The Dynamics of University-Industry Linkage: The Case of Mekelle City, Tigray Regional State, Ethiopia†

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Abstract

In the past few decades, the importance of dynamics of University-Industry Linkage(UIL) in strengthening national and regional innovation competency and global competitiveness has been progressively more acknowledged. However, establishing an effective UIL for a better economic development is still a challenging endeavor in Ethiopia, particularly in Tigray region. This study is aimed at assessing the status of UIL and in order to achieve such aim it analyzed the determinants of firms' intensity of interaction with the Mekelle University (MU) and the effect of the intensity of interaction on the relevant firms' innovation performance. The findings of the study showed that the status of UIL between the firms and the university in Tigray region was at an infant stage. The study also found that firm size, firm age (startups) and government supports have had a significant effect on firms' intensity of interaction with the MU. However, the firms' intensity of interaction with the MU did not have any significant effect on the firms' innovation performance. In contrast, cooperation with customers, other groups and suppliers, firm size, firm age, and in-house R&D activities were found to have a significant effect on the firms' innovation performance. In conclusion, the acquisition of knowledge and technology from university does not have an important role in firms' innovation performance in the studied region. Consequently, the government should design effective strategies and assign responsible bodies to implement the strategies, create awareness, and organize both firms and university to meet and work together in order to enhance firms' innovation performance.

Keywords
Manufacturing firms, University, Linkage, Innovation, Mekelle

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1. INTRODUCTION

1.1. Background

In the past few decades, the importance of dynamic UIL in strengthening national and regional innovation competency and global competitiveness has been progressively more acknowledged. Hence, in today's highly interconnected global market "knowledge and innovation" are used as springs to enhance global economic attractiveness and economic development. Today, the prominence of having linkage between academia and firm is significantly growing on the schema of tertiary education policy making process (Esham, 2008). Similarly, many scholars and international organizations argue that the global economy is moving toward what is called the "knowledge-based economy" in which the role and importance of knowledge for strong economic development are vital (OCED, 1996, 1997; and World Bank, 2007).

Despite the increasing trend, however, the attention of UIL in developing countries, especially many of the African countries, lacks an enabling environment to effectively utilize their universities. Particularly, the Sub-Saharan countries lack high-tech industries and technological cultures that boost them and develop technology in order to cope in a competitive global market (Belete, 2014).

In Ethiopia, though the expansion of higher education has increased in pace, the UIL has been less developed. Studies indicate that some of the factors that adversely affected the development of UIL in Ethiopia are: low absorptive capacity of the industries, organizational structures of firms, lack of finance, knowledge and skill gap, and information gap on existing options of technology (Belete, 2010; as cited in Belete, 2014).

Nevertheless, studies in the field of UIL in Ethiopia, in general, and in Tigray region, in particular, are scanty. Therefore, this study aims to look into the current status of UIL, the effect of some firm level determinants on the level of interaction with universities as well as the effect of the level of interaction on the relevant firms' in the studied region.

1.2. General Objective of the Study

The overall objective of this study is to assess the dynamics of UIL between the Mekelle University (MU) and the manufacturing industries (firms) in Mekelle city, Tigray Regional State, Ethiopia.

1.3. Specific Objective of the Study

1. To assess the status of linkage between the MU and the manufacturing firms in the studied region,
2. To examine the determinant factors that affect the intensity of interaction of manufacturing firms in Mekelle city with the MU, and

3. To explain the effect of intensity of interaction/linkage on the relevant manufacturing firms' innovation performance

1.4. Statement of the Problem

The main problem addressed in this study was the underlying dynamic factors, which affect the UIL in Mekelle city, Tigray regional state, Ethiopia. With the view to raise the growth of domestic technological abilities, several government policies in Ethiopia have emphasized the need for creation of effective UIL. These different policies envisioned to (a) establish ways to facilitate partnerships and the flow of information; (b) strengthen graduate students and university research; and (c) produce the demand of firms for technology and knowledge made in academia (MoST, 2012; FDRE, 2009; FDRE, 2002a; FDRE, 2002b; and FDRE, 1994). Despite the fact that the UIL is promoted by different national policies of Ethiopia, still there are many challenges to move forward and the interactions between the industries and universities mad the context suggests the UIL failed to make fruitful results to support the economic development in knowledge, science and technology (Kitaw, 2008; Belete, 2014; and Derbew, et al., 2015). Considering this broad problem (in the area of UIL) and research gap, therefore, this study aims to explore the bottle necks for strong interactions by taking the UIL in Mekelle city as a case study and thereby provide some valuable insights for strengthening the linkage among the institutional actors and give a helping hand for the development of the region through knowledge, science and technology.

Thus, this research study addresses the following research questions:

1. What is the status of linkage between the MU and manufacturing firms?
2. What are the determinant factors that affect the intensity of firms' interactions with the MU?
3. Does the intensity of interactions between the industry and the MU have a significant effect on the relevant firms' innovation performance?

1.5. Scope and Significance of the Study

Basically, the thematic scope of this study focused on the status and level of interactions between manufacturing firms and the MU. The study also geographically covered Mekelle city only. The research used a cross-sectional data (for the first two research questions). For the third research question, the research involved use of a panel data covering the time period from January 2015 to January 2017. This study, in accordance with this researcher's belief, will make a contribution to the limited know- how of, concerning the UIL, and therefore, it will reveal and highlight the existing dynamics of relationships between the manufacturing industries and the MU.

