counterbalanced by the partnership with community trainers and Peace Corps volunteers, who interact with the local population at a personal level. Overall, in course of CocoaLink's activity, its international and, especially, national and grassroots network has expanded.

The quantification of symbolic capital is the most difficult. In addition, the inherent complexity of this form of capital – and the conflicting values attributed to the sub-types of this capital – renders its overall estimation nearly impossible. That is, a given asset may have a high value from one perspective, but a low value from another. There is not an easy and straightforward way to average these disparities.

Since its beginning, Farmerline has been bestowed with a high degree of social trust. This stems from the owners' local and rural background. Having experienced the challenges of small-scale farming in Ghana, they not only had accurate comprehension of the national

16 It should be recalled that when in 2005 TradeNet entered into the MISTOWA project, it gained access to American (through USAID) and African networks.

17 International headquarters are located in Mauritius and in Kenya.

18 The relationships with the Cocoa Research Institute of Ghana was also relevant in this aspect.

Table 1: Indicators of capital at the time of entry into the ecosystem as an intermediary

	Capital				
	Economic	Cultural	Technical	Social	Symbolic
Farmerline	Donor funding S+, U+	Tertiary education qualifications S+	Production company S+	Consultant O+	Echoing Green Global fellows O+
		Local language U+	Web start-up S+	Farmer U+	Personnel U+
		Women employees U+	Developer S+	GODAN S+, U+	
			Science degree S+	BCtA S+, U+	
			Skilled staff in short supply U-	TAHMO S+, U+	
				Product too complex U-	
Esoko	Donor and private funding S+, U+	Owners'/ directors' qualifications S+	Data curation S+, U+	Network (multiple countries) O+	Reputation (TradeNet) O+, U+
	Own revenue S+	Call center in 12 languages U+	Problems with information delivery U-	Network (TradeNet) O+	Reputation based on evidence of produce impact O+
				Partnership with government O+, S+	First to market (call centre) O+
				Jim Forster O+	
				CABI O+	
CocoaLink	Hershey S+		Text only (no voice) U-	Network of companies O+	Impersonal U-
	World Cocoa Foundation S+, U+			Local trainers U+	Reputation of multinational (Hershey) U-
	Donor funding S+			Peace Corps and government partnership S+, U+	Hand over to COCOBOD U+, O-
	Private funding S+, U+				
	COCOBOD U+				
	Free product U+				

NOTES: In this table the following abbreviations are used: S = capital that holds value in relation to the data **source** or owner; U = capital that holds value in relation to the data **user** (farmers); O = capital that holds value in relation to **owners** of resources required to operate a business. Furthermore, the + sign indicates that capital is enhanced while the - sign indicates that capital is reduced.

reality, but also benefited from the local populations' support. On the other hand, Farmerline was not a well-known company with the type of reputation that could generate corporate or organisational trust. However, this trust has gradually been gained, and in 2014 Farmerline was awarded the title of Echoing Green Global Fellows. Despite this, one of the main goals of Farmerline remains contributing to the local rural community from which the founders originated.

Esoko built its trust on the reputation of TradeNet and the funders of the Mistowa programme (e.g. the International Finance Corporation). This reputation existed both at a Ghanaian and continental level. This may explain the more international and business-oriented character of Esoko if compared to Farmerline. Currently, the company has arguably increased its trust extent or reputation through partnerships, both national and international, related to trade and farming, as well as (and in fact principally) to research.

With respect to CocoaLink, this company originally lacked any direct grassroots trust as it emerged from

multinational corporations and international organisations. However, this origin and CocoaLink's profound corporate and institutional character have generated an immense corporate and institutional trust and reputation. Local trust significantly increased after the company was handed over to COCOBOD and the Ghanaian authorities. The grassroots reputation was, at least, partially gained through partnerships with entities such as Peace Corps, which enjoys a renown a highly positive image. This also counterbalanced the original negative image of Hershey, whose good name in Ghana and Africa was obscured by its alleged lack of commitment to fair trade and to combatting child labour in West Africa.

Additionally, trust – viewed as part of symbolic capital – is also related to constant monitoring and reliable evaluation. In general terms, evaluation-based trust is low in the case of Farmerline, but relatively high as far as Esoko and CocoaLink are concerned. To be exact, the examination of Farmerline's activities and results is not consistent, as only sporadic field tests and a few internal assessments have been reported. In contrast, the performance and the effects of Esoko have been

monitored by well-known and highly experienced external research centres, such as the NIAR in France. In fact, Esoko is constantly seeking research partners to engage in studies on its own impact on farmers' revenues and businesses' efficiency. Lastly, the activities of CocoaLink and, especially, the progress of its training and literacy/numeracy programmes have been monitored by international professional evaluators and by trainers at community level.

