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THE PERCEIVED ROLE OF INNOVATION PLATFORMS IN ADDRESSING THE AGRICULTURAL VALUE CHAIN COLLECTIVE PROBLEMS: AN EMPIRICAL APPLICATION OF TRANSACTION COST THEORY

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Abstract

Agricultural innovation platforms are increasingly seen as a panacea for mitigating the agricultural value chain challenges through enabling the co-evolution of different elements in the innovation process. A number of previous studies on IPs show processes for their formation and contribution to innovations. Very few studies have attempted to investigate the perceived benefits from platforms as important determinants for actor participation. Using a sample of 319 randomly selected farmers from one innovation platform in Uganda, it was established that the uncertain markets for the agricultural output, sources of inputs and agricultural information were perceived to be the key motivators for the formation of the platform. The study found a positive significant relationship between transaction cost challenges of environmental uncertainty and structural embeddedness ($p<0.01$) and frequency of interaction and structural embeddedness ($p<0.05$). On the other hand, environmental uncertainty, asset specificity and frequency of interactions were significantly correlated with relational embeddedness ($p<0.05$). However, the complexity of tasks in the value chain was not significantly correlated with structural and relational embeddedness ($p\geq0.05$). It therefore means that to ensure effective participation and implementation of platform activities, efforts ought to be placed on fulfilling the platform's promise as a forum for mitigation of transaction cost challenges such as inadequate markets for both output and inputs, customized products and inputs and lack of valuable agricultural information.

Keywords: Exchange Conditions, Innovation Platforms, Relational Embeddedness, Structural Embeddedness.

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Introduction

Innovation platforms (IPs) are increasingly being used as one of the approaches for engaging different players to mitigate the agricultural value chain problems (Swaans *et al*., 2013; Cullen *et al*., 2014). They are considered to be a new and dynamic mechanism that involves farmers and diverse service providers who interact for knowledge generation, sharing and diffusion for purposes of social learning (Cullen *et al*., 2014). An innovation platform is a forum for learning and action involving a group of actors with different backgrounds and interests: farmers, agricultural input suppliers, traders, food processors, researchers, government officials, etc. who come together to identify common challenges and develop common ways to mitigate them through social learning (Homann-Kee Tui *et al*., 2013). Whereas some innovation platforms emerge through spontaneous processes, others may emerge through facilitation and direction by external forces (Consoli and Patrucco, 2011). Innovation platforms bring together different stakeholders to identify solutions to common problems or to achieve common goals, joint conflict resolution, negotiation, social learning and collective decision making towards concerted action (Cadilhon, 2013). Innovation platforms are part of wider participatory approaches that were promoted since the mid-1980s as a means of implementing the agricultural innovation systems (Cullen *et al*., 2014; Swaans *et al*., 2013).

An agricultural innovation system is a network of different stakeholders from farmers, research, extension, policy, and markets focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their innovation behavior and performance (Hall *et al*., 2006). Innovation systems thinking represents a shift away from technology transfer paradigm towards recognition that agricultural change entails complex interactions among multiple actors and a range of technical, social and institutional factors (Pali and Swaans, 2013). The innovation systems framework sees innovation in a more systematic, interactive and evolutionary way, whereby networks or organizations, together with the institutions and policies influence their innovative behaviors and performance and bring new products and processes into economic and social use (Hall *et al.,* 2006). Therefore, innovation platforms are simply a means of operationalizing the innovation systems framework (Cullen *et al*., 2014).