2. REVIEW OF LITERATURES

2.1. The Concept of UIL and Firm's Innovation

In the competitive and expanding global market, knowledge and technological competencies are more and more essential factors of firm's competitive advantage (OCED, 1996). The linkage between industries and universities has been a classical theme in the agenda of nation states, the OECD, the EU and several other organizations as well as among the academic circles. It involves search of industries for new ways of product and service enhancement and improvement. To advance the technological capability and to speed up innovation, the UIL could be an appropriate solution (OCED, 1996, 1997).

The collaborations between knowledge centers (i.e., university) and firms have become interactive, which lead to more effective and productive flow of knowledge and technology from universities to industry. When these collaborations have become much more interrelated and non-linear, the form and model of these linkages have expanded and diversified. Furthermore, according to the 'Triple Helix Model' of UIL (Etzkowitz, 2005; as cited in Dzisah & Etzkowitz, 2008), the interaction involves three basic elements. The first element refers to the core role of university in innovation. The second element addresses the ways for partnership among the three distinct major institutional actors (i.e., industry, university and government). The third element recognizes that one institutional actor (i.e., industry, university or government) can take the role of the others beyond satisfying their own traditional objectives.

Thus, Houghton & Sheehan (2000) and the OCED (1996) argued that innovation is a result of numerous interactions between actors and institutions, which together form an innovation system and within these systems influence the innovative performance of firms and ultimately the economy.

2.2. Empirical Evidence

2.2.1. Determinants of Industry Interaction with University

In the study of Cohen, Nelson, & Walsh (2002), the size and age of firm were included as explanatory variables in their regression analysis. It was found that larger firms and startups have a higher probability of interaction and tend to benefit from the higher level of education research. And this study found that large firms have a more probability of interaction with external partners than small firms because large firms have more resources than small ones, and such availability of resources helps them to interact easily with external partners –like universities. Besides, in his study on UK innovative firms, Tether (2002) found that large firms rather than small firms are more attractive to the external partners (as cited in Sanchez and Herrera, 2010). Similarly (as cited in Segarra-Blasco and Arauzo-Carod, 2008), Segarra et al. (2008) found that small manufacturing industries in Spain found it very challenging to find R&D partnerships.

In addition, Laursen & Salter (2004) found a positive effect of the number of employee on the degree of knowledge use that was produced at universities measured by the number of employees. Nonetheless, findings of some studies are not in agreement with this argument. For example, Eom & Lee (2010) argued that small firms are more eager than large firms to interact with external partners because they are challenged with insufficient internal resources, particularly financial, R&D capacity or other facility to increase their production. Another firm level characteristic that affects its interaction with universities is the level of R&D Eom & Lee (2010) and Fritsch & Lukas (2001) empirically investigated and found that firms' interaction with university is positively affected by R&D intensity. Similarly, Mohnen & Hoareau (2003) and Eom & Lee (2010) argued that government's support of R&D for firms with financial problems or networking problems is important to motivate firms to create linkages with universities.

The literature review so far highlights that firm size, firm age, internal R&D activities of firms and government support are among the potential determinants that need to be considered in the analysis of determinants of intensity of manufacturing firms' interactions with the MU.

2.2.2. The Effect of Interaction with University on Firm's Innovation Performance

In a competitive environment, industries have to craft new solutions to overcome existing problems, enhance production capacity and satisfy customers. There are some studies that examined the effect of firms' interactions with universities on the innovation performances of firms. Belderbos, Carree, & Lokshin (2004b) found that firms that have interactions with universities in their R&D activities show large sales growth due to new products than firms that do not have interactions with universities in their R&D activities. Similarly, Loof and Brostrom (2008) in Sweden and Asxhoff and Schmidt (2008) in Germany found that establishing linkage with universities or research institutions has a positive effect on the share of sales of new products in the markets (as cited in Vega, J., et al., 2010).

In addition to the above studies (as cited in Vega, J., et al., 2010), Amara and Landry (2005), who by employing the 1999 Statistics of Canada Innovation Survey regressed the degree of novelty of product innovation on a variable indicating the use of scientific organizations as sources of knowledge and technological information, found a significant and positive relationship between such interactions and innovation of firms. Specifically, they found that firms that cooperate with universities and use universities as a source of information and technology improve the likelihood of radical innovation.

Conversely, there are also some researchers who discovered different empirical results regarding the effect of firms' linkages with universities. For instance, Miotti & Sachwald (2003) and Laursen & Salter (2004) revealed that interaction with public institutions has no significant effect on the share of innovative products in turnover; compared to suppliers or clients, interaction with universities was only moderately important.

In the literature, there are different empirical studies that analyze the specific motivations behind cooperation with different partners (Fritsch & Lukas, 2001; Miotti & Sachwald, 2003; Belderbos et al., 2004b; and Sanchez and Herrera, 2010). These various sources of knowledge and information can be categorized into the following two types: internal and external sources for creating innovation (Sanchez and Herrera, 2010). It was also found that internal sources of innovation are related to internal R&D activities carried out within the firm units, employee's skill within firms, and marketing and production units of firms.

