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Applying economics to networks: What analytical insight do we gain?

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Abstract

A case is made for theoretical and empirical specification of agribusiness systems as networks or netchains. This primarily involves characterization not only of the actors in value chains but also of the links between them. Selected recent work on applications of network analysis methods and approaches to economics generally, and agribusiness specifically, is discussed and extended to an empirical study of smallholder and informal dairy value chains in Tanzania and Uganda. Results are discussed in terms of network-related indicators and their economic and gender-related implications. A logical progression of hypotheses about network-mediated development impact is presented.

Introduction

Agribusiness trading systems in developing countries are being challenged to perform new functions, respond to new trends, and offer new opportunities for development. New functions include households' accelerated cash generation needs and increased use of markets. New trends include the retail revolution and associated changes in distribution and service provision, as well as rising consumer demand for safety and quality. New development opportunities include improvements in the performance of informal markets and their capacity to generate employment and added value.

Most past studies of agricultural production and trading systems have treated the individual market actor (most commonly the producer household) as the unit of observation. Network-related thinking such as social network analysis and netchains (Lazzarini *et al.*, 2001) treat observations on households as just one source on information, to be complemented by knowledge about the linkages between households, and between households and other market actors. Further, the linkages themselves are being studied in terms of their multiple forms, and/or as continuous variables describing the magnitude or extent of linkages. Network models' capacity to emulate economic systems has been demonstrated conceptually (Kranton and Meinhart, 2001), and the features of agribusiness systems have been directly compared to counterparts in networks (Talamini and Ferreira, 2010).

Using binomial data (presence or absence of a linkage) Talamini and Ferreira (2010) identify several agribusiness network metrics which apply economic concepts of competitive markets. These include "degree" (numbers of inwards or outwards connections, relating to monopoly/monopsony effects), "closeness" (numbers of transaction steps between actors), and "betweenness" (the extent to which networks can be controlled by way of individual actors' dominating single linkages between groups of actors) (see figure 1).

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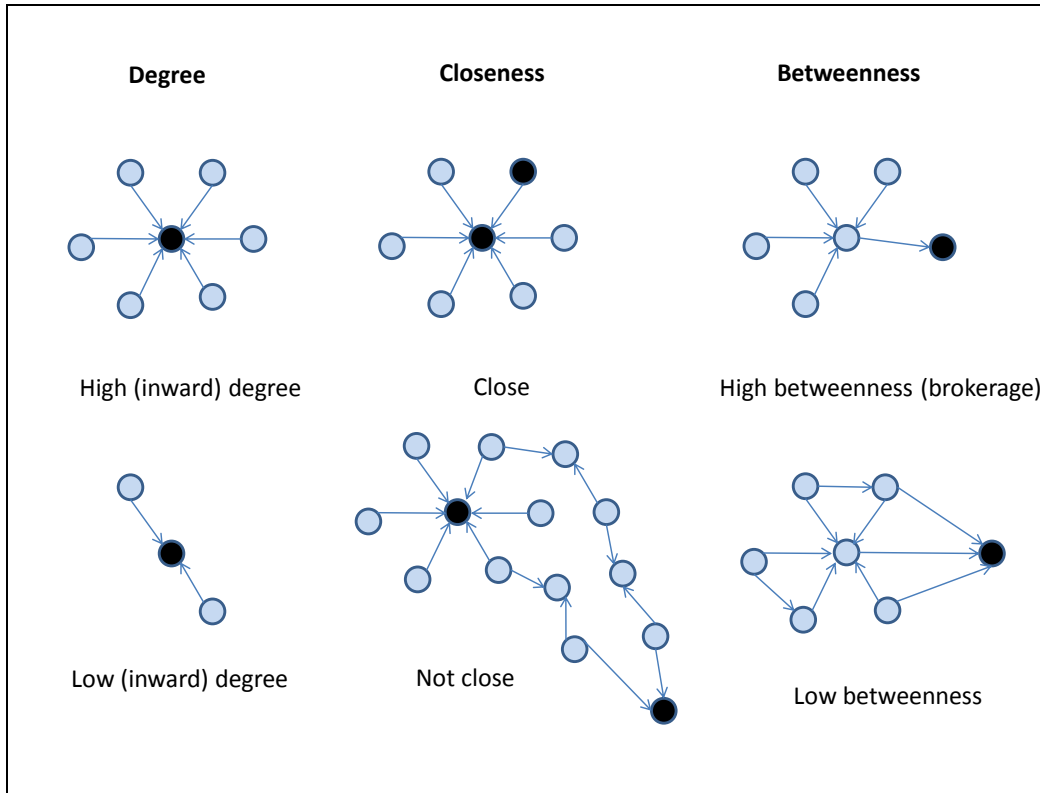


