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**From Knowledge Sourcing to Firms' Productivity:  
Investigating Innovation Value Chain of Indonesian  
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## **From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms**

**Purpose** – The study investigates the innovation value chain (IVC) that encompasses knowledge sourcing, transformation, and exploitation activities among Indonesian manufacturing firms by using data from the Indonesia Innovation Survey (IIS).

**Design/methodology/approach** – A simple approach of single equation Probit model, Logit regression, and Tobit regression are used in the first, second, and third stages of IVC consecutively.

**Findings** – The study finds the existence of a synergistic relationship between internal and external sources of knowledge as well as among external sources of knowledge. In terms of the second link of the IVC, internal R&D plays an important role that positively influences knowledge transformation into all types of innovation and innovation success. External knowledge that has a similar pattern in shaping innovation mainly comes from market/commercials and open sources. Scientific institutions tend to contribute to innovation in a negative manner, and few positive impacts on process innovation are observed from government R&D and non-profit R&D institutions. Informal knowledge is more likely to influence technological than non-technological innovation.

**Originality** – This study is different from the previous IVC studies due to the following reasons. First, in this study a broader source of knowledge is tested. Second, wider innovation (i.e. technological and non-technological innovation) is also assessed.

**Research limitations** – Since Indonesia has only three waves of innovation surveys i.e. 2008, 2011, and 2014, hence update insight taken from the survey is not available.

**Keywords:** innovation value chain, productivity, manufacturing firms, Indonesia

## 1. Introduction

Interest in innovation studies has been increasing in general, with no exception in the case of developing countries. However, innovation in the context of developing countries cannot necessarily be explained using the same concepts applied to developed countries, because developing countries are subject to different challenges in terms of the capital, infrastructure, intellectual and analytical foundations of innovation system analysis (Choi and Williams, 2013; Lorentzen, 2010; Metcalfe and Ramlogan, 2008; Mytelka, 2000). Da Silveira (2001) emphasises that it is important to study innovation in developing countries because most theories, approaches, mechanisms and technical changes associated with innovation that affect managerial practices and skills were developed based on evidence from developed countries. The relevancy and adaptability of any model, framework or construct of innovation studies that was developed, built and tested in developed countries needs to be re-evaluated prior to being implemented in developing countries. This study aims to extend previous studies of innovation value chains (IVC) conducted in developed economies, such as North America and Europe (Hansen and Birkinshaw, 2007), Ireland (Roper et al., 2008) and the UK (Ganotakis and Love, 2012; Love et al., 2011), by using innovation survey data of manufacturing firms in the developing economy of Indonesia. As suggested by Roper, Du, and Love (2008), it is of considerable interest to compare IVC studies across different national boundaries.

According to Hansen and Birkinshaw (2007, p. 122), the IVC is “a sequential, three-phase process that involves idea generation, idea development, and the diffusion of developed concepts”. The IVC concept was derived from innovation research projects which interviewed 130 executives from 30 multi-national firms in North America and Europe. Extending Hansen and Birkinshaw’s (2007) work, innovation survey based IVC studies were conducted by other scholars (Doran and O’leary, 2011; Ganotakis and Love, 2012; Love et al., 2011; Roper et al., 2008; Roper and Arvanitis, 2012). Following these scholars, this study aims to investigate the IVCs of knowledge sourcing, transformation and exploitation activities performed by Indonesian manufacturing firms. This study focuses on the IVC in Indonesia context because to date, no previous study has looked at the IVC based on data derived from innovation surveys of Indonesian firms. This study intends to address previous studies’ imbalance and to provide a new empirical contribution to the understanding of IVC activity based on a firm-level analysis of Indonesian manufacturing firms. From a practical perspective, findings of this study are expected to be used by policy makers at the government and firm levels to identify innovation activities as well as to detect any weak links in the IVC.

## 2. Conceptual Foundation and Hypotheses Development

### 2.1. Knowledge sourcing activity

In the first link of the IVC, knowledge is sourced from both inside and outside the firms (Hansen and Birkinshaw, 2007). Therefore, the main task in this activity is to assemble the knowledge used for innovation (Roper et al., 2008). In terms of the degree of externalisation, Frenz and Ietto-Gillies (2009, p. 1126) explain that internal R&D is the knowledge generated inside a firm, while knowledge from external R&D, from informal and open networks, and from cooperation activities are “external to the enterprise to various degrees, depending on their ownership and the contractual structures of the relationship between our enterprise and the other party or parties to the transfer”. Knowledge from external linkages can be differentiated based on the form of access, whether informal or formal, and the knowledge content being transferred (Monjon and Waelbroeck, 2003). Storper (1997) classified formal cooperation as that which involves more formalised interactions among firms. In contrast, informal interactions, which normally involve informal relations, “might explain the spatial concentration of innovative industries and activities” (Tödtling et al., 2009, p. 61).

Informal linkages can include “personal contacts or communities of practice or simply arise in the normal course of business”, while formal linkages “can be organised by business organisations such as chambers of commerce, research associations, technology services companies, consultants, universities or public research organisations or sponsored by local, regional or central governments” (OECD/Eurostat, 2005, p. 79). Internal firm capabilities are necessary to access and absorb knowledge from informal linkages, while formal cooperation activity is associated with the use of knowledge resulting from access to resources and innovative capabilities of partners (Freitas et al., 2011).