Innovation platforms in agriculture are premised on the assumption that by bringing together various actors, they are able to identify and address existing agricultural value chain challenges to innovation among the stakeholders (Swaans *et al*., 2013). By having a joint vision about the future, innovation platforms improve the performance of an innovation (Swaans *et al.,* 2013; Cullen *et al*., 2014). According to Kilelu *et al*. (2013), the agricultural innovation systems approach emphasizes the collective nature of innovation and stresses that innovation is a co-evolutionary process that should align technical, social, institutional and organizational dimensions. Interventions in commodity innovations are therefore increasingly redirecting their attention toward setting up innovation platforms and networks, as mechanisms for enhancing agricultural innovation. They are generally social networks and informal partnerships that are guided by informal social systems rather than by bureaucratic structures and formal contractual relationships (Hall *et al*., 2006). They are designed to bring together stakeholders from different interest groups, disciplines, sectors and organizations to exchange knowledge, ideas and resources and take action to solve common problems in order to bring about a desired change (Cullen *et al*., 2014). Innovation platforms have been emphasized in agriculture because they are seen as a promising avenue for finding solutions to complex social, economic and environmental problems that have necessitated the engagement of stakeholders such as farmers, development practitioners and policymakers (Schut *et al*., 2015). It is argued that innovation platforms increase collaboration, exchange of knowledge and influence mediation among multiple actors such as farmers, researchers and policy makers thereby enhancing their capacity to scale up the innovations (Hermans *et al.,* 2017) and mitigate the transaction cost challenges of environmental uncertainty, complex tasks, customized products and frequency of interaction (Williamson, 1991; Jones *et al*., 1997). The foregoing discussion is a clear manifestation of the fundamental role of innovation platforms in mitigating the agricultural value chain challenges through enabling the co-evolution of different elements in innovation (Hounkonnou *et al*., 2012; Kilelu *et al*., 2013). For this reason, the Kiboga-Kyankwanzi IP was formed in 2013 to promote new maize and soybean varieties and transform them into a commercial agricultural activity in the two districts of Kiboga and Kyankwanzi in central Uganda. Like many parts of Uganda, the area is occupied by smallholder farmers who usually cultivate less than one hectare of land. The IP was initiated by humid tropics, a Consultative Group on International Agriculture Research (CGIAR). Research Program led by International Institute for Tropical Agriculture (IITA) to help poor farm families to boost their income from integrated agricultural systems intensification while preserving their land for future generations. The IP started with a number of actors such as National Agricultural and Advisory Services (NAADS) and other government bodies, Non-Governmental Organizations (NGOs) such as World Vision, Heifer International, Send a cow, Hunger project and Agro Empowerment, farmer organizations, training institutions such as Makerere University, Local government, food processors, Traders and input suppliers.

Despite the role played by innovation platforms, there is constant member attrition and limited participation in platform activities. Most of the studies on innovation platforms such as Martey *et al.* (2014) that have attempted to study the determinants for effective actor participation tend to look at social and demographic characteristics of actors and whether IPs can be an important avenue for intervening in agricultural value chain challenges (Sartas *et al.,* 2017). Very few studies if any have attempted to study why actors would want to join agricultural innovation platforms. The current study sought to investigate the perceived challenges within an agricultural context that expedite structural and relational embeddedness into the platform activities using the transaction cost theory. Key questions that we seek to answer are: What value related challenges do actors perceive as posed by the environment in which platform members interact? To what extent do members consider structural and relational embeddedness effective responses to exchange conditions of environmental uncertainties, task complexity, customized products and frequency of interactions? Answers to these questions help in gaining more understanding regarding the actors' perception while making the choices to participate in innovation platforms.

Theoretical framework

This paper makes use of transaction cost theory in exploring the actors' perception on Kiboga-Kyankwanzi innovation platform as a structure for addressing the maize and soybean value chain challenges. According to the transaction cost theory, there are four conditions that necessitate the emergency of networks—environmental uncertainty, asset specificity (customized products), task complexity and interaction frequency. These conditions are referred to as exchange conditions (Williamson, 1991; Jones *et al.*, 1997). Environmental uncertainty comes from the unstable and unpredictable environment within which individuals and organizations work (Williamson, 1991). It may also result from unpredictable supply and demand, which necessitates individuals to integrate with a number of other actors in production processes (Helfat and Teece, 1987). According to Jones *et al.* (1997), the main sources of demand uncertainty are generated by unknown and rapid shifts in consumer tastes and preferences, seasonality, rapid changes in knowledge and technology and lack of information about past, current and future states in the environment Because of these uncertainties, an individual actor encounters the costs of determining the price of a product or service, the cost of negotiating and creating the contracts, and the costs of information failure. Uncertainty further arises from the inability to identify actors in a network who are likely to behave opportunistically (Williamson, 1994). In addition to environmental, it has been argued that in order to manage interdependence with either sources of inputs or purchasers of output and diversify operations, individual actors no longer work alone in a closed environment but rather seek external resources through network formation and adapting to external environment (Pfeffer and Leblebici, 1973). This comes out of resource dependency theory, which presupposes that no single actor possesses all the necessary resources such as information, skills and inputs needed for enhancing production (Hay and Richards, 2000).

Asset specificity is the extent to which resources can be redeployed to alternative uses and by alternative users without a substantial sacrifice of its productive value (Williamson, 1989). Asset specificity also known as customized exchanges involve unique equipment, processes, or knowledge developed by actors to complete exchanges. Customized (or asset-specific) exchanges create dependency between actors and increases demand for coordination since it is often hard to transfer resources including human skills to production of other products. It is further argued that products with high levels of human specificity require networks in order to enhance cooperation to gain tacit knowledge among the actors (Liebeskind *et al.*, 1996). Customization combined with uncertainty requires intensification of coordination between actors to safeguard exchanges by reducing behavioral uncertainty (Hesterly and Zenger, 1993).