Overall, the evidence indicates that capitals held by an intermediary determines the niche which it can possibly populate. However, as already mentioned, the capital can also be adjusted to the niche (or to a part of this niche). The relation is clearly two-directional. The optimisation and maximisation of the capital possessed to fit into one of the connected niches is the key to entering and surviving in the ecosystem. This means that, as postulated by the theory, capital is not intrinsic and absolute, even in its most objective form, namely as economic capital. It is not the extent of each type of capital that matters but rather its fitness, which is inversely and almost tautologically determined by this very capital. Accordingly, capital fits what it can fit – the important operation is to determine the appropriate fitness of the capital and understand the balance between the capital and the niche.

In this manner, the behaviour of an intermediary, or its properties, is not only conditioned by this intermediary's inherent components, but is also determined by the environment in which it exists. That is, the properties of the whole – in this case of the agro-mobile ecosystem – can be regarded as the individual's own properties. Any form of capital is an essentially situated phenomenon – it has a value only within the individual-whole context, never outside it.

EFFECTS ON THE ECOSYSTEM

The three intermediaries analysed in this study have a profound effect on the ecosystem in which they are embedded. Thus, they are not only conditioned by their environment's structure and properties (see the previous section), but also actively modify the hosting milieu, as far as its configuration and characteristics are concerned.

Overall, the intermediaries improve connectivity between the various agents in the ecosystem, by which they generally enhance the flow of data. Farmerline contributes to the connectivity of farmers. It connects farmers to the information, to the market and to businesses. Esoko licenses a better connection between

farmers and the information either directly or via an additional intermediary of businesses that group farmers. It also improves connectivity between farmer and other businesses. CocoaLink enhances farmers' connection to the information and to other farmers.

This improvement of connectivity – and in particular the wider access to the information – results in certain (material or financial) benefits of the users of data.¹⁹ That is, it leads to more effective crop harvesting and planting outcomes, which directly translate into farmers' higher incomes. As explained in the previous section, the incomes of Farmerline's farmers increased by more than 50%, those of Esoko by 10%, and those using the products of CocoaLink by more than 45%.²⁰ The increase declared by CocoaLink concerns the period spanning three years, that is, with an average annual increase of 15%, thus being close to that attributed to Esoko. Another benefit, less quantifiable but no less relevant, is the improvement of farmers' education: their literacy and numeracy skills, and their agrarian, economic and financial knowledge. It seems that the effect on farmers' education is the greatest in the case of CocoaLink, which also delivers relatively sophisticated educative products, both mobile (agrarian, economic, financial and social information)²¹ and non-mobile (educational and skills training).²² The contribution of Esoko and Farmerline to farmers' knowledge is less extensive. Esoko's impact is mainly limited to improving farmers' knowledge on crop production protocols and strategic planning. Farmerline's contribution principally concerns farming practices and certain financial tips.

An important effect of the three intermediaries' activities is an increase in the transparency of the value chain. Due to products offered by Farmerline, Esoko and CocoaLink and their openness, farmers can compare prices at various markets in the country. They can also more easily recognise the structure of food production in which they participate and the roles of other agents involved in the value chain. As a result, farmers can negotiate higher prices and discover entirely new markets – they can trade more effectively.

This transparency also affects the activities of other agents in the ecosystem. For instance, being aware of

19 This confirms the finding of Van Schalkwyk, Willmers & McNaughton (2016) reduce the viscosity of data in an ecosystem.

20 The outcome reported by Farmerline should be taken with caution, as it has not been corroborated by an external organisation.

21 Specifically, the information on fair trade, farming practices, farm safety, child labour, crop disease prevention, post-harvest production and marketing.

22 Especially, on literacy and numeracy.

farmers' understating of the ecosystem, traders modify their own bargaining and trading strategy. Accordingly, as all actors are aware of one another's position in the ecosystem (at least to a certain degree), elements that were not revealed previously cannot be hidden anymore. Additionally, more transparency means more trust. For example, the activity of CocoaLink contributed to farmers' trust in government information, while the operation of Farmerline and Esoko contributed to more trusting relationships between farmers and buyers.