Several previous studies have investigated the interaction among sources of knowledge used for innovation activities. One of the main discussions in these studies is whether complementary or substitution relationships exist between internal and external knowledge sourcing strategies in innovation activities. Some scholars argue that studies of such relationships remain unclear and inconclusive (Hagedoorn and Wang, 2012; Schmiedeberg, 2008). On the one hand, some studies reveal a complementary relationship between internal R&D and external knowledge in knowledge sourcing activities (Cassiman and Veugelers, 2002; Hagedoorn and Wang, 2012; Roper et al., 2008; Schmiedeberg, 2008; Veugelers and Cassiman, 2005). On the other hand, other empirical studies identify a substitution relationship in these activities (Hess and Rothaermel, 2011; Laursen and Salter, 2006; Love and Roper,

2001; Xu et al., 2013). In this study, the term ‘complementarity’ is used interchangeably with ‘synergistic’, which means that implementation of one strategy increases the marginal returns from another (Milgrom and Roberts, 1995).

Turning to the Indonesia context, there are a few insights related to synergistic or substitution strategies in innovation activities performed by Indonesian firms. In general, as in any other developing country, advanced knowledge of technology is accessed by importing from the advanced industrial countries, and the international technology transfer process mostly takes place in the private sector (Wie, 2005) because public support for R&D is minimal (Hill and Tandon, 2010). Wie (2005) identifies two major channels of international technology transfer to Indonesia: (1) a formal or market-mediated channel that includes FDI; technology licensing agreements; imports of capital goods; foreign education and training; turnkey plants; and technical consultancies, and (2) an informal or non-market mediated channel composed of technical assistance by foreign buyers and foreign vendors; copying or reverse engineering; information from trade journals; and technical information services provided by public agencies.

Apart from imported technology, the use of various sources of knowledge by Indonesian firms has also been studied. For example, Indonesian small furniture firms tend to generate knowledge through in-house learning by experimentation as well as from customers (Van Geenhuizen and Indarti, 2005). Cooperative activity was also found positively related to innovation in a cluster of Indonesian small food processors (Najib and Kiminami, 2011) and small scale roof tile firms (Sandee and Rietveld, 2001). Collaboration within Indonesian small firm clusters is also effective for sharing costs and risks (Sandee and Rietveld, 2001). As an example of an Indonesian high-technology industry, the automotive industry develops innovation mainly from inside the organisation and competitors are the main source of external knowledge to support the creation of new products in a competitive market (Aminullah and Adnan, 2012). On the other hand, universities and public research institutions contribute little external knowledge to the Indonesian automotive industry (Aminullah and Adnan, 2012). Although literature that discusses the involvement of external actors as sources of knowledge in the innovation process is scarce, a synergistic relationship between internal and external knowledge may exist to some extent. Based on this, a hypothesis is proposed:

*H1 In knowledge sourcing activities, a synergistic relationship exists between internal R&D and external sources of knowledge.*



## 2.2. Knowledge transformation activity

In the second link of the IVC, different sources of knowledge used in the innovation activities are transformed or converted into different types of innovation (Hansen and Birkinshaw, 2007; Roper et al., 2008). This involves innovation or knowledge production in which the success of knowledge transforming activities relies on the firms' knowledge sources (Griliches, 1992; Love and Roper, 1999). Therefore, the main issue addressed in this stage is the empirical assessment of the comparative impact of various sources of knowledge (e.g. R&D activities and informal knowledge) on different types of innovations (e.g. product, process, organisational, and marketing innovations).

Innovation is a complex phenomenon and normally firms use several sources of information simultaneously (Freitas et al., 2011). The link between various sources of knowledge and the adoption of different innovations has been investigated (Amara and Landry, 2005; Srholec and Verspagen, 2012; Tödting et al., 2009). Previous scholars (Amara and Landry, 2005; Tödting et al., 2009) find that advanced innovations that are new to the market need a higher level of extended internal R&D, patent and more knowledge from universities, and research organisations to stimulate and support them. Meanwhile, less advanced innovations, such as business services (Tödting et al., 2009) and market innovations (Amara and Landry, 2005), require knowledge links with less research-based input.