Figure 1. Network diagnostics (after Talamini and Ferreira, 2010)

Extension of these concepts can yield further economic insights. Identification of multiple forms of linkage in the same network (e.g. product transactions, superimposed on provision of 2-3 input services) provides evidence of patterns of economies of scope. This informs the analyst of the likelihood of services being “bundled” (all services provided by single actors) or not (single services provided by specialist actors) (figure 2).

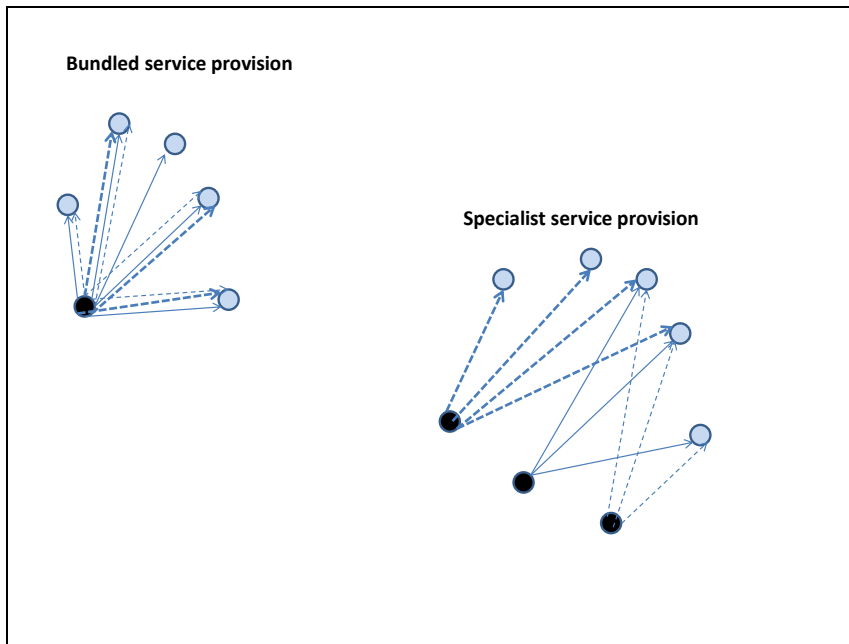


Figure 2. Bundling of value chain functions (author’s representation)

Where continuous variables can be used, network representation offers an interpretation of scale economies. Transaction costs such as search and storage are subject to economies of scale, which provide explanation of marketing actions in value chains. Volumes represented as regularity or seasonality of supply provide for different scale-related (such as access to lucrative contracts) or to trust-driven (advance payments) aspects of market access.

This paper discusses economic approaches to researching developing country agribusiness systems using network constructs. Reference is made to on-going work on informal and smallholder-dominated dairy systems, in terms of their new roles in enhancing producer access to market, new mechanisms for facilitation of delivery of input services and product quality, and onwards to the selected microeconomic elements of broader economic growth. The empirical work encompasses Business Development Services (BDS) as an approach to value chain development, and discusses network elements of service delivery as a key development step.