Task complexity refers to the number of different specialized inputs together with human resources needed to complete a product or service (Jones *et al.*, 1997). Task complexity creates behavioral interdependence and heightens the need for coordinating activities (Pfeffer and Leblebici, 1973). This comes from different tasks and inputs as a result of increased scope of activities, number of products created, or number of differing markets served and the need to reduce costs in a rapidly changing environment which increases time pressures. Task complexity in conjunction with time pressures leads to team coordination where diversely skilled members work simultaneously to produce a good or service (Faulkner and Anderson, 1987). On the other hand, frequency concerns how often specific actors exchange with one other (Jones *et al.*, 1997). It transforms the orientation that actors have toward an exchange because repeated personal contacts across organizational boundaries support some minimum level of courtesy and consideration between the actors and the amount of informal controls that can be exerted over exchanges (Granovetter, 1992). This owes to the fact that the bureaucratic costs in the network increasingly become lower than the repetitive contracting cost (Williamson, 1991). Therefore, as frequency of interactions increases, the need for the network formation becomes increasingly necessary. The main thrust of transactional cost theory is that the above conditions together with the need to pool strategic resources together drive actors toward structurally embedding their transactions (Jones *et al.*, 1997). It is therefore hypothesized that:

- There is a positive significant correlation between transaction cost challenges and structural embeddedness.
- There is a positive significant correlation between transaction cost challenges and relational embeddedness.

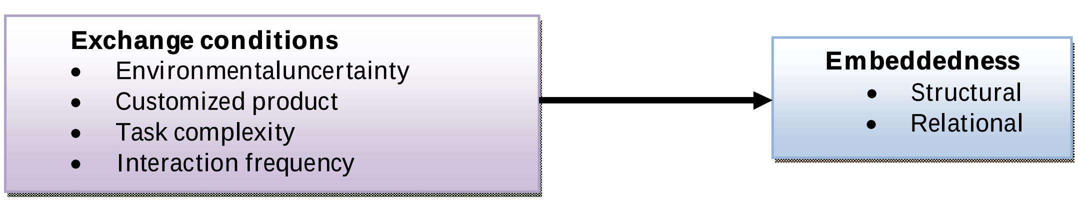

Fig. 1. Conceptual model

Source: *Adapted from* Jones et al. (1997)

Methods and Materials

To answer the research questions, a cross sectional survey design was used in this study. The Kiboga-Kyankwanzi innovation platform was selected purposively because of its diverse activities along the value chain in the maize and soybean production. The IP also has a wide membership in terms of gender and actors. The IP was imitated in February 2014 by Humid Tropics with the ultimate aim of changing the lives of the rural farmers both in Kiboga and Kyankwanzi districts. The IP was formed as a commodity focused platform to promote the commercialization of maize and Soybean production through adoption of high yielding varieties in Kiboga and Kyankwanzi districts of central Uganda. The study population was all members of IPs who include farmers, private business sector, researchers, non-governmental organization, IP executive committee members, farmer group leaders, local policy makers, members of training institutions and extension workers who constituted the units of observation. Since the IP stretches to two districts, a stratified sampling technique was used to select farmers from the two districts. One farmer group with the biggest registered farmers was purposively selected from each district. In Kyankwanzi district, Tukolele wamu group with a population of 486 farmers was selected whereas Twezimbe with a population of 262 farmers was selected in Kiboga. Lists of registered farmers were obtained from the IP leadership. A sample size of 319 farmers was determined from the two farmer groups of the platform (Tukolele wamu and Twezimbe) using Krejcie and Morgan (1970). Simple random sampling was then used to select the farmers whereas positional purposive selection was used to select IP executive committee members, private business operators, researchers, NGOs, IP chairpersons, local policy makers, training institutions and farmer group leaders for FGDs and in-depth interviews.

Data collection

In this study, interviewer administered questionnaire technique was used to collect quantitative data from farmers after translating the questionnaire into the local language. Multi-item scales were used to measure all constructs whose questions were put on a five point likert scale (ranging from 1= strongly disagree to 5= strongly agree) to test the level of agreement. Given the extensive measurement problems of transaction costs of asset specificity, environmental uncertainties, task complexity and frequency of interaction, this study used proxy variables as proposed by (Battu *et al.*, 2002). In-depth interviews and focus group discussions were also used to collect qualitative data from other stakeholders i.e. IP executive committee members, private business operators, researchers, NGOs, IP chairpersons, local policy makers, training institutions and farmer group leaders so as to improve the validity and reliability of the information.