A majority of previous IVC studies in advanced economies reveal that internal R&D activities are positively and significantly associated with innovation adoption (Doran and O'leary, 2011; Ganotakis and Love, 2012; Roper et al., 2008; Roper and Arvanitis, 2012). Apart from the IVC studies, other studies in industrialised countries at the firm level show positive links among R&D, innovation and productivity (Griffith et al., 2004, 2006; Mohnen et al., 2006). Evidence from developing and newly industrialised countries also shows a positive association between R&D, innovation and productivity, with examples including Argentina (Chudnovsky et al., 2006), Malaysia (Hegde and Shapira, 2007), China (Jefferson et al., 2006) and Taiwan (Aw et al., 2011). Firms that have higher levels of investment in R&D are more likely to introduce technological innovation as was found in Brazil (Raffo et al., 2008) and Chile (Alvarez et al., 2010). Based on this, a second hypothesis is proposed:

*H2a Internal R&D positively influences innovation and innovation success.*

The use of informal knowledge as input for the innovation process comes mainly from external information sources gained without any formal arrangements (Garcia-Torres and Hollanders, 2009). The informal link between certain actors and types of innovation has been

investigated in previous studies. Past subjects of investigation have included the role and involvement of *customers* in the innovation process (Franke and Schreier, 2002; von Hippel and Katz, 2002; Joshi and Sharma, 2004); key *suppliers* and their roles in product innovation development (Amara and Landry, 2005; Nieto and Santamaría, 2007; Smith and Tranfield, 2005); the role of *competitors* in knowledge transfer and innovation (Malmberg and Maskell, 2002); and fostering advanced technological innovation (Gnyawali and Park, 2011). Open source information and knowledge from *scientific publications* proves beneficial for firms (Caloghirou et al., 2004).

In the case of Indonesian firms, studies of informal knowledge usage for innovation have been conducted and the results show that different sources of external knowledge contribute to diverse benefits for the firms. External actors apart from the market, for example *foreign suppliers*, have very important roles in the development of technological capability and innovation in Indonesian firms (Wie, 2005). *Foreign buyers* also contribute technical and managerial assistance for many Indonesian SMEs (Wie, 2005). *Competitors* support the development of new products in the competitive market (Aminullah and Adnan, 2012). However, there is no single study in the Indonesia context that links diverse knowledge of innovation and adoption of different types of innovation with innovation success achieved by Indonesian manufacturing firms. In this study, informal knowledge derived from the IIS 2011 is grouped into *market/commercials*, including suppliers, customers, competitors, consultants and commercial labs; *science institutions*, including universities, polytechnic institutes, government R&D and non-profit R&D; *associations*, including industry associations, investors and entrepreneurs; and *open sources*, including events, scientific publications and the internet. Therefore, another hypothesis is proposed:

*H2b Different levels of informal knowledge influence innovation adoption differently.*

### 2.3. Knowledge exploitation activities

The final link in the IVC is knowledge exploitation that generates value for the firm. Starting with the work of Geroski, Machin, and Reenen (1993), previous scholars such as (Ganotakis and Love, 2012; Love et al., 2011; Roper et al., 2008) argue that, in the knowledge exploitation stage, firm performance is affected by innovation output as the result of codified knowledge gained through knowledge sourcing activities. They state that innovation output needs to be determined prior to knowledge exploitation. Therefore, the main interest at this stage is how firms gain business productivity or profitability from the exploitation of adopted innovation.

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3 In this study, productivity (indicated by total sales/number of employees) is used to measure  
4 how innovation affects overall firms' performance. Prior IVC studies find that innovation  
5 output in the form of product and process innovation significantly and positively influences  
6 innovation performance as measured by sales and employment growth (Ganotakis and Love,  
7 2012; Roper et al., 2008). Surprisingly, both a negative impact (Roper et al., 2008) and no  
8 relationship (Ganotakis and Love, 2012) of product innovation success on productivity have  
9 been found. Therefore, in this study, the involvement of wider innovation, is expected to  
10 provide a different view compared to previous IVC studies. Hence, an additional hypothesis is  
11 proposed:

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19 *H3 In knowledge exploitation activity, innovation and innovation success positively affects*  
20 *a firm's performance.*  
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### 22 23 24 **3. DATA AND METHODS**

#### 25 26 **3.1. Data**

27 The empirical analysis in this study is derived from the Indonesia Innovation Survey (IIS) 2011  
28 that covers 2009-2010. In terms of firm size, the IIS 2011 surveyed only medium (20-99  
29 employees) and large (more than 99 employees) Indonesian manufacturing firms. The surveyed  
30 firms are classified based on the International Standard Industrial Classification (ISIC) Rev.  
31 3.1. Multi-stage random sampling was used to collect data from 1,500 firms and a total of 1,375  
32 questions were successfully collected. Of the returned questionnaires, 1,179 were usable. Face  
33 to face interviews with R&D or production managers were conducted to collect the data. The  
34 IIS 2011 used the Oslo Manual (OECD/Eurostat, 2005) as the guideline for collecting and  
35 interpreting innovation data and adjustments were made to facilitate innovation activities in  
36 Indonesia that may differ from those in developed economies. For example, the innovation  
37 activity and internal sources of knowledge variables in the IIS 2011 have broader categories  
38 than the same variables in the UK CIS. Unfortunately, Indonesia has three waves of innovation  
39 survey only i.e. 2008, 2011, and 2014 and no continuity of the survey. As a result, there is no  
40 update on the innovation survey.  
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#### 51 52 53 **3.2. Methods**