East African Dairy systems as networks

The last two decades have seen East African dairy production increase substantially: by 65% in Kenya and 270% in Uganda (FAOSTAT, 2012), for example. Development interest in the sector encompasses its provision of cheap but high quality dietary protein, daily generation of cash income, and service industries. Although much development effort has targeted co-operative-oriented formal large scale dairy processing, treatment and packaging, small scale producers and informal raw milk markets continue to dominate the region's dairy sectors (Omore *et al.*, 2004a, b; Ahmed *et al.*, 2004). Recognizing the importance of input and service supply, training of providers has been used as an intervention, in the form of BDS (ILRI, 2006). Consumer willingness to pay for enhanced hygiene and other quality attributes (Jabbar *et al.*, 2010) has been targeted in such markets, with significant development impact reported (Kaitibie *et al.*, 2008). Despite criticism of value chain analysis for its lack of strong ex ante constructs and projections (Rich *et al.*, 2011), there are interesting cases of such studies used to mobilise interventions in informal dairy value chains. These employed a description of the actors along the value chain and centered on estimation of margins (e.g. Sevo, 2008), but not the network, and more specifically netchain, aspects of dairy systems.

Dairy value chain actors feature aspects of netchains as described by Lazzarini *et al.* (2001), including significant horizontal linkages (by way of various collective actions) as well vertical ones. The vertical linkages between actors take many forms and perform numerous functions (Coppock *et al.*, 2011) and they can be measured both as binomial presence-absence variables such as a sales transaction, or continuous variables such as the volumes of milk traded at various times of the year. Services and inputs are offered by a variety of actors, in a range of combinations which may be either likely to be provided together (e.g. animal health services and animal health products) or separately (e.g. feed and artificial insemination).

Networks, value chains and development

The foregoing discussion obviates a need for empirical approaches that record not only the characteristics of economic actors in value chains, but also the nature of the networks within which they operate. As a first step, discussed below in terms of empirical work, measures of network characteristics are made. On-going work relates these to actors' and networks' performance. It is proposed that this can ultimately be employed in a progression of nested or semi-nested hypotheses (figure 3) allowing examination of the link between interventions in the value chain and development outcomes.