The activity of the three intermediaries stimulates the emergence of new niches in the ecosystem. At least four new (albeit interconnected) niches can be identified. First, the presence of Farmerline, Esoko and CocoaLink has created room for additional research and thus the need for companies dedicated to agro-data capture and processing. The three intermediaries seek information that would go beyond what is currently available or provided directly from open sources present in the ecosystem. That is, they generate a need for experts, data collectors, and data processing personnel (e.g. translators). Second, the intermediaries create a demand for a wide range of educational and training organisations that can interact with individuals and communities. Third, the intermediaries contribute to technological innovation. By discovering more efficient means of conveying information and connecting agents in the ecosystem, they create an additional need for technical personnel, for instance programmers and mobile-phone specialists. In fact, the efficiency of the services offered by the intermediaries may also contribute to a more rapid development of the entire mobile sector. Fourth, the emergence of the three intermediary companies enables a more adequate use or even a reuse (or relocation) of elements already present in the ecosystem. To be exact, in all the cases analysed in this study, extension agents – relatively ineffective in the traditional framework – have been relocated to new purposes and roles. This relocation has turned out to be successful and beneficial both for these agents themselves and for the data flow.

Certain innovations and products developed by the intermediaries can be applied to entirely new ecosystems. For example, as reported by Farmerline, the IVR and voice survey systems can be used in the health sector in cases of disasters and emergencies (e.g. the Ebola crisis) and in other sub-areas of agriculture and food sectors.

Lastly, the activity of the intermediaries and their products can also be employed to link the private and public sectors in Ghana more efficiently, thus enhancing the connectivity between these two sectors – components of the larger national ecosystem.

DATA SOURCES

This study found that most of the intermediaries actively contribute to the generation of data. Overall, the sourcing of data is highly heterogeneous. A portion of data is originally open while another is not (being purchased instead for a certain price). Yet another portion of the required data is collected by the intermediaries themselves. In the case of Farmerline, the open element of data mainly comes from Ghana Meteorological Services, the ministry of food and agriculture, KNUST and the Aquafish Innovation Lab. This open data is subsequently enhanced by data generated by Farmerline via the company's own field agents (market prices) or employers (financial tips), or via partnerships with the Ghana Meteorological Services and Trans-African Hydro-Meteorological Observatory. Certain portions of weather forecast data are also purchased from external sources. The data sourcing is structurally complex also in the case of Esoko. Open data are sourced from the ministry of food and agriculture and CABI. These data are improved by adding a large portion of information generated by Esoko itself, for example, via agents deployed in the field (market prices).²³ In contrast, CocoaLink relies in most part on the data outsourced from open resources provided by the government. Furthermore, the three intermediaries curate the data, both those freely received and purchased, as well as those generated by themselves. For example, the data are structured, packaged and translated into local languages.

Because of the cost involved in the generation of information and/or its structuration, data (even those that were previously open) sometimes become closed. For example, small fees are charged to access the data once they have been repackaged as useful information. This may correspond to subscription fees (Farmerline and Esoko) or call fees to the helpline or call centres (the three companies).²⁴ In some cases, other businesses and/or organisations cover the farmers' fees, thus rendering the service free for farmers (Esoko). If only the passive products are considered (e.g. receiving texts messages), the data remain open in the case of CocoaLink, but semi-closed in the case of Esoko (fees are sometimes waived by tertiary parties) and closed in the case of Farmerline.

Some intermediaries also generate new data related to the bottom level of the ecosystem, that is, to farmers. This

²³ As mentioned previously, some of these agents are in fact employees of the ministry for food and agriculture.

²⁴ The cost to the call centers is at a regular call rate.

type of data production is most evident in the case of Esoko, which collects information on farmers: their age, interests, agronomic profile, etc. These data are not open. They are available to other clients of the company at a certain price.

5 Conclusion

The present study provided empirical, fine-grained evidence on the emergence of open data intermediaries in a particular ecosystem, their use of the various forms of capital, and the effects their entry and persistence have on the ecosystem. The analysis of the behaviour of the three intermediaries located at the interface of open data in the agricultural and mobile-phone sectors in Ghana entails the following conclusions.

- The emergence of all the intermediaries is primarily conditioned by the previous presence of a (broad) niche area. That is, in order for intermediaries to appear, there must be new spaces available in the ecosystem for them to occupy.
- The niche is sufficiently broad to accommodate not just a single specific intermediary but rather a range of similar yet distinct intermediaries that could populate different zones within the niche.
- Each intermediary explores the five forms of the capital differently in order to connect to users successfully. No intermediary has all the types of capital in their highest extents. Rather, all intermediaries excel in some forms of capital (or even in sub-types of such forms) while the degree of the other forms is deficient.²⁵
- Given the extent of capitals which it possesses, each intermediary identifies a different area of the ecosystem where this capital would assure the highest return. That is, even intermediaries with low capital may maximise it if they correctly identify the niche and thus fully exploit their own fitness. The capital (and thus the intermediaries themselves) are situated phenomena. Overall, the adequate fitness and reduction of their own deficiencies by further intermediacy seem to be the key factors for intermediaries to survive.