54 In the knowledge sourcing activity, the main issue that is addressed is the behaviour of  
55 Indonesian manufacturing firms in sourcing knowledge from various sources. More  
56 specifically, synergistic or substitution relationships among the three groups of knowledge are  
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3 tested. Following Roper, Du, and Love (2008), a simple approach of single equation probit  
4 model is used to test Hypothesis 1 with the dependent variables being a series of sources of  
5 knowledge. This allows for a detailed analysis of the impact of 17 various knowledge sources.  
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9 In the knowledge transformation link, an innovation or knowledge production function  
10 is used to model the knowledge transformation activities (Geroski, 1990; Harris and Trainor,  
11 1995). Logit regression is used to test Hypotheses 2 with the dependent variables being  
12 different types of innovation. Tobit regression is employed when the dependent variable is  
13 innovation success (i.e. the proportion of sales derived from product innovation new to the  
14 market) that has both upper and lower bounds (0 to 100%). In the knowledge exploitation stage,  
15 OLS regression is used to test Hypothesis 3, and the dependent variable is the firms'  
16 productivity, which is a measure of how innovation affects overall firm performance.  
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#### 24 **4. RESULTS**

##### 25 4.1. Descriptive statistics

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27 Table 1 presents descriptive statistics for the IIS 2011. Following the 3<sup>rd</sup> Oslo Manual, the IIS  
28 2011 defines innovation as “the implementation of a new or significantly improved product  
29 (good or services), or process, a new marketing method, or a new organisational method in  
30 business practices, workplace organisation or external relations” (OECD/Eurostat, 2005, p.  
31 46). Based on the definition that covers broad range of possible innovations, the IIS 2011 then  
32 defines an innovative firm as a firm that performed any product, process, organisational or  
33 marketing innovation from 2009 to 2010. According to Table 1, the mean of productivity (total  
34 sales/number of employees) is approximately IDR 1.3 trillion. The highest proportion is  
35 marketing innovation (42.8%), while the lowest is organisational innovation (31%). The mean  
36 of product innovations that are new to the market is lower than the same innovations that are  
37 new to the firm, and account for 28.8% versus 35.8% respectively. The mean of innovation  
38 success as the proportion of launched products new to the market accounted for 8.43%. The  
39 fact that marketing innovation outnumbered other innovation is typical in developing countries  
40 that tend to focus on the market rather than on the technology (Wamae, 2009).  
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52 Turning to knowledge sourcing activities, approximately 29% of firms report generating  
53 their own knowledge from internal R&D, while only 3.2% of firms source knowledge from  
54 external R&D. Firms report market/commercials as more important than other sources of  
55 knowledge, including suppliers, competitors and customers which represent 19.1%, 22.5% and  
56 34.4%, respectively. These are followed by open sources (internet) and associations  
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3 (entrepreneurs) that account for 11.3% and 14.6%, respectively. In contrast, less than 5% of  
4 firms source science-based knowledge from universities, polytechnic, government and non-  
5 profit R&D institutions.  
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8 The mean of firm size as indicated by the number of employees is nearly 175 people. Of  
9 surveyed firms, mature firms (more than 20 years) dominate in the IIS 2011 data. The  
10 proportion of national firms is significantly higher at 90%, compared to multi-nationals and  
11 joint ventures, at 6% and 4.2%, respectively. Most of the surveyed firms operate in their  
12 headquarters, not in the manufacturing plants (91% versus 9.2%). Labour education levels are  
13 low. More than 50% of employees have no high school degree, which indicates the low level  
14 of education of the firms' human resources. In contrast, less than 5% of employees hold  
15 undergraduate degrees.  
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Table 1 Descriptive statistics

VARIABLES	Obs.	Mean	SD	Min.	Max.
<b><i>Firm performance</i></b>					
Productivity (total sales/number of employee)	1179	1312.096	8399.761	.088	125000
<b><i>Innovation performance</i></b>					
Innovation success (INNOVSUCCESS) (% <i>PRODINOV_NEW2MARKET</i> sales)	1179	8.43	16.99	0	100
<b><i>Innovation output</i></b>					
Product innovation (PRODINOV)	1179	.377	.485	0	1
Product innovation new to the market (PRODINOV_NEW2MARKET)	1179	.288	.453	0	1
Product innovation new to the firms (PRODINOV_NEW2FIRM)	1179	.358	.480	0	1
Process innovation (PROCINOV)	1179	.322	.468	0	1
Organisational innovation (ORGINOV)	1179	.310	.463	0	1
Marketing innovation (MKTGINOV)	1179	.428	.495	0	1
<b><i>R&amp;D Activities</i></b>					
Internal R&D-R&D activities (IN_RD)	1179	.292	.455	0	1
External R&D-R&D activities (EX_RD)	1179	.032	.177	0	1
<b><i>Market agents (highly important)</i></b>					
Suppliers (SUPPLIERS)	1179	.191	.393	0	1
Customers (CUSTOMERS)	1188	.344	.475	0	1
Competitors (COMPETITORS)	1179	.225	.418	0	1
Consultant (CONSULTANTS)	1179	.041	.198	0	1
Commercial labs (COMMLAB)	1179	.042	.200	0	1
<b><i>Science institutions (highly important)</i></b>					
University (UNIVERSITIES)	1179	.031	.174	0	1
Polytechnic (POLTECH)	1179	.027	.163	0	1
Government R&D institutions (GOV_RD)	1179	.041	.198	0	1
Non-profit R&D institutions (NONPROF_RD)	1179	.036	.185	0	1
<b><i>Associations (highly important)</i></b>					
Investors (INVESTORS)	1179	.091	.287	0	1
Industry Association (IND_ASSOC)	1179	.065	.247	0	1
Entrepreneurs (ENTREPRENEURS)	1179	.146	.353	0	1
<b><i>Open sources (highly important)</i></b>					
Events (EVENTS)	1188	.109	.312	0	1
Science Publication (SCIENCE_PUB)	1188	.067	.251	0	1
Internet (INTERNET)	1179	.113	.316	0	1
<b><i>Firms Resources</i></b>					
Size (number of employee)	1179	174.608	1318.078	20	32977
Firms' age (years)	1179	21.077	12.704	0	84
Export (%)	1179	9.726	25.106	0	100
Ownership National (OWN_NATIONAL)	1179	0.899	0.301	0	1
Ownership Multi National (OWN_MULTI)	1179	0.059	0.235	0	1
Ownership Joint Venture (OWN_JOINT)	1179	0.042	0.202	0	1
Operation Plant (OPS_PLANT)	1179	0.092	0.289	0	1
Operation Head Quarter (OPS_HQ)	1179	0.908	0.289	0	1
Education Under High school (EDU_UNDERHS) (%)	1179	56.247	36.423	0	100