On the other hand, the external sources are comprised of: (a) market-based sources such as competitors, customers or users, experts and consultants, suppliers, and commercial laboratories or R&D firms; (b) educational centers or research centers such as public or private research organizations, and universities; (c) general public information such as conferences, professional meetings, journals patents, and exhibitions. Creating linkage with public R&D organizations (Miotti & Sachwald, 2003), customers, suppliers, consultants (Tether, 2002), and competitors (Harabi, 2002) (as cited in Sanchez and Herrera, 2010) has a positive effect on innovation performance of firms and it is important for strengthening international competitiveness of industries in particular and the relevant countries' competitiveness in the global market in general. It is also important to control the challenges of market imperfection or failure and other knowledge and technological incapability of firms. Similarly, the firm level characteristics such as firm size, internal R&D activity, firm age, and government support affect the performance level of firms' innovation capacity.

Bearing all of the abovementioned empirical studies in mind, this empirical study examined the effect of intensity of interaction between industries and the MU on the performance of firms' innovation by controlling all other internal and external variables that have an effect on firms' innovation performance.

3. RESEARCH METHODOLOGY

3.1. Type of Research

In this research study, the researcher used descriptive as well as explanatory research designs in order to examine the dynamics of UIL and its effect on firms' innovation performance in the case of Mekelle city. The researcher also used qualitative as well as quantitative research approaches in order to collect two different types of data –qualitative and quantitative simultaneously. Hence, the researcher used a research type of 'Concurrent Mixed Method Approach' to systematically answer the research questions of what and how.

3.2.Types, Sources and Methods of Data Collection

The researcher used both quantitative and qualitative data types and both primary and secondary sources of data for this study. The secondary data that include information that are obtained mainly from different reports, journal articles, policy briefs, books, regulations and pertinent academic thesis, which are relevant to the theme of the study, were gathered and analyzed. The primary sources of data are responses from manufacturing industries and academics from the MU, which were collected via questionnaires and interviews with key informants of the MU. The researcher also used questionnaires, interviews and document analysis instruments for data collection.

3.3. Sampling Design

3.3.1.Population

From the perspective of methodological language, the population/universe is defined as the place where the relevant data is collected for the relevant research work. Hence, because this study was intended to be conducted in Mekelle city, the population or universe of the study was Mekelle city.

3.3.2.Sampling Frame/Target Population

For this study, the sampling frames were managers of manufacturing industries, instructors and researchers of MU, college deans and department heads of MU.

3.3.3.Sampling Unit and Unit of Analysis

The sampling units of this study were manufacturing firms (i.e., micro, small, medium and large manufacturing firms) and the MU (including lecturers and researchers as well as principals of college/institute heads, department heads, UIL unit officers and R&D directorate). Therefore, the units of analysis of this study were all individual and group respondents (i.e., the MU and manufacturing firms)

3.3.4.Sampling Technique

As for the sampling technique used for the MU to select sample representatives of academics and researchers, the study used both random and non-random techniques. First, by using judgmental purposive sampling, two colleges were selected. Second, from the selected two colleges, the researcher took all the departments under these two colleges and by using simple random sampling technique the representative respondents were drawn. Therefore, by using purposive sampling, the college of Business and Economics and the Ethiopian Institute of Technology-Mekelle were selected. Finally, by using simple random sampling, the representative respondents were selected from each department of academics and/or researchers with the Masters degrees and above. Non-probability sampling technique was also used to select key informant for interviews.

The sampling technique for manufacturing industries used a two-stage sampling method. In Mekelle city, there are different manufacturing firms including micro, small, medium and large. Thus, the manufacturing industry is diverse and need to be stratified to obtain adequate representation from each stratum. Hence, in order to first ensure uniformity, stratification was conducted based on the size of the firms. Second, within the stratum, simple random sampling was applied in order to select the representative samples. Finally, the industry owners/managers were selected purposively.

3.3.5.Sample Size

The total sample size used in the study was 257 participants. The total sample was determined by taking 7% sample error for the owners of manufacturing firms and academics and researchers of the MU. Therefore, the sample size for manufacturing firms and the MU academics and researchers were calculated by using the following formula:

$$N_o = \frac{N}{1+N(e)^2} \text{ , and corrected by } n_o = \frac{No}{1+\frac{(No\text{-}1)}{N}}$$

Where: N_O is the unadjusted sample size, N is the total population, n is the adjusted sample size and e represents the sampling error. If the population is small then the sample size can be reduced slightly by adjustment called the finite population correction which can substantially reduce the necessary sample size for small populations (Israel, 2009). Hence, there were a total of 2083 manufacturing firms; the sample size was calculated as follows:

$$No = \frac{2083}{1+2083(7\%)^2} = 189$$

Where the unadjusted sample size is 189 and the adjusted sample becomes,

$$n = \frac{189}{1+\frac{(189\text{-}1)}{2083}} = 171$$

TABLE 1. Sample Distribution of Manufacturing Firms

Firm Size	Total No. of Firms	Calculated Sample Size	Actual Sample Taken
Micro	1021	53	46
Small	884	53	45
Medium	167	53	49
Large	11	11	8
Total	2083	159	148

Source: Investment Bureau and MSE Bureau of Mekelle Zone, 2017

From the obtained samples of manufacturing firms, for each stratum, the samples were further selected through disproportional stratified sampling by judgmental decision. Thus, the final response rate of the manufacturing firms was 87% as indicated in Table 1.