Statistical Package for Social Scientists (SPSS) version 23 was used to generate the cross tabulation and independent samples t-tests to give a general description of categorical data and compare the mean scores between various study constructs. Validity for quantitative data was ensured by computing the Pearson product moment correlation coefficient between the scale items and the total score of each construct while reliability was assessed using Cronbach's Coefficient alpha in the SPSS. The Cronbach's coefficient above 0.8 was preferred but 0.7 was also accepted for reliability of the construct (Hinkins, 1995). For validity, all items that are significantly correlated with the total score of the items were retained. For Qualitative data, reliability was achieved by using more than one person to collect the data for comparison of notes. Probing more in-depth information as well as triangulation also helped to validate data.

Results

This section presents key findings on the perceived challenges facing the actors in the maize and soybean value chain, which facilitate the emergence of networks. The overall response rate in the two districts was 86%. In Kyankwanzi district, one hundred eighty nine (189) answered the questionnaire while one hundred and thirty (130) answered in Kiboga representing 88% and 84%, respectively as shown in the Table 1.

Table 1. Response rate.

District/IP	Population	Sample	Response rate
Kyankwanzi/Tukolele wamu	486	214	189 (88%)
Kiboga/Twezimbe	262	155	130 (84%)
Total	748	369	319 (86%)

Source: Field survey, 2017

Demographic characteristics of respondents

In terms of gender, majority of the respondents were females (53.3%) as compared to males (46.7%). This is probably because most of the smallholder farmers in Uganda are women. However, Kyankwanzi district had more males in the sample. Majority of the farmers in the sample were married (71.8%) whereas only 17.2% were not yet married. In terms of formal education, majority (44.5%) had stopped at primary school level while only 1.6% had attained post-secondary school education. This again alludes to the fact that small holder farming in Uganda is occupied by the uneducated. In fact, about 74.9% of the sample had either not attained formal education at all or stopped at the first level of Uganda's formal education system. Majority of the respondents (35.4%) were further in the age bracket of 50-59 whereas only 1.9% was below 20 years of age. In most cases, these were cases of child headed households. The chi-square test indicates a significant difference in age (χ^2 *(5) = 125.545, p = 0.000)*, marital status *(*χ^2 *(3)* = 385.589, *p = 0.000)*, and level of education *(*χ^2 *(4)* = 192.458, *p = 0.000.* This might partially explain the variations in perceptions about the role of innovation platforms in mitigating the transaction cost challenges. However, the Chi-Square reveals that there was no significant difference in gender of the respondents *(*χ^2 *(1)* = 1.382*, p = 0.240).*

Table 2. Demographic characteristics of respondents.

Characteristic	Category	Sample statistics (n=319)		Total
		Kyankwanzi (Tukolele wamu)	Twezimbe (Kiboga)	
Gender	Male	109	40	149 (46.7%)
	Female	80	90	170 (53.3%)
	Total	189	130	319 (100%)
Education	No school	71	26	97 (30.4%)
	Primary	76	66	142 (44.5%)
	O Level	16	11	27 (8.5%)
	A Level	21	27	48 (15.0%)
	Tertiary	5	0	5 (1.6%)
	Total	189	130	319 (100%)
Marital status	Single	45	10	55 (17.2%)
	Married	119	110	229 (71.8%)
	Divorced	20	5	25 (7.8%)
	Widowed	5	5	10 (3.1%)
	Total	189	130	319 (100%)
Age of farmers	Below 20 years	1	5	6 (1.9%)
	20-29	25	16	41 (12.9%)
	30-39	32	26	58 (18.2%)
	40-49	48	21	69 (21.6%)
	50-59	66	47	113 (35.4%)
	60 and above	17	15	32 (10.0%)
	Total	189	130	319 (100%)

Source: Field survey, 2017

Socio-economic characteristics of respondents

Although land is taken as an important resource especially for agriculture, an analysis of land ownership showed that majority of the respondents were tenants (50.2%). Only 5.3% of the respondents said they owned land on which they farm. Of the 11.9 ha of mean size of land possessed, respondents were allocating an average of 6.3 ha (about 53%) to maize and soya bean production. This is because 72.1% of the respondents had livestock in addition to crop husbandry. Majority of the respondents (89.3%) were semi-commercial since they grow crops for both market and home consumption whereas only 10.7% indicated that they grow maize and soybean for only commercial purposes. Further analysis across the two groups, shows that there was a significant difference in land ownership (χ^2 (2) **=** 114.100, p = 0.000)**,** types of farms (χ^2 (1) **=** 62.323**,** p = 0.000)**,** size of land (χ^2 (18) **=** 176.608**,** p = 0.000)**,** purpose of farms (χ^2 (2) **=** 245.292**,** p = 0.000) and land allocation to enterprises (χ^2 (15) **=** 315.132**,** p = 0.000).