Education High School (EDU_HS) (%)	1179	36.430	31.492	0	100
Education Diploma (EDU_DIPLOMA) (%)	1179	3.246	6.779	0	55
Education Under Graduate (EDU_UNDERGRAD) (%)	1179	4.077	8.623	0	90
Employees' proportion in R&D dept. (RD_STAFF) (%)	1179	2.986	6.717	0	57
Low technology (LOW_TECH)	1179	.735	.442	0	1
Medium-low technology (MEDLOW_TECH)	1179	.174	.379	0	1
Medium-high technology (MEDHIGH_TECH)	1179	.082	.275	0	1
High technology (HIGH_TECH)	1179	.009	.096	0	1

#### 4.2. Knowledge sourcing activity

Table 2 indicates a synergistic relationship between internal and external R&D and this in line with previous findings (Cassiman and Veugelers, 2002, 2006; Ganotakis and Love, 2012; Schmiedeberg, 2008). Firms are more likely to perform external R&D (EX\_RD) if they also generate their own knowledge from internal R&D (IN\_RD). The same relationship also exists between IN\_RD and external agents from market/commercials (CUSTOMERS, COMPETITORS and COMM\_LAB) and from associations (ASSOCIATIONS and ENTREPRENEURS). However, the firms interact less with external networks from science institutions and open sources. Firms also interact less with external actors if they already perform EX\_RD. Based on this finding, the first hypothesis is supported.

Turning to informal knowledge (see Table 2), it can be observed that firms that source knowledge from market/commercials tend to interact with other market/commercials networks, associations and open sources. However, these firms interact less with scientific institutions, with the exception that firms sourcing knowledge from COMM\_LABS tend to interact with UNIVERSITIES and GOV\_RD. Firms that source knowledge from SUPPLIERS and COMPETITORS are more likely to source from ASSOCIATIONS. In addition, firms tend to source knowledge from open sources if they already source from CUSTOMERS. To sum up, in the market/commercials groups, synergistic relationships tend to exist among market/commercials; between market/commercials and associations; and between market/commercials and open sources networks.

In relation to scientific institutions, a synergistic relationship can also be identified among the institutions and between the institutions and associations. However, there are few negative and significant associations, and these are shown only between POLTECH and INVESTORS and between UNIVERSITIES and SCIENCE\_PUB. This may indicate that firms that already source knowledge from POLTECH tend not to interact with INVESTORS, while

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3 firms that source knowledge from UNIVERSITIES tend to cite knowledge from  
4 SCIENCE\_PUB. Lastly, firms that source knowledge from associations and open source  
5 networks are more likely to interact with all external knowledge networks proportionally.  
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8 Turning to control variables, exporters tend to rely on knowledge that is sourced from  
9 SUPPLIERS and ENTREPRENEURS. Both national and multi-national firms are similar in  
10 that they have positive and significant associations with ENTREPRENEURS. In contrast, both  
11 national and multi-national firms have negative and significant associations with INVESTORS  
12 and the INTERNET. It is striking that HIGH\_TECH firms do not have positive associations  
13 with R&D activities. A speculative reason for this phenomenon is that these firms tend to  
14 import advanced technology from advanced countries as shown in Wie (2005) study. However,  
15 it is important to note that all the coefficient values among firm resources and a wide range of  
16 sources of knowledge tend to show weak relationships.  
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Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge)