- The deficiency of certain parts of capital can also be appeased by linking to other intermediaries. That is, even though no intermediary possesses all types of capital to the highest extent, it can gain access to higher degrees of a given form of capital through the intermediacy of other agents. This means that a realistic channel of data flow is highly complex – it constitutes an intricate network whose chains are related bi-directionally. Thus, the channel is not a unidirectional and unidimensional line – it is a vector.
- The emergence and subsequent survival of the intermediaries importantly modifies the ecosystem which they have entered and populated. This impact creates further niches for new intermediaries. It may also substantially modify the original niche of the intermediary and thus have a circular impact or a loop-back effect.
- Open data intermediaries enhance the flow of data.
- Open data intermediaries actively ‘interact’ with data. They mix and curate open data. In some cases, they also close data.

To conclude, the study has provided empirical evidence that corroborates certain hypotheses formulated in previous studies on open data intermediaries: the absence of all possible forms of capital for a single intermediary; the need for further intermediaries to ensure a more efficient data flow; the relation between the success (survival in the ecosystem) and the engagement with other intermediaries that supply the intermediary’s own deficiency of capital; a non-linear (and thus, multi-directional and multi-dimensional) structure of data flow; the dynamic and complex character of the data intermediacy network (Van Schalkwyk, Cañares, Chattapadhyay & Andrason 2016).

²⁵ Van Schalkwyk, Cañares, Chattapadhyay & Andrason (2016).