Table 3. Socio-economic characteristics of respondents.

Characteristic	Category	Sample statistics (n=319)		Total
		Kyankwanzi (Tukolele wamu)	Twezimbe (Kiboga)	
Land ownership	Tenant	92	68	160 (50.2%)
	Hired	86	56	152 (44.5%)
	Self-owned	11	6	17 (5.3%)
	Total	189	130	319 (100%)
Type of farm	Crop only	54	35	89 (27.9%)
	Crop and livestock	135	95	230 (72.1%)
	Total	189	130	319 (100%)
Purpose of crops	Commercial	23	11	34 (10.7%)
	Semi Commercial	166	119	285 (89.3%)
	Total	189	130	319 (100%)

Source: Field survey, 2017

Perceived challenges that influence farmers' decision to join innovation platforms

An important question for this study was to find out the perceived maize and soya bean value related challenges facing the farmers, which form the basis for joining the innovation platforms. The study was anchored on the transaction cost theory to unearth the perceived factors that influence individual actors to join the innovation networks. The theory underscores the importance of environmental uncertainty, customized products and skills, task complexity and frequency of interactions in explaining the networks. The table below shows the descriptive statistics of factors, which facilitate actors' decision to join the platforms. The constructs were measured using a five point likert scale (1= strongly disagree, 2=Disagree, 3= Neutral, 4= Agree and 5=Strongly agree).

Table 4. Descriptive statistics of factors influencing the formation of innovation networks.

Variable	No.	Min.	Max.	Sum	Mean	Std. Deviation
ENVIRONMENTAL UNCERTAINTY Unstable steady market	319	1.00	5.00	1335.00	4.1850	0.95839
Unstable clientele	319	1.00	5.00	1171.00	3.6708	1.26943
Source of agricultural finance	319	1.00	5.00	1168.00	3.6614	1.30485
Unreliable source of agricultural inputs	319	1.00	5.00	1284.00	4.0251	1.08419
Lack of agricultural information	319	1.00	5.00	1346.00	4.2194	1.15012
Unpredictable context of agriculture	319	1.00	5.00	1226.00	3.8433	1.26163
COMPLEX TASKS REQUIRED Complex inputs	319	1.00	5.00	1029.00	3.2257	1.17862
Information	319	1.00	5.00	931.00	2.9185	0.99666
Complex skills	319	1.00	5.00	990.00	3.1034	1.02114
Coordination CUSTOMIZED EXCHANGES	319	1.00	5.00	938.00	2.9404	0.92802
Customized output markets	319	1.00	5.00	1036.00	3.2476	1.05722
Customized input markets	319	1.00	5.00	947.00	2.9687	0.96428
Customized inputs	319	1.00	5.00	1072.00	3.3605	0.97378
Customized skills	319	1.00	5.00	1010.00	3.1661	0.95198
Customized stockists	319	1.00	5.00	938.00	2.9404	0.89349
FREQUENCY OF INTERACTIONS Exchange of information	319	1.00	5.00	1010.00	3.1661	1.00344
Exchange of crop related services	319	1.00	5.00	969.00	3.0376	1.05143
Frequent contact with clients	319	1.00	5.00	1055.00	3.3072	0.96462
Exchange of maize and maize products	319	1.00	5.00	947.00	2.9687	0.90019

Source: Survey data, 2017

The most important factors under environmental uncertainty were found to be the unstable markets for the output (mean 4.1850 and std. dev 0.95839), lack of adequate agricultural information ($\bar{x}$= 4.2194 and std. dev. 1.15012) and lack of agricultural inputs (mean 4.0251 and std. dev. 1.08419). This implies that farmers join the platforms in search of ready markets for their products, steady supply of inputs and reliable agricultural information. Under the complex task within the new crop varieties, the inputs ($\bar{x}$= 3.2257; std. dev. =1.17862) and skills (mean 3.1034 and std. dev. 1.02114) required were the most important explanatory factors for entering the platform. Under customized exchanges, it was found that the inability to transfer the committed resources from maize and soya bean enterprise ($\bar{x}$= 3.3605; std. dev. 0.97378) together with a narrow range of clients for the new crops ($\bar{x}$= 3.2476; std. dev. 1.05722) explained the decision to join the innovation platforms. The need for frequent contact with clients ($\bar{x}$=3.3072; std. dev.0 .96462) was the most important factor under the frequency of exchange.