There were also 260 instructors and researchers holding the Masters degrees and above in the College of Business and Economics and the Ethiopian Institute of Technology-Mekelle. There were also 10 department units. Therefore, the sample size for academics and researchers of MU was calculated by the following formula:

$$No = \frac{260}{1+260(7\%)^2} = 114$$

TABLE 2. Sampling Proportion of Academics and Researchers

College of Business and Economics			
Department	No. of Academics	Sample Size (Proportional)	Actual Sample Taken
Accounting	37	16	15
Cooperative	12	5	5
Marketing	12	5	5
Economics	23	10	10
Management	31	13	13
Ethiopian Institute of Technology-Mekelle			
Department			
Mechanical and Industrial Engineering	47	21	18
Architecture Engineering	24	11	9
Electrical & Computer Engineering	43	20	19
Chemical Engineering	8	3	3
Civil Engineering	23	10	6
Total	260	114	103

Source: Mekelle University Human Resource Management, 2017

In addition, six key informants (one college dean, three department heads, one UIL unit officer and one R&D director) were included purposively for interviews. Finally, the response rate of the sample respondents of academics and researchers from MU was 90.4% (see Table 2).

3.4. Method of Data Analysis

In this study, the qualitative and quantitative methods of data analysis techniques were used. The qualitative data that were collected from interview and document analysis were converted into texts to support the responses gathered through questionnaire.

On the other hand, the quantitative data collected from both industrialists and academics via questionnaire were analyzed by using descriptive statistics and regression analysis. Specifically, for the first research question, the researcher used a descriptive method of analysis (percentages and frequencies) and presented the information with graphs and tables and the meanings and interpretations for the outputs were provided. For the second and third research questions, the researcher used multiple linear regression analysis.

In order to make clear and easy the level of measurements with Likert scale, two of the points in the scale (very low and low) were considered as showing a negative response and added the value of the two. And also two of the points in the scale (very high and high) were considered as showing a positive response and added the value of the two, which indicated the absence or presence of the object depending on the statement.

Furthermore, in order to strengthen the descriptive analysis, test of proportions was applied to test if (a) there was a statistically significant difference between the proportion of one group of respondents (P1) with that of another group (P2); and (b) a given proportion (P) exceeded 50% (i.e., whether the proportion constituted a majority). In the first test, the null hypothesis was: Ho: P1=P2 while in the second test the null hypothesis was Ho: P=50%. The decision rule was that if the Z-calculated value exceeded 1.96 or 2.57, we rejected the null hypothesis at 5% and 1% levels of significance, respectively.

3.4.1. Model Specification

The researcher used the empirical models of specification for analysis. First, the researcher analyzed what determines manufacturing firms to form linkage/interaction with the MU using multiple linear regression method.

$$UIi = \beta o + \beta iXi + ui \ldots\ldots\ldots equation\ (1)$$
$$Xi = \{Size,\ IRD,\ Startup,\ G_{sup}\}$$

Where; *UIi* indicates the extent to which firms cooperate with the MU. The model specification is also specified by explanatory variables such as: firm size (Size), internal R&D activities (IRD), government support (G_SUP), and startup (firm age). Where, *ui* is a random error term that includes the effect of variables omitted by the researcher (partial ignorance of the determinants of interaction or due to the lack of data). Secondly, the researcher tested whether the level of interaction affected the firms' innovation performance using Multiple Regression Analysis.

$$P_{INNOi} = \beta o + \beta iUIi + \beta iXi + ui \ldots\ldots\ldots equation\ (2)$$
$$Xi = \{Size,\ IRD,\ startups\ , G_{sup},\ , Cop_{Client},\ Cop_{sup},\ Cop_{group},\ Cop_{consult},\ Cop_{PRI},\}$$

Where; P_{INNOi} is the firms' innovation performance capability, which is determined by *UIi* (intensity of firms' interactions with the MU) and other controlled explanatory variables (*Xi*). These are firms' cooperation with customers (Cop-customers), firms' cooperation with suppliers (Cop-sup), firms' cooperation with other same groups (Cop-group), firms' cooperation with consultants (Cop-consult), firms' cooperation with public research institution (Cop-PRI) and the firm level characteristics such as firm size, startups (firm age), in-house R&D activities and government support. *ui* is a random error term which includes the effect of left-out variables omitted by the researcher (partial ignorance of the determinants of innovative process). This analysis also dealt with only innovative firms. The researcher asked firms' questions regarding their innovation performances (i.e., process innovation and product innovation) that were introduced during the period of between 2015 and 2017.

4. RESULTS AND DISCUSSIONS

4.1. Characteristics of Respondents

From the sample manufacturing firms, 148 sample respondents were included. Hence, the researcher used the variables of gender, age, education background as well as area of occupation in which the sample industries are currently engaged in order to describe the inherent background of the respondents of manufacturing firms.

TABLE 3. Age and Educational Background of Sample Respondents of Manufacturing Firms

No	Category	Description	No. Respondent	Percentage
1	Age of the Respondents	21-30 years	32	21.6
		31-40 years	99	66.9
		41-50 years	16	10.8
		51-60 years	1	0.7
		Total	148	100.0
2	Educational Status of the Respondents	Primary school	12	8.1
		High school	90	60.8
		Vocational school	33	22.3
		BA/BSC & above	13	8.8
		Total	148	100.0

Source: Own analysis, 2017
Note: 148 respondents representing 148 manufacturing firms

Hence, a majority of the respondents (i.e., 95.9%, Z=8.79) were males. This may indicate that the participation of females in the area of manufacturing industries was low. With regard to the educational backgrounds of the respondents, the results that are depicted in Table 3 reveal that the level of education with the highest frequency was “high school”, followed by “vocational school”. The samples constituted very few respondents that had either completed primary school or a Bachelor’s degree and above. With regard to the age group of the respondents in Table 3, the proportion of respondents under the age group of 21-40 years old (88.5%, Z=7.18) was significantly greater than the proportion of those respondents in the higher age group (i.e., 41-60 years). This implies that the samples constituted more respondents in the younger age group. From the sample of MU, as reported in Table 4, a majority of respondents had the educational background of Master’s degree (91.3%, Z= 6.5). Furthermore, a majority (82.5%, Z=4.93) of the sample academics and researchers from the MU had an academic rank of lecturer.