INDEPENDENT VARIABLES	Model 1 IN RD	Model 2 EXT RD	Model 3 SUPPLIER	Model 4 CUSTOM	Model 5 COMPET	Model 6 CONSUL	Model 7 COMMLAB	Model 8 UNIVERSITY	Model 9 POLTECH
INTERNAL_RD	-	<b>.088**(.017)</b>	-.021 (.029)	<b>.059**(.026)</b>	<b>.045**(.023)</b>	.018 (.011)	<b>.023**(.011)</b>	<b>.019**(.009)</b>	.006 (.008)
EXTERNAL_RD <sup>1</sup>	<b>.568**(.098)</b>	-	.012 (.065)	-.032 (.060)	.021 (.051)	-.002 (.021)	.019 (.020)	-.003 (.016)	.010 (.013)
<i>Market/Commercials</i>									
SUPPLIERS	-.023 (.030)	.006 (.013)	-	.031 (.028)	-.005 (.026)	-.008 (.014)	<b>.025**(.012)</b>	-.003 (.011)	.005 (.009)
CUSTOMERS	<b>.077**(.028)</b>	-.006 (.012)	.041 (.029)	-	<b>.287**(.018)</b>	<b>-.023*(.014)</b>	.000 (.013)	.006 (.010)	-.003 (.009)
COMPETITORS	.044 (.030)	.005 (.011)	-.004 (.032)	<b>.329**(.022)</b>	-	<b>.031**(.012)</b>	.016 (.012)	-.003 (.010)	.006 (.008)
CONSULTANT	.081 (.063)	-.003 (.019)	-.043 (.066)	<b>-.158**(.063)</b>	<b>.109**(.047)</b>	-	<b>.072**(.016)</b>	.008 (.014)	.008 (.012)
COMMLAB	.085 (.063)	.031 (.019)	<b>.121*(.062)</b>	-.017(.066)	.050 (.051)	<b>.069**(.016)</b>	-	<b>.042**(.013)</b>	-.005 (.012)
<i>Science</i>									
UNIVERSITIES	<b>.176**(.076)</b>	-.027 (.026)	.0004 (.077)	.023 (.077)	-.075 (.063)	.020 (.020)	<b>.065**(.019)</b>	-	<b>.042**(.011)</b>
POLYTECHNIC	-.036 (.083)	.015 (.025)	.046 (.084)	-.134 (.085)	.018 (.062)	-.003 (.023)	-.016 (.024)	<b>.047**(.015)</b>	-
GOV_RD	-.013 (.071)	<b>-.051*(.029)</b>	-.014 (.078)	-.038 (.073)	-.025 (.057)	.001 (.021)	<b>.036*(.021)</b>	<b>.024*(.013)</b>	<b>.037**(.011)</b>
NON_PROFITRD	-.012 (.072)	<b>.048**(.023)</b>	-.034 (.077)	<b>.224**(.078)</b>	-.037 (.055)	.030 (.020)	.021 (.020)	.012 (.013)	<b>.019*(.010)</b>
<i>Associations</i>									
INVESTORS	.033 (.045)	<b>.024*(.014)</b>	.017 (.045)	.045 (.045)	.031 (.035)	.013 (.014)	-.001 (.015)	<b>.019*(.011)</b>	-.015 (.011)
IND_ASSOC.	.051 (.050)	-.011 (.017)	-.043 (.053)	.031 (.054)	-.007 (.041)	<b>.030**(.015)</b>	.004 (.016)	<b>.025**(.011)</b>	.006 (.010)
ENTREPRENEURS	<b>.176**(.037)</b>	-.006 (.013)	-.021 (.040)	<b>.125**(.036)</b>	<b>.064**(.030)</b>	.003 (.014)	.012 (.014)	-.010 (.012)	.010 (.009)
<i>Open sources</i>									
EVENTS	-.003 (.043)	.004 (.015)	.041 (.043)	<b>.177**(.044)</b>	<b>.064**(.033)</b>	.001 (.015)	-.005 (.015)	.009 (.011)	-.002 (.009)
SCIENCE_PUB	-.026 (.053)	.0003 (.017)	-.060 (.053)	<b>.215**(.061)</b>	.039 (.039)	.018 (.016)	<b>.033**(.015)</b>	-.014 (.013)	<b>.029**(.010)</b>
INTERNET	<b>.229**(.037)</b>	.011 (.012)	.050 (.040)	<b>.177**(.037)</b>	-.048 (.031)	<b>.029**(.013)</b>	-.022 (.015)	-.004 (.011)	.009 (.008)
<i>Firm resources</i>									
SIZE	-.0002(.0003)	-.0003(.0003)	.0002(.0001)	-.0001(.0001)	-.0003(.0003)	-.0003(.0004)	-.0003(.0002)	-.0001(.0002)	-.0002(.0003)
AGE	-.00006(.001)	-.0003(.0004)	.001(.001)	.001(.001)	.0001(.001)	.0003(.0004)	-.001(.0005)	-.001(.0004)	.0002(.0003)
EXPORT	-.0003(.0005)	.00002(.0002)	<b>.001**(.0004)</b>	.0004(.0004)	-.0001(.0004)	.0002(.0002)	.0002(.0002)	-.0003(.0002)	.00003(.0001)

<sup>1</sup> External R&D in this study is grouped in R&D activities along with internal R&D, however, based on the degree of externalisation, external R&D, informal and open networks, and cooperation activities 'are external to the enterprise to various degrees, depending on their ownership and the contractual structures of the relationship between our enterprise and the other party or parties to the transfer' (Frenz and Ietto-Gillies, 2009, p. 1126).