Gender dimensions of transaction cost challenges

As noted by a number of studies, gender is an important aspect of innovation. This is because women tend to be under represented in policy spaces and therefore there was a need to integrate gender aspects of innovation in the study. Consequently, an independent samples t- test was conducted to compare the transaction cost challenges scores for males and females. For environmental uncertainty and complex tasks, the significance level of the Levene's test was less than 0.05 i.e. p=0.028 and p=0.000, respectively. This means that the variances of the two groups were not the same thus violating the assumption of equal variance. This necessitated the use of an alternative significance t-value that compensates for this variation in variance.

Table 5. Summary statistics of gender on transaction cost challenges.

Group Statistics					
	Gender of respondents	N	Mean	Std. Deviation	Std. Error Mean
Environmental uncertainty	Male	149	17.9396	8.27421	0.67785
	Female	170	17.8529	7.41473	0.56868
Complex tasks required	Male	149	12.3356	5.13416	0.42061
	Female	170	12.4412	4.11514	0.31562
Customized exchanges	Male	149	15.0805	6.16717	0.50523
	Female	170	14.5882	6.72854	0.51606
Frequency of interactions	Male	149	12.2416	6.06012	0.49646
	Female	170	11.5882	5.97885	0.45856

Source: Survey data, 2017

There were no significant differences in mean scores for males and females on all the four transaction cost challenges. For environmental uncertainty, the scores for males were ($\bar{x}$=17.9396, Std. Dev. = 8.27421 and females ($\bar{x}$=17.8529, Std. Dev. = 7.41473; t (317) =0.099, p=0.921, two tailed). The p values for task complexity, customized exchanges and frequency of interactions were 0.841, 0.498 and 0.334, respectively.

Table 6. Independent Samples Test for transaction cost challenges.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Environmental uncertainty	Equal variances assumed	4.904	0.028	0.099	317	0.921	0.08666	0.87845	-1.64166	1.81498
	Equal variances not assumed			0.098	299.655	0.922	0.08666	0.88481	-1.65456	1.82788
Complex tasks required	Equal variances assumed	13.735	0.000	-0.204	317	0.839	-0.10561	0.51835	-1.12544	0.91423
	Equal variances not assumed			-0.201	283.014	0.841	-0.10561	0.52586	-1.14069	0.92948
Customized exchanges	Equal variances assumed	1.779	0.183	.0678	317	0.498	0.49230	0.72636	-.093679	1.92139
	Equal variances not assumed			0.682	316.355	0.496	0.49230	0.72220	-0.92862	1.91323
Frequency of interactions	Equal variances assumed	0.005	0.942	0.968	317	0.334	0.65338	0.67523	-0.67513	1.98188
	Equal variances not assumed			0.967	310.399	0.334	0.65338	0.67583	-0.67642	1.98317

Source: Field survey, 2017

The effect size statistics were obtained using Eta squared = t^2/t^2+ (N1+N2-2) (Cohen, 1988). Consequently, the effect sizes were obtained as 3.02956E-05, 0.000127432, 0.001448007 and 0.0029472 for environmental uncertainty, complex tasks, customized exchanges and frequency of interactions, respectively. Following Cohen's interpretation guidelines, the effect sizes were established to be small for all the transaction cost challenges. The magnitude of the differences in the means were 0.08666, 95% CI= -1.64166 to 1.81498 for environmental uncertainty, -0.10561, 95% CI=-1.12544 to 0.91423 for complex tasks, 0.49230, 95% CI=-

0.93679 to 1.92139 for customized exchanges and 0.65338, 95% CI= -0.67513 to 1.98317 for frequency of interactions. Therefore, only small percentages of variations in perceptions about transaction cost challenges as motivators for joining networks can be explained by gender differences of the respondents.

Table 7. Effect size of gender on transaction cost challenges.

Transaction cost challenge	t	t^2	N1	N2	t^2/t^2+ (N1+N2-2)	Eta squared*100%
Environmental uncertainty	0.098	0.009604	149	170	3.02956E-05	0.003
Complex tasks required	-0.201	0.040401	149	170	0.000127432	0.013
Customized exchanges	0.678	0.459684	149	170	0.001448007	0.145
Frequency of interactions	0.968	0.937024	149	170	0.0029472	0.295

Source: Computed from Field survey, 2017

From the one sample t-test, it was established that the uncertain environment within which farmers operate, complex tasks that come with new crops, customized inputs and products and the frequent interactions with a multiplicity of other stakeholders are all significant in explaining why farmers join innovation networks (p=0.000).