REFERENCES

- Andrason A (2016) *A complex system of complex predicates: Tense, Taxis, Aspect and Mood in Basse Mandinka from a grammaticalization and cognitive perspective*. PhD Dissertation. Stellenbosch: Stellenbosch University
- Bishop R (2011) Metaphysical and epistemological issues in complex systems. In: C Hooker (ed.) *Philosophy of Complex Systems*. Amsterdam: Elsevier. pp. 105–136
- Bourdieu P (1984) *Distinctions*. London: Routledge
- Bourdieu P (1986) The forms of capital. In: J Richardson (ed.) *Handbook of Theory and Research for the Sociology of Education*. New York: Greenwood. pp. 241–258
- Bourdieu P (1996) *The Rules of Art: Genesis and Structure of the Literary Field*. Stanford CA: Stanford University Press
- Canares M (2014) Opening the local: Full disclosure policy and its impact on local governments in the Philippines. Accepted for presentation at the Eighth International Conference on Theory and Practice of Electronic Governance, 27–30 October 2014. pp. 89–98. DOI: 10.1145/2691195.2691214
- Cilliers P (1998) *Complexity and Postmodernism: Understanding Complex Systems*. London: Routledge
- Cilliers P (2005) Complexity, deconstruction and relativism. *Theory, Culture and Society* 22(5): 255–267
- Cilliers P et al. (2013) Complexity, modeling, and natural resource management. *Ecology and Society* 18(3): 1–12
- Courtois P & J Subervie (2014) Farmer bargaining power and market information services. *American Journal of Agricultural Economics*. DOI: 10.1093/ajae/aa051
- Davies T (2014) Open Data in Developing Countries: Emerging Insights from Phase I. ODDC Report. <http://www.opendataresearch.org/content/2014/704/open-data-developing-countries-emerging-insights-phase-i>
- Davies T & F Perini (2016) Researching the emerging impacts of open data: revisiting the ODCC conceptual framework. *The Journal of Community Informatics* (Special issue on Open Data for Social Change and Sustainable Development) 12(2): 148–178
- Dimitrov V (2002) Introduction to fuzziology. In: V Dimitrov & V Korotkich (eds) *Fuzzy Logic: A Framework for the New Millennium*. Heidelberg: Springer. pp. 9–26
- Dimitrov V (2003) Fuzziology: A study of fuzziness of human knowing and being. *Kybernetes* 32(4): 491–510
- Dimitrov V & Hodge B (2002) Why does fuzzy logic need the challenge of social complexity. In: V Dimitrov & V Korotkich (eds) *Fuzzy Logic: A Framework for the New Millennium*. Heidelberg: Springer. pp. 27–44
- Dimitrov V & V Korotkich (eds) (2002) *Fuzzy Logic: A Framework for the New Millennium*. Heidelberg: Physica Verlag
- Dumpawar S (2015) *Open Government Data Intermediaries: Mediating Data to Drive Changes in the Built Environment*. Cambridge, MA: Massachusetts Institute of Technology
- Gama K & Lóscio BF (2014) Towards ecosystems based on open data as a service. *ICEIS 2*: 659–664
- Gell-Mann M (1995) What is complexity? *Complexity* 1(1): 16–19
- Gell-Mann M & Lloyd S (1996) Information measures, effective complexity, and total information. *Complexity* 2: 44–52
- Gell-Mann M & Tsallis C (eds) (2004) *Nonextensive Entropy: Interdisciplinary Applications*. Oxford: Oxford University Press
- Gurstein M (2011) Open data: Empowering the empowered or effective data use for everyone? *First Monday* 16:2. <http://journals.uic.edu/ojs/index.php/fm/article/view/3316>. DOI: 10.5210/fm.v16i2.3316
- Halford S & M Savage (2010) Reconceptualizing digital social inequality. *Information, Communication & Society* 13(7): 937–955
- Heimstädt M, Saunderson F & Heath T (2014a) From toddler to teen: Growth of an open data ecosystem. *JeDEM* 6(2): 123–135
- Heimstädt M, Saunderson F & Heath T (2014b) Conceptualizing open data ecosystems: A timeline analysis of open data development in the UK. In: *Conference for E-Democracy and Open Government*. p. 245
- Hooker C (ed.) (2011a) *Philosophy of Complex Systems*. Amsterdam: Elsevier
- Hooker C (2011b) Introduction to philosophy of complex systems: A. In: C. Hooker (ed.) *Philosophy of Complex Systems*. Amsterdam: Elsevier. pp. 3–90
- Janssen M., Charalabidis Y & Zuiderwijk A (2012) Benefits, adoption barriers and myths of open data and open government. *Information Systems Management* 29: 258–268
- Klir G (1992) *Fuzzy Sets, Uncertainty and Information*. New York: John Wiley
- Li M & Vitányi PMB (2008) *An Introduction to Kolmogorov Complexity and its Applications*. New York: Springer
- Magalhaes G, Roseira C & Strover S (2013) Open government data intermediaries. *Seventh International Conference on Theory and Practice of Electronic Governance, ICEGOV 2013*. Seoul, South Korea. pp. 330–333
- Mayer-Schoenberger V & Zappia Z (2011) Participation and power: Intermediaries of open data. Talk at the First Berlin Symposium on Internet and Society, Berlin, 26–28 October 2011
- Munné F (2013) The Fuzzy Complexity of Language. In: À Massip-Bonet & A Bastardas-Boada (eds) *Complexity Perspectives on Language, Communication and Society*. Heidelberg: Springer. pp. 175–196
- Roberts A (2014) Making transparency policies work. <http://www.freedominfo.org/2014/10/making-transparency-policies-work/>
- Schlundwein SL & Ison R (2007). Human knowing and perceived complexity: Implications for system practise.

- In: P Cilliers (ed.) *Thinking Complexity*. Mansfield: ISCE. pp. 229–238
- Siagian R (2003) Introducing study fuzziness in complexity research. *Journal of Social Complexity* 2: 38–46
- Van Schalkwyk F, Cañares M, Chattapadhyay S & Andrason A (2016) Open data intermediaries in developing countries. *Journal of Community Informatics* (Special Issue on Open Data for Social Change and Sustainable Development) 12(2): 9–25
- Van Schalkwyk F, Willmers M & McNaughton M (2016) Viscous open data: The roles of intermediaries in an open data ecosystem. *Information Technology for Development* 22(1): 68–83. DOI: 10.1080/02681102.2015.1081868
- Van Schalkwyk F, Willmers M & Czerniewicz (2014) Case study: Open data in the governance of South African higher education. <http://www.opendataresearch.org/content/2014/710/case-study-open-data-governance-south-african-higher-education>
- Wacquant L (2006) Pierre Bourdieu. In: R Stones (ed.) *Key Contemporary Thinkers*. London: Macmillan. pp. 1–15
- Wagensberg J (2007) *Ideas Sobre la Complejidad del Mundo*. Barcelona: Tusquets
- Zhang W (2010) Technical capital and participatory inequality in eDeliberation: An actor–network analysis. *Information, Communication & Society* 13(7): 1019–1039

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