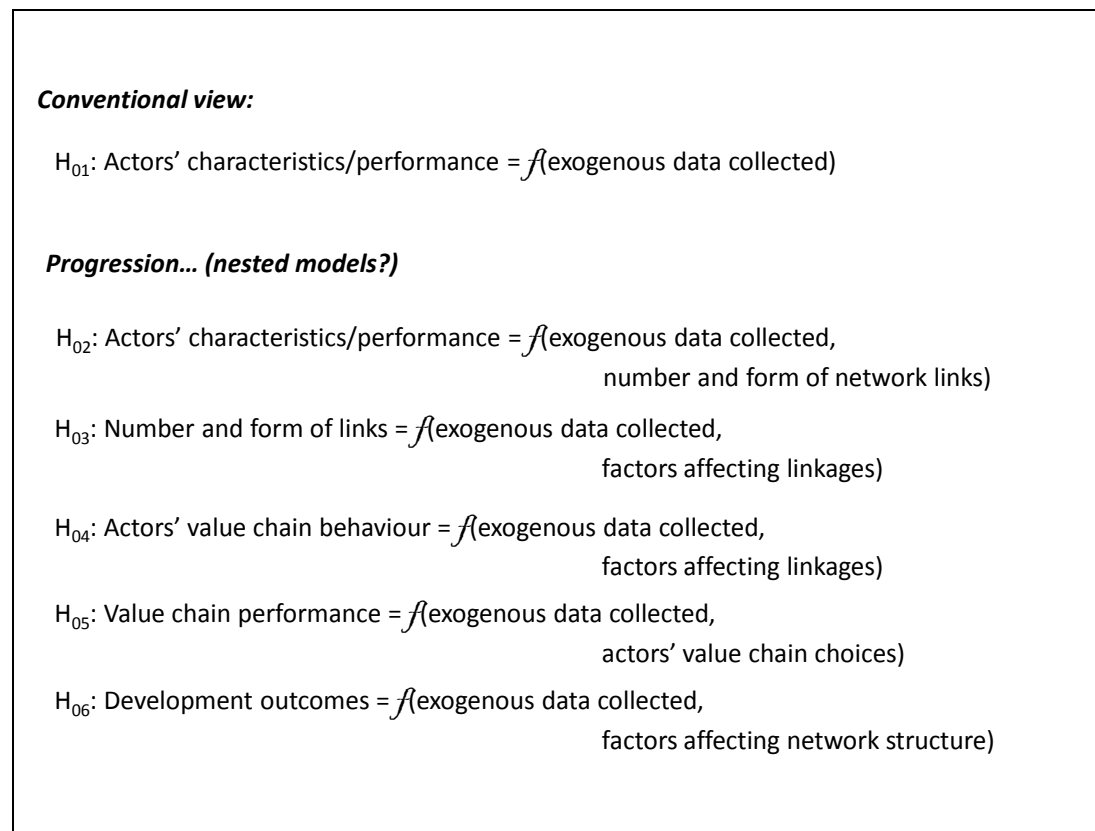


Figure 3. A logical progression of networks' influence on the impact of value chain development (author's representation)

The study of dairy networks in Tanzania and Uganda

A 3-actor network (traders, producers and BDS providers) was studied in Tanzania and Uganda. The work sought to characterize the network and draw inference about the competitive structures in place and form taken by costs or service provision. On-going work is examining the performance of the actors and the impact of interventions supporting BDS. Focus groups discussions were used to establish sample frames for actors in selected regions, and a snowballing procedure was amongst actors. Questionnaires (of 3 types, one for each actor) were implemented. Questions sought information on both the actors and the linkages amongst them, extending to both binomial and continuous variables.

In four regions of Uganda², a total of 195 network actors were interviewed, as were 173 in two regions of Tanzania (see table 1).

Table 1. Participants' distribution

Country	Region	Producers	Traders	BDS providers
Uganda	Kampala	34	33	4
	Masaka	26	16	2
	Mbarara	22	16	2
	Rushere	22	16	2
	Total	104	81	10
Tanzania	Arusha	28	33	32
	Mwanza	38	40	42
	Total	66	73	74

Examination of the (binomial form) linkages between actors reveals that the majority of traders (62%; 58% and 53% respectively for Mwanza, Uganda, and Arusha) are linked to just one or two producers (see figures 4-6). Turning to continuous data on the network linkages, milk traders in Uganda handle generally larger volumes of milk (represented by thickness of lines in figures 4-6) compared to their Tanzanian peers. Average daily milk purchases by Ugandan and Tanzanian (both Mwanza and Arusha) traders which are respectively 133.7, 22.9 and 18.9 litres in the wet season, and 89.1, 19.4 and 10.7 litres in the dry season.