Table 8. One-Sample Test.

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Environmental uncertainty	40.891	318	0.000	17.89342	17.0325	18.7543
Complex tasks	47.989	318	0.000	12.39185	11.8838	12.8999
Asset specificity	40.925	318	0.000	14.81818	14.1058	15.5306
Frequency of interactions	35.308	318	0.000	11.89342	11.2307	12.5562

Source: Field survey, 2017

Relationship between embeddedness and Transaction cost challenges

A spearman's rank correlation was done to establish the relationship between the above transaction cost challenges and the need for structural and relational embeddedness. These factors were also correlated to establish their relationships. The objective was to determine the extent to which structural and relational embeddedness are a result of the perceived challenges facing the production and other value chain activities of maize and soya bean in the area.

Table 9. Correlations between embeddedness and transaction cost challenges.

		1	2	3	4	5	6
Environmental uncertainty	Correlation Coefficient	1					
	Sig. (2-tailed)	.					
Task complexity	Correlation Coefficient	0.878**	1				
	Sig. (2-tailed)	0.000	.				
Customized exchanges	Correlation Coefficient	0.834**	0.877**	1			
	Sig. (2-tailed)	0.000	0.000	.			
Frequency of interactions	Correlation Coefficient	0.940**	0.875**	0.877**	1		
	Sig. (2-tailed)	0.000	0.000	0.000	.		
Structural embeddedness	Correlation Coefficient	0.155**	0.063	0.085	0.141*	1	
	Sig. (2-tailed)	0.006	0.261	0.131	0.012	.	
Relational embeddedness	Correlation Coefficient	0.138*	0.081	0.115*	0.147**	0.680**	1
	Sig. (2-tailed)	0.014	0.146	0.040	0.009	0.000	.

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

From the correlations in table 9, there was a positive significant relationship between the perceived environmental uncertainty and both constructs of embeddedness i.e. (rho=0.155 and p=0.006) and (rho=0.138 and p=0.014) for structural and relational embeddedness, respectively. There was also a significant positive relationship between the frequency of interactions and structural embbededdness (rho=0.141, p=0.12) and relational embeddedness (rho=0.147, p=0.009).

However, complex task did not reach statistical significance with any of the constructs of embeddedness. The correlations were found to be (rho=0.063, p=0.261) and (rho=0.081, p=0.146) for structural and relational embeddedness, respectively. The correlation between customized products and skills was significant for relational embeddedness (rho=0.115, p=0.040) but insignificant for structural embeddedness (rho=0.085, p=0.131). However, since the correlations between each of the constructs of embeddedness and the factors in question were less than 0.29, the effect size is considered small (Cohen, 1988). Overall, these results are an indicator that embeddedness both structural and relational is a result of exchange conditions of uncertain environment in agriculture, customized assets, complex tasks and frequent actor interactions.

Discussion

The study found a positive correlation between transaction cost challenges and social embeddedness. The statistical significance of environmental uncertainty is an indicator that actors in the maize value chain work in a risky environment characterized by unstable markets, agricultural finance, inputs and information. This makes it hard to predict the context of production for the two crops both in the short run and long run. Indeed these findings are in line with Williamson (1991) who asserts that the environment within which economic actors operate is never stable and predictable. Under conditions of demand uncertainty for the new crops, it becomes feasible for farmers to vertically integrate with food processors, input suppliers and marketers in order to easily access buyers. Indeed the major factors that were perceived to pose risk were lack of steady markets, steady supply of agricultural inputs for the new crops and lack of adequate agricultural information.

The results are further in agreement with other scholars such as Jones *et al.* (1997); Dubini and Aldrich (1991) who have previously asserted that networks allow for flexibility and quick response to a wide range of environmental risks such as unpredictable demand. Such scholars argue that networking enhances flexibility because actors learn from one another through knowledge sharing which reduced lead time and improved quality for new products. It can therefore be deduced that actors who perceive a number of environmental risks join innovation networks as a means of insurance to guard against the unpredictable context within which agriculture takes place. The findings however, did not show significant differences in mean scores for males and females on all the four transaction cost challenges. This means that only small percentages of variations in perceptions about transaction cost challenges as motivators for joining networks can be explained by gender differences of the respondents. This means that the perception about transaction cost challenges is independent of gender. Part of the explanation to this could be the gender equality campaigns that have been promoted in Uganda during the recent past and the reduction in patriarchal relations.