OWN_NATIONAL	.098(.064)	.007(.030)	.034(.059)	-.029(.057)	-.003(.051)	.013(.030)	.042(.033)	-.002(.021)	.014(.024)
OWN_MULTI	.123(.077)	-.0002(.037)	.102(.072)	-.005(.071)	-.067(.068)	.017(.036)	-	.014(.024)	.004 .029)
OWN_JOIN	-	-	-	-	-	-	-	-	-
OPS_PLANT	-.002 (.043)	-.020 (.022)	.016 (.041)	-.031 (.040)	-.013 (.038)	-.001 (.019)	-.027 (.027)	.009 (.013)	.012 (.011)
OPS_HEAD	-	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.071 (.029)	.012 (.016)	.032 (.031)	.027 (.029)	-.032 (.027)	.025 (.016)	.007 (.014)	<b>-.024***(.008)</b>	.010 (.012)
MEDHIGH_TECH	.004 (.044)	<b>-.025**(.010)</b>	.005 (.042)	.036 (.041)	-.036 (.037)	-.006 (.017)	.014 (.023)	-.001 (.015)	.008 (.016)
HIGH_TECH	-.049 (.109)	-	-.045 (.095)	.188 (.137)	-.095 (.082)	-	-	.002 (.037)	-
EDU_UNDERHS	-.0003 (.001)	-.001 (.001)	-.0004 (.001)	-.0005 (.001)	-.001 (.001)	-.001 (.001)	.001(.001)	-.0002(.0005)	.001(.001)
EDU_HIGHSCHOOL	-.0004 (.002)	-.001 (.001)	.001 (.001)	-.0002 (.001)	-.001 (.001)	-.001 (.001)	.001(.001)	-.0003(.001)	.0005(.001)
EDU_DIPLOMA	-.001 (.003)	-.0004 (.001)	.001 (.003)	.001 (.003)	.000 (.002)	.000 (.001)	.001(.001)	-.0002(.001)	.0004(.001)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-	-
RD_STAFF	.0001 (.002)	<b>-.002*(.001)</b>	<b>.006***(.002)</b>	-.002 (.002)	.000 (.002)	.000 (.001)	.000 (.001)	-.0002 (.001)	.000 (.001)
Observation	1,179	1,168	1,179	1,179	1,179	1,168	1,119	1,179	1,168
LR chi2(29)	297.2	98.16	53.52	498.23	352.76	136.41	154.75	154.13	162.17
Prob > chi2	.000	.000	.0037	.000	.000	.000	.000	.000	.000
Pseudo R2	.209	.293	.047	.327	.281	.341	.385	.469	.553
Log likelihood	-563.198	-118.462	-547.930	-511.940	-451.881	-132.001	-123.827	-87.424	-65.588
Mean VIF	2.76	2.77	2.78	2.74	2.75	2.76	2.76	2.75	2.75

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.

Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge) (continued)