TABLE 4. Academic Rank and Educational Background of Sample Respondents of Researchers and Academics of MU

		Lecturer	Assistant Professor	Associate Professor
Academic Rank	Frequency	85	14	4
	%	82.5%	13.6%	3.9%
		Masters	PhD	Professor
Educational Background	Frequency	94	9	0
	%	91.3%	8.7%	0

Source: Own analysis, 2017

4.2. Results Pertinent to Research Objective One

4.2.1. The Status of UIL: From the Perspective of Manufacturing Firms

From the perspective of manufacturing firms, the researcher asked the sample of manufacturing firms whether they had linkage with the MU. As a result, from the total of 140 sample firms, 58.8% of the manufacturing firms had linkage with the MU; in the meanwhile, 41.2% of the manufacturing firms did not have any linkage with the MU. Furthermore, to measure the intensity of interaction, the researcher asked the manufacturing firms that had linkage with the MU, to indicate the level of interaction. Hence, a majority of the manufacturing firms (66.7%, Z = 2.23) believed that the intensity of interaction was low.

However, there were substantial sectoral variations in the level of interaction. Even when the total figures were low, examining the examination of the cross-tabulation of firm size and linkage with the MU in Table 5 show that there were more medium and small size firms that had linkage with the MU than micro manufacturing firms. In other words, there was a positive relationship between firm size and linkage with the MU. Thus, 31.1% of the firms in this study were micro manufacturing firms and there were 87 manufacturing firms that had linkage with the MU. In addition, the information collected from the key informants of MU (i.e., interviewees) indicated that the exposure, capacity, and resources of the firms affected their interactions with academics and researchers. The interviewees also indicated that there is an information barrier with regard to the resources, skill and technology available within the university.

TABLE 5. Linkage with MU Firm Size Cross-Tabulation

			Linkage with MU		Total
			No	Yes	
Firm Size	Micro Firms	Count	38	8	46
		% within Firms Size	82.6%	17.4%	100.0%
		% of Total	25.7%	5.4%	31.1%
	Small Firms	Count	11	34	45
		% within Firms Size	24.4%	75.6%	100.0%
		% of Total	7.4%	23.0%	30.4%
	Medium Firms	Count	12	37	49
		% within Firms Size	24.5%	75.5%	100.0%
		% of Total	8.1%	25.0%	33.1%
	Large Firms	Count	0	8	8
		% within Firms Size	0.0%	100.0%	100.0%
		% of Total	0.0%	5.4%	5.4%
Total		Count	61	87	148
% within Firms Size		41.2%	58.8%	100.0%	
% of Total		41.2%	58.8%	100.0%	

Source: Own analysis, 2017

4.2.2. The Status of UIL: from the Academics and Researcher Perspective

With regard to the academics and researchers' linkage with manufacturing firms, a majority of the respondents (67 percent, Z=2.476) did not have any linkage with the manufacturing firms as shown in Table 6. Furthermore, regarding the involvement of academics and researchers in innovation activities, a majority (81.6 percent, Z=4.78) of the respondents was not actively engaged in innovation activities as indicated in Table 6. Table 5 also shows that those academics and researchers that engaged in innovative activities had more interest to interact with manufacturing firms than the others.

TABLE 6. Linkage with Manufacturing Firm's Engaged in Innovation Activities Cross-Tabulation

			Engaged in innovation activities		Total
			No	Yes	
Linkage with manufacturing firms	No	Count	64	5	69
		% within linkage with manufacturing firms	92.8%	7.2%	100.0%
		% within involved in innovation activities	76.2%	26.3%	67.0%
		% of Total	62.1%	4.9%	67.0%
	Yes	Count	20	14	34
		% within linkage with manufacturing firms	58.8%	41.2%	100.0%
		% within involved in innovation activities	23.8%	73.7%	33.0%
		% of Total	19.4%	13.6%	33.0%

Total	Count	84	19	103
% within linkage with manufacturing firms	81.6%	18.4%	100.0%	
% within involved in innovation activities	100.0%	100.0%	100.0%	
% of Total	81.6%	18.4%	100.0%	

Source: Own analysis, 2017

From a total of 33 percent of academics and researchers that collaborate with manufacturing firms, 41.2% of them were engaged in innovative activities, while from a total of 67 percent of academics and researcher that did not interact with manufacturing firms, only 7.2 percent of them were engaged in innovative activities. This finding indicates that, though it is not surprising, the more the academics and researchers engaged in innovation activities, the more interactions they had with manufacturing firms. The information gathered from the interviewees also indicated that the involvement of academics in innovative activities was very low. The researchers and academics' capacity in R&D also mattered in creating strong interactions with manufacturing firms. Most of the manufacturing firms were engaged in routine activities and then they expected new innovation from researchers and academics; otherwise they would not have been interested in having interactions with universities. Generally, the responses from the interviewees showed that the status of linkage between the manufacturing fims and the MU was very low.