The complex tasks that result from the introduction of new crops were found to be insignificantly correlated with actors' embeddedness in the network. In the context of the study, the complex tasks were noted to emanate from a variety of specialized inputs, information, skills and coordination required to accomplish the entire value chain of the crops in question. These tasks necessitate interdependence between actors and consequently the need to join the network rather than sequential exchange of production activities (Jones *et al.*, 1997). Pfeffer and Leblebici (1973), Clark and Fujimoto (1989), Imai *et al.* (1985) have established that task complexity creates behavioral interdependence between firms and enhances coordination of activities through group meetings which speeds up information sharing among them and reduces the time they take to accomplish complex tasks. In order to complete the value chain, Powell (1990) has found that the need for quick delivery of output to markets is a critical condition for networks. Clark and Fujimoto (1989) while studying networks in the Japanese auto industry also found that networks had for a long time given Japanese a competitive advantage due to reduced lead times and reduced costs. These studies therefore support the view that rather than exchange of activities along the maize value chain, it is only feasible for firms to work in a network and reduce the costs in terms of time, information and other resources.

The findings in the current study however; contradict a number of previous studies that have asserted the role of complex tasks in influencing network formation. Part of the explanation for the non-significant relationship is possibly that farmers and especially smallholder farmers do not possess specialized resources such as skills that would require actor interdependence. Further still, unlike the industrial setting, farmers do not work under intense time pressures to produce a product, which would require coordination as a critical condition for the formation of networks. Arguably, agricultural production is characterized by long production cycles. As argued by Boehlje *et al*. (2011), this implies that the time delays between idea generation and implementation are much longer than in industry, which is characterized by continuous flow of processing and short production cycles.

Results showed a positive significant relationship between customized exchanges (asset specificity) and relational embeddedness but insignificant for structural embeddedness. This means that when actors perceive to have assets and skills that cannot be transferred to other uses, they would be willing to relate and coordinate with a multiplicity of other actors rather than simply knowing and being connected to them. In cases where actors such as input suppliers had customized products and skills, they would want a network so as to enhance cooperation and exchange tacit knowledge amongst themselves. The findings showed that the decision to join the networks is engineered by the actors' perception that their output can only be sold to a narrow range of stockists and clients together with their low abilities to transfer resources such as skills acquired to other uses. The major customized exchanges were indeed found to be customized markets for the new crops, customized sources of inputs and customized skills. In such circumstances, it was only feasible for actors such as input suppliers and stockists to join the platforms. This argument has been made by other scholars such as Clark and Fujimoto (1989) who found out that under conditions of non-transferable skills and other specialized resources, cooperation is necessary because parties must work together to gain tacit knowledge. Other previous studies by Lengel and Daft (1988); Nohria and Eccles (1992) show that networks offer important media such as face-to-face communication for the transfer of customized skills. All these studies probably explain why the results showed significant correlations with relational embeddedness but insignificant with structural embeddedness.

The significant correlation between relational embeddedness and frequency implies that when actors perceive the costs of constant interactions to be high, they tend to join the network. This again implies that as frequency of interactions increases, the need for the network form of governance becomes increasingly necessary. The degree of frequency ranges from occasional to recurrent interactions (Williamson, 1991). The findings also show that actors joined the platform because of the frequent requirements for information and other services related to maize and soybean production. These services include extension, training, processing and input supplies. By joining the network, actors receive the services at reduced costs. According to Williamson (1991), this reduced cost justifies joining inter-firm networks rather than internal bureaucratic means.

Conclusion

There is no doubt that the complexity of agricultural challenges requires an equally complex set of solutions. Innovation platforms can offer a wide range of such solutions ranging from demand articulation, institutional support, network brokering, innovation process management and knowledge brokering. Using the transaction cost framework, the study has shown that the formation of an innovation platform can be motivated by the perception that it offers potential solutions for the complex agricultural value chain challenges. A number of scholars such as Jones *et al*., (1997), Williamson (1991) and Granovetter (1992) have demonstrated the role of environmental uncertainty, customized exchanges, task complexities and frequent interactions in motivating network formation. These however, have not been tested to establish their application in agricultural network formations such as innovation platforms. The ability of the platform to link farmers to markets for both output and inputs and provide the much needed extension services came out as strong motivators for joining the innovation platforms. Although factors such as non-transferability of skills and resources and a narrow range of markets for inputs are important, the study finds the risky agricultural environment characterized by uncertain demand for both output and inputs, agricultural finance and information the most explanatory factors for the emergence of network form of governance. To maintain membership of farmers and input suppliers, platforms should invest valuable resources in ensuring steady markets and extension services.

Conflict of interest

The authors declare that there were no conflicts of interest in this study. They are independent university researchers who are not part of the platform under study.

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