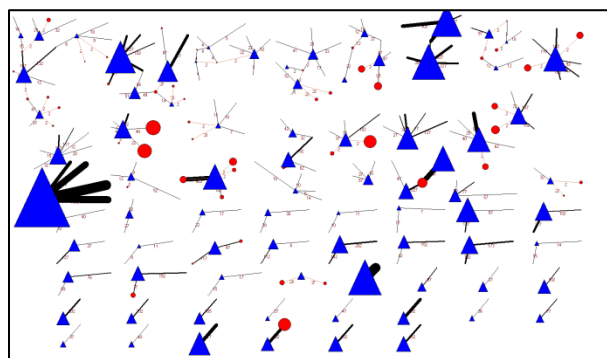


Figure 4. Milk supply network in Uganda

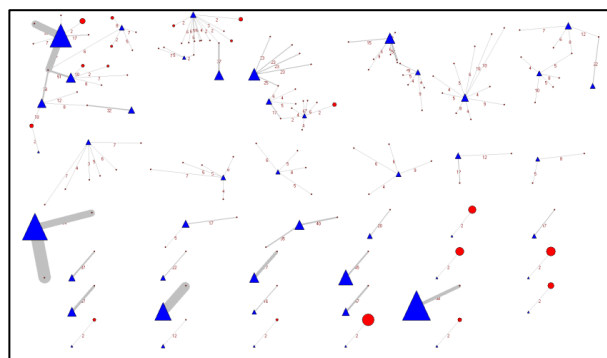


Figure 5. Milk supply network in Mwanza

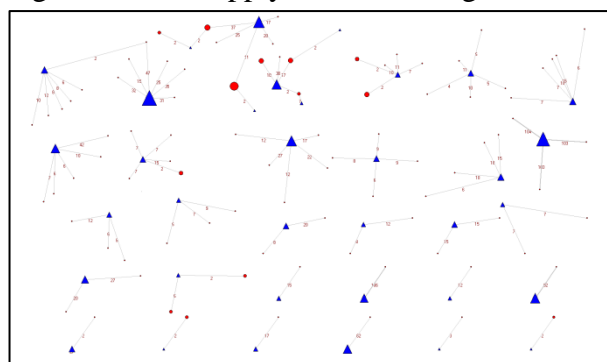


Figure 6. Milk supply network in Arusha

Blue triangle: Trader (size depicts sales volumes); Red circle: Producer (size depicts milk volume)
Thickness of line: Quantity of milk traded between producers and traders.

² For practical reasons, in what follows the Ugandan data set is treated as one region and Tanzania's as two.

Gender differences were apparent: Tanzanian male milk traders' purchasing networks appear to be more dense (i.e. have higher inward degree) than those of female traders. For Arusha, male traders average around 3.26 producer suppliers, while female traders average just 1.92. These results are repeated for Mwanza. An interesting result is that this difference is not apparent for Ugandan milk traders (males and females each average about 2.4 suppliers).

Examination of competitive structures further downstream in the value chain (figure 7) was achieved by counting the linkages between traders and retailers, and observing the type of retailer served (roadside shops, small shops, street vendors, hotels, and direct to consumers). The majority of milk traders are linked to only one type of retail outlet. In the case of Ugandan traders around two thirds (67%) are selling milk to only one type of retailer.

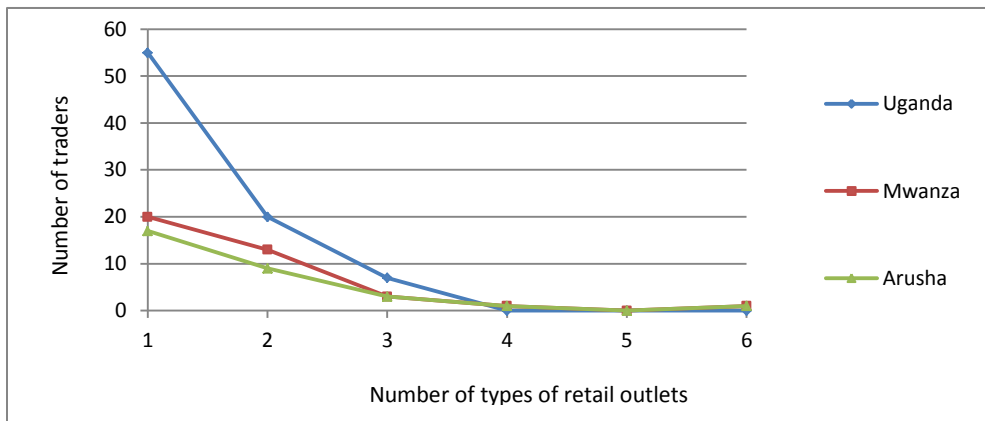


Figure 7. Number of connections between traders and retail outlets

Turning to bundling of services, figures 8, 9 and 10 present network configurations for milk producers, milk traders and BDS providers. Although many Tanzanian BDS providers report just one link, Ugandan BDS providers average over 5 links. This result requires further investigation, but may be due to differences in the passage of time or commercial environment enabling growth in service provision networks. Considering the range of services offered by BDS providers, patterns emerge of both specialization and bundling, and interestingly, specialization in serving particular forms of client:

- BDS providers working exclusively with producers, and supplying them with inputs (animal feeds, drugs, vaccines, etc.) and services (training on milk hygiene, information and advisory services, etc.).
- BDS providers working exclusively with traders, and supplying them with inputs and services.

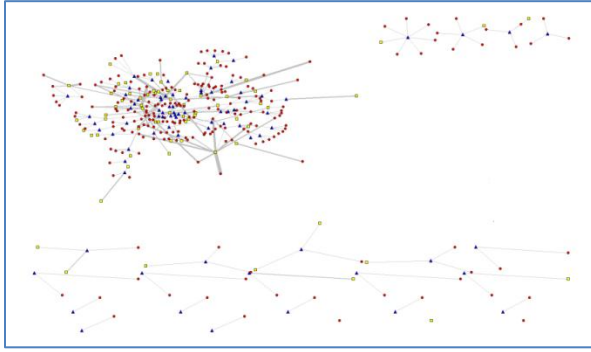


Figure 8. Milk supply and BDS network in Uganda

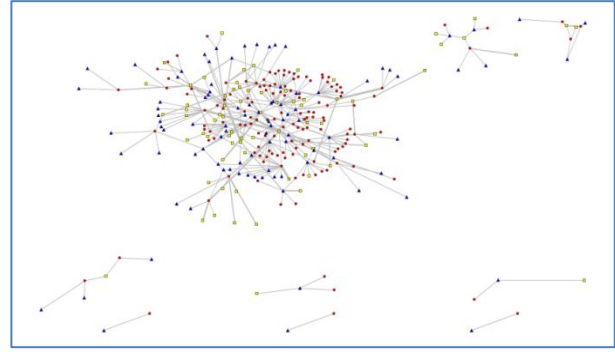


Figure 9. Milk supply and BDS network in Mwanza

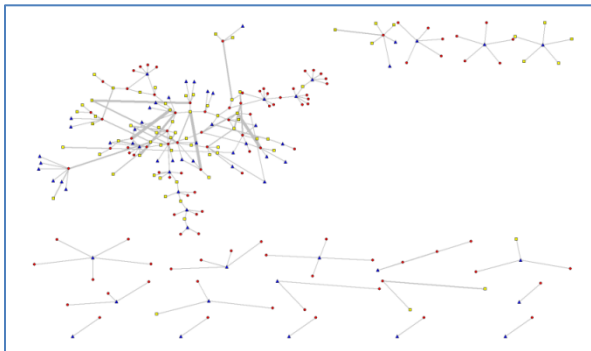


Figure 10. Milk supply and BDS network in Arusha

Blue triangle: Trader

Red circle: Producer

Yellow box: BDS provider

Conclusion

A case is made for theoretical and empirical specification of agribusiness systems as networks or netchains. Discussion centers on the research need to characterize not only the actors in value chains but also the links between them. If some network configurations are deemed more desirable in terms of development goals than others, *and* such configurations can be influenced by interventions, then an alternative development approach may be viable: by targeting the linkages rather than the actors.

Preliminary results from an empirical network specification the informal markets for milk in Tanzania and Uganda are presented. Insights are available in terms of market power (by way of degree), volumes provided (indicating economies of scale), and bundling of services (indicating economies of scale). Gender differences are also revealed in terms of traders' numbers of market links, although an intriguing question not addressed here is the extent to which the nature of links may differ according to gender.

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