4.3. Results Pertinent to Research Objective Two

The firm level characteristics that may determine the intensity of firms' interactions with universities are: firm size, firm age, in-house R&D, and government support as the explanatory variables to predict the intensity of interaction between manufacturing firms with the MU. In this study, ordinal variables (with five points level of measurement) were considered as continuous variables (Newsom, 2013).

In this regard, Table 7 reports the descriptive statistics and the Spearman's rho correlations coefficients showing the degree of association among the variables. Table 7 also shows that the explanatory variables were significantly correlated with the dependent variables, which was firms' intensity of interaction with the MU (FIIMU). As a part of the regression analysis, the problem of multicollinearity was checked and the variance of inflation factor (VIF) was below 10 and the Cronbach alpha was 0.65.

TABLE 7. Descriptive Statistics for Determinants of Firms Intensity of Interaction with MU

		Mean	Std.	1	2	3	4	5
1	Startup (firm age)	0.28	0.45	1				
2	Firm Size	1.05	0.47	-0.465**	1			
3	In-house R&D	0.07	0.26	-0.168	0.436**	1		
4	G-support	0.84	0.37	0.270*	0.008	0.119	1	
5	FIIMU	2.47	1.31	-0.541**	0.610**	0.445**	0.149	1

Source: Own analysis, 2017
*Note: **. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

TABLE 8. Regression Results for Firm's Intensity of Interaction with MU

Independent Variables	Dependent Variable: Firm's Intensity of Interaction with MU (FIIMU)	
	Model_1	Multicollinearity (VIF)
Constant	0.920* (0.416)	
Startup	-0.971*** (0.257)	1.291
Firm Size	0.988** (0.348)	2.782
In-house R&D	0.830 (0.630)	2.496
Government Support	0.868** (0.292)	1.125
R2	0.506	
Adjusted R2	0.482	
F	21.024	
Sig.	0.000	
No. of observation (N)	87	

Source: Own survey of analysis of 2017
*Note: - ***.Significance level at 0.1%; **. Significance level at 1%; *.Significance level at 5%; Data in the parenthesis are the corresponding standard errors; N (87) represents those firms that interact with the MU*

Table 8 presents the results of multiple linear regression analysis. In general term the specifications of econometric considered have acceptable predictive power. The F value (21.024) with its p-value, which is equal to 0.000, suggests rejection of the null hypothesis that all regression coefficients are equal to zero with a significance level of 1%. This means that the model is adequate and the intensity of interaction with the MU is jointly and significantly determined by those explanatory variables that are included in the model. The coefficient of determination (R2) is 0.506; this tells us that 50.6% of the change in the intensity of interaction between manufacturing firms and the MU is attributed to the effect of variables such as firm age, firm size, in-house R&D and government support. Hence, the result shows us that startup (firm age), firm size, and government support have a significant effect on the intensity of interaction with the MU.

The positive sign for the coefficient of the variable firm size indicates that the larger firm's size is (in terms of human resources), the more will be the firms' interaction with the MU. This is supported by the studies of Cohen, et al. (2002), Segarra-Blasco and Arauzo-Carod (2008), and Eom & Lee (2010). The negative sign for the coefficient of startup indicates that older firms are more likely to interact with the MU compared to younger firms (startups). However, this finding is not consistent with the empirical studies provided by Cohen, et al. (2002). The positive sign for the third coefficient of the variable representing government support indicates that the more firms supported by the government, the more they form linkage with the MU. This finding may support a view that the government of Ethiopia designs a policy and strategy in science and technology to support and motivate the individual innovators and research.

Hence, in Tigray Regional State, there is an annual award of science and technology which is organized by the government to support and motivate outstanding innovators and researchers. This supports the studies of Eom & Lee (2010), and Mohnen & Hoareau (2003). The regression result for the variable of in-house R&D did not have any significant effect on firms' intensity of interaction with the MU. This might be due to a small sample size of the manufacturing firms engaged in in-house R&D activities.

Therefore, the fitted model that shows the causal relationship between the explanatory variables such as startups (X_1), firm size (X_2), in-house R&D (X_3) and government support (X_4) and firms' intensity of interaction with the MU (Y), which is the dependent variable, is expressed as follows:

$$Y = 0.92 - 0.971\ X_1 + 0.988X_2 + 0.83X_3 + 0.8686X_4$$

As a conclusion, the variables of firm size; firm age and government support do have a significant impact on firms' intensity of interaction with the MU. This implies that the variables are the causes of the low level of interaction with the MU in knowledge and technology transfer.

4.4. Results Pertinent to Research Objective Three

In this section, this study examined the effect of the intensity of interaction on innovation performance of manufacturing firms in terms of process and product innovation. Table 9 indicates a significant spearman's rho correlations coefficient among the explanatory variables and between the explanatory variables and the dependent variable that is product and process innovation. In the regression analysis, the explanatory variable of interest is intensity of interaction. However, the model controls the possible effects of other independent variables in order to test the cause-effect relationship between the intensity of interaction with the MU and the innovation performance of manufacturing firms.

TABLE 9. Descriptive Statistics for Determinants of Firm's Innovation Performance

		Mean	Std.	1	2	3	4	5	6	7	8	9	10	11	12
1	Startups	.21	.409	1											
2	Firm Size	1.14	.578	-.411**	1										
3	In-house R&D	.11	.320	-.183	.542**	1									
4	G-support	.85	.361	.216	.033	.151	1								
5	FIIMU	2.77	1.339	.353**	.623**	.550**	.270	1							
6	Co-customers	2.68	1.529	-.050	.190	.262	.417**	.305*	1						
7	Co-other group	2.98	1.308	.040	.271*	.416**	.148	.132	.466**	1					
8	Co-suppliers	2.51	1.409	-.213	.508**	.518**	.164	.438**	.454**	.610**	1				
9	Co-PRI	2.58	1.434	-.105	.316*	.494**	-.021	.153	.197	.358**	.295*	1			

10	Co-consultants	2.81	1.401	.073	.196	.455**	.320*	.250	.601**	.738**	.545**	.323*	1		
11	Process Innovation	3.23	1.396	-.020	.358**	.470**	.370**	.299*	.671**	.729**	.434**	.399**	.726**	1	
12	Product Innovation	3.09	1.290	-.008	.391**	.529**	.366**	.311*	.694**	.686**	.478**	.443**	.698**	.947**	1

Source: Own analysis, 2017

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

As indicated in Table 10, the researcher conducted a hypothesis testing to confirm the model fitness. To start with the regression results of process innovation the specifications of econometric considered have acceptable predictive power. The F value (16.498) with the p-value, which is equal to 0.000, suggests rejection of the null hypothesis that all regression coefficients are equal to zero with a significance level of 1%. This means that the model is adequate and the performance of firms' process innovation is jointly and significantly determined by those explanatory variables that are included in the model. The coefficient of determination for the fourth model (R2) is 0.797; this indicates that 79.7% of the change in the performance of firms process innovation is attributed to the effect of the explanatory variables included in this model.

The effect and significance of each of the explanatory variables were also tested as the model was adequate. As a result, in the first model the effect of the firms' intensity of interaction with the MU was checked and initially it had a positive and significant effect on the performance of firms process innovation at a conventional level of 1% (p-value = 0.014 < 0.05). However when we added the other explanatory variables in model-2 and model-3 and controlled them, the effect of firms' interaction with the MU on the relevant firms' performance of process innovation become insignificant. In the second model, G-support had a positive and significant effect on the performance of firms' process innovation. Hence, by keeping constant the other explanatory variables the result in the third aggregated model showed us that firms' intensity of interaction with the MU did not have any significant effect on firms' process innovation.

With regard to the performance of firms' product innovation in Table 10, the effect of firms' intensity of interaction with the MU on the performance of firms' product innovation was analyzed. To test the adequacy of the model, the hypothesis testing was conducted. Hence, the specification of the econometric considered has acceptable predictive power. The F value (16.126) with p-value, which is equal to 0.000, suggests rejection of the null hypothesis that all regression coefficients are equal to zero with a significance level of 1%. This implies that the model is useful and the performance of firms' product innovation is jointly and significantly determined by those explanatory variables that are included in the model. Further, the coefficient of determination (in model-7, Table 10) (R2) is 0.793; this indicates that 79.3% of the change in the performance of firms product innovation is attributed to the effect of the explanatory variables included in this model.

As reported in model-5 under Table 10, the relevant firms' intensity of interaction (FIIMU) with the MU alone explains the firms' performance of product innovation by 13.6%; while in model-6 and model-7 it increases to 42% and 79.3% respectively when we added other explanatory variables. The researcher also tested the effect and significance of each of the explanatory variables. As a result, in model-5 the effect of the firms' intensity of interaction with the MU was checked and initially it had a positive and significant effect on the performance of firms' product innovation at a conventional level of 1% (p-value = 0.007 < 0.05). However, when we added the other explanatory variables in model-6 and model-7 and controlled them the effect of firms' interaction with the MU on the relevant firms' performance of product innovation become insignificant. In model-6 firm size and G-support had a positive and significant effect on the performance of firms' product innovation. In the meanwhile, in model-7 the effects of G-support become insignificant whereas the effect of firm size remained to be significant. In addition, the explanatory variables of 'cooperation with customers'; 'cooperation with other groups'; and 'cooperation with suppliers' were found to have a positive and significant effect on firms' performance of product innovation.

TABLE 10. Regression Results Concerning the Effect of Firm's Intensity of Interaction on Firm's Innovation Performance

Independent variables	Dependent Variable: Process Innovation			Dependent Variable: Product Innovation			
	Model_2	Model_3	Model_4	Model_5	Model_6	Model_7	VIF
Constant	2.254*** (0.422)	1.314 (0.656)	-0.294 (0.455)	2.109*** (0.385)	1.275* (0.572)	-0.076 (0.425)	
FIIMU	0.351** (0.137)	-0.096 (0.175)	0.033 (0.108)	0.355** (0.125)	-0.098 (0.153)	-0.011 (0.101)	2.23
Startups		0.097 (0.452)	-0.100 (0.267)		0.229 (0.394)	0.148 (0.257)	1.35
Firm size		0.888 (0.508)	0.732* (0.324)		0.930* (0.886)	0.799** (0.302)	3.73
In-house R&D		0.780 (0.865)	-0.221 (0.551)		0.940 (0.754)	0.057 (0.514)	3.29
G-support		1.248* (0.503)	0.477 (0.325)		1.032** (0.439)	0.336 (0.303)	1.47
Co-customers			0.360*** (0.088)			0.379*** (0.082)	1.91
Co-other group			0.534*** (0.137)			0.344** (0.128)	3.41
Co-suppliers			0.301** (0.110)			0.201* (0.102)	2.54
Co-PRI			0.025 (0.085)			0.090 (0.079)	1.57
Co-consultants			0.129 (0.129)			0.070 (0.121)	3.49
R2	0.113	0.348	0.797	0.136	0.420	0.793	
Adjusted R2	0.096	0.278	0.749	0.119	0.358	0.744	
F value	6.516	5.013	16.498	8.028	6.803	16.126	
Sig.	0.014	0.001	0.000	0.007	0.000	0.000	
N	53			53			

Source: Own analysis, 2017
*Note: ***. Significance level at 0.1%; ** Significance level at 1%; * Significance level at 5%*
: Data in the parenthesis are the corresponding standard errors
: N (53) represents the innovative firms only

The result supports the studies of Tether (2002) (as cited in Sanchez, and Herrera, 2010), Miotti & Sachwald (2003), and Laursen & Salter (2004). The authors argued that firms creating collaboration with customers, competitors and suppliers perform a high degree of efficiency in their new product innovation or new process innovation compared to other types of collaboration. However, it is different from the empirical studies of Belderbos, Carree, & Lokshin (2004b), which found that firms that have interactions with universities in their R&D activities show large sales growth due to new products than firms that do not have interactions with universities in their R&D activities. Similarly, Vega, J., et al. (2010) found that establishing linkage with universities or research institutions has a positive effect on the share of sales of new products in the markets.

To conclude, the firms' intensity of interaction with the MU did not have any effect either on process innovation or product innovation when we controlled other internal and external factors that affected the firms' innovation performance. The multiple regression result that showed the cause-effect relationship between the performances of firms' process innovation (Y), i.e., the dependent variable and the independent variables such as firms' intensity of interaction with university (X1), firms age (X2), firms size (X3), in-house research and development (X4), government support (X5), firms cooperation with customers (X6), firms cooperation with other groups (X7), firms cooperation with suppliers (X8), firms cooperation with public research institutions (X9) and firms cooperation with consultancies (X10) were provided by the last aggregated model 3 as follows:

$$Y = -0.294 + 0.033 X_1 - 0.19X_2 + 0.732 X_3 - 0.221X_4 + 0.477X_5 + 0.36 X_6 + 0.534X_7 - 0.301X_8 + 0.025X_9 + 0.129 X_{10}$$

Similarly, the multiple regression result that showed the cause-effect relationship between the performances of firms' product innovation (Y), i.e., the dependent variable and the independent variables such as firms' intensity of interaction with university (X1), startups (X2), firms size (X3), in-house research and development (X4), government support (X5), firms cooperation with customers (X6), firms cooperation with other group (X7), firms cooperation with suppliers (X8), firms cooperation with public research institutions (X9), firms cooperation with consultancies (X10) were provided by the last aggregated model 3 as follows:

$$Y = -0.076 - 0.011X_1 + 0.148X_2 + 0.799X_3 + 0.057X_4 + 0.336X_5 + 0.379X_6 + 0.344X_7 - 0.201X_8 + 0.09X_9 + 0.07 X_{10}$$

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

To deepen our understanding of the role of UIL in enhancing firms' innovation performance and in the overall technological competitiveness and economic development of the region, this study examined the relevant manufacturing firms' intensity of interaction with the MU and its effects on product and process innovation performance of manufacturing firms. Therefore, this study found that the status of linkage and intensity of interaction between the relevant manufacturing firms and the MU was at its infancy stage. The firms' size, firms' age, and government support were the main factors that determined the manufacturing firms' intensity of interaction with academics and researchers of the MU; and, the firms' intensity of interaction with the MU did not significantly affect the process and product innovation performance of the manufacturing firms keeping other variables constant.

Hence, though the national and regional policy and strategy framework exist to stimulate the UIL, all the principal stakeholders such as university, government and the industry did not place the effective mechanism and institutional modality to implement the policies and strategies of UIL in the ground. Hence, the problem of ineffectiveness of the UIL is due to weak implementation of the policies and strategies. In addition, the awareness gap and the lack of commitment of the stakeholders and practitioners is another problem. The academic staffs of the university are also highly engaged with heavy teaching and learning processes.

5.2. Recommendations

- ► Policy makers should focus on strengthening the internal technological capabilities and external absorptive capacity of the industries as these features have the crucial role and impact on the social and economic transformational plan of the region as well as the country.
- ► The STI policy should go beyond the existing simple support for the interaction between the university and industry. It should also place mechanisms to augment industries' trust on the R&D conducted by universities to resolve gaps in the relevant industries. This can be realized by placing sufficient incentives for researchers and innovators, providing sufficient fund for R&D and innovation activities and clearly articulating the R&D activities carried out to be inline with existing gaps and problems of the industries.
- ► Platforms should be created for periodically transferring knowledge and technological information between these alliances and others. This can help both parties and other stakeholders in order to actively participate, understand and implement the STI policies and strategies of UIL for effective interactions between them. This can be realized by awareness creation, motivating industries, and motivating academics and researchers.
- ► It should place regional knowledge and technology transfer guidelines. This might help to reduce unnecessary bureaucracy and make easy for technology transfer to end users. The STI policies of UIL should be also integrated with university policies in order to effectively promote the commercialization of their knowledge and technology.

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