INDEPENDENT VARIABLES	Model 10 GOV_RD	Model 11 NPROFIT_RD	Model 12 INVESTOR	Model 13 TRADE ASSOC	Model 14 ENTREPRENEUR	Model 15 EVENTS	Model 16 SCIENCE PUB	Model 17 INTERNET
INTERNAL_RD	.004 (.009)	.001 (.010)	.025 (.015)	<b>.030**(.013)</b>	<b>.087***(.016)</b>	.010 (.016)	.003 (.013)	<b>.112***(.016)</b>
EXTERNAL_RD	-.022 (.018)	<b>.030*(.017)</b>	<b>.048*(.028)</b>	-.011 (.025)	-.020 (.035)	.014 (.031)	.010 (.025)	.030 (.032)
<i>Market/commercials</i>								
SUPPLIERS	-.001 (.011)	-.007 (.012)	.004 (.017)	-.009 (.015)	-.014 (.020)	.017 (.018)	-.020 (.015)	.025 (.020)
CUSTOMERS	.002 (.010)	<b>.041***(.013)</b>	<b>.037**(.017)</b>	.013 (.015)	<b>.084***(.018)</b>	<b>.078***(.018)</b>	<b>.071***(.016)</b>	<b>.087***(.018)</b>
COMPETITORS	-.003 (.009)	-.010 (.010)	.016 (.016)	<b>.024*(.014)</b>	<b>.047***(.017)</b>	<b>.039**(.016)</b>	.019 (.013)	-.009 (.018)
CONSULTANT	-.000004 (.015)	.008 (.017)	.012 (.028)	<b>.042**(.021)</b>	.020 (.035)	-.003 (.031)	.019 (.022)	<b>.080**(.033)</b>
COMMLAB	<b>.023*(.014)</b>	.010 (.015)	-.009 (.028)	-.012 (.023)	.045 (.033)	-.005 (.030)	<b>.048**(.021)</b>	-.039 (.037)
<i>Science institutions</i>								
UNIVERSITIES	<b>.023*(.013)</b>	.013 (.015)	<b>.065**(.032)</b>	<b>.045*(.024)</b>	-.030 (.042)	.029 (.035)	<b>-.045*(.027)</b>	-.019 (.040)
POLYTECHNIC	<b>.050***(.015)</b>	.019 (.016)	<b>-.105**(.042)</b>	.001 (.027)	<b>.079*(.044)</b>	-.031 (.036)	<b>.081***(.024)</b>	.044 (.041)
GOV_RD	-	<b>.071***(.015)</b>	<b>.130***(.030)</b>	.032 (.022)	-.036 (.038)	.046 (.031)	.000 (.024)	.055 (.038)
NON_PROFITRD	<b>.061***(.012)</b>	-	.009 (.024)	<b>.036**(.017)</b>	-.029 (.028)	-.005 (.022)	.015 (.017)	-.028 (.029)
<i>Associations</i>								
INVESTORS	<b>.043***(.011)</b>	-.001 (.013)	-	<b>.046***(.015)</b>	<b>.164***(.021)</b>	<b>.058**(.023)</b>	.024 (.017)	.013 (.023)
IND_ASSOC.	.013 (.010)	<b>.022*(.012)</b>	<b>.058***(.021)</b>	-	<b>.085***(.020)</b>	<b>.077***(.018)</b>	-.017 (.016)	<b>.072***(.020)</b>
ENTREPRENEURS	-.010 (.011)	-.001 (.012)	<b>.123***(.017)</b>	.018 (.015)	-	.009 (.030)	.029 (.021)	-.062 (.040)
<i>Open sources</i>								
EVENTS	.016 (.010)	.002 (.012)	-.018 (.031)	.026 (.022)	-.010 (.039)	-	<b>.096***(.013)</b>	.033 (.023)
SCIENCE_PUB	-.0001 (.011)	<b>.026**(.012)</b>	-.019 (.021)	<b>.036**(.015)</b>	<b>.099***(.022)</b>	<b>.145***(.019)</b>	-	<b>.057**(.025)</b>
INTERNET	<b>.019*(.010)</b>	-.015 (.013)	.008 (.018)	<b>.034**(.014)</b>	.039 (.027)	.030 (.019)	-.007 (.016)	-
<i>Firm resources</i>								
SIZE	.00001(.00003)	-.00001(.00003)	.00002(.00001)	-.00001(.00002)	-.00004(.00003)	.00002(.00001)	-.00002(.00001)	.00003(.00001)
AGE	-.0004 (.0004)	.0001 (.0004)	.0002(.001)	-.001(.0005)	.001(.001)	-.001(.001)	-.0002(.0005)	-.0004 (.001)
EXPORT	-.00003 (.0002)	-.0002 (.0002)	-.00001(.0003)	.0002(.0002)	<b>.001**(.0003)</b>	-.0003(.0003)	-.0002(.0002)	-.00001(.0003)
OWN_NATIONAL	.022(.025)	-.01 (.020)	<b>-.061**(.031)</b>	.033(.035)	<b>.105**(.048)</b>	-.047(.033)	.008(.029)	<b>-.067*(.035)</b>
OWN_MULTI	.003(.030)	.007(.025)	<b>-.078**(.042)</b>	<b>.069*(.039)</b>	<b>.105*(.056)</b>	-.030(.043)	-.009(.039)	-.054(.045)
OWN_JOIN	-	-	-	-	-	-	-	-

OPS_PLANT	-.016(.020)	.002(.017)	-.030(.027)	-.021(.024)	.042(.027)	-.008(.027)	.005(.021)	.005(.028)
OPS_HEAD	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.006(.011)	<b>.0100(.010)**</b>	-.005(.018)	.002(.016)	.023(.023)	-.026(.019)	-.011(.016)	.014(.022)
MEDHIGH_TECH	.001(.015)	-	.018 (.029)	<b>.048(.028)*</b>	-.0003(.029)	-.027)	.027(.025)	.027(.031)
HIGH_TECH	.0111(.103)	-.005(.034)	-.055 (.037)	.049(.076)	.015(.072)	.082 (.090)	-	-.038(.061)
EDU_UNDERHS	-.0004(.0004)	.001(.001)	-.001(.001)	.001(.001)	-.0001(.001)	.002(.001)	-.001(.001)	.000(.001)
EDU_HIGHSCHOOL	-.0004(.0005)	.001(.001)	-.001(.001)	.002(.001)	.0003 (.001)	.002 (.001)	<b>-.001*(.001)</b>	.000(.001)
EDU_DIPLOMA	-.0003(.001)	.002(.001)	-.0001(.002)	.001(.002)	-.002 (.002)	.002 (.002)	-.001 (.001)	.000(.002)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-
RD_STAFF	-.0004(.001)	.001(.001)	.001(.001)	.001(.001)	-.0004(.001)	.00 (.001)	.0002 (.001)	-.002(.001)
Observation	1179	1082	1179	1179	1179	1179	1168	1179
LR chi2(29)	226.89	172.32	249.06	210.13	405.55	326.27	251.48	252.34
Prob > chi2	.000	.000	.000	.000	.000	.000	.000	.000
Pseudo R2	.565	.485	.347	.369	.414	.399	.431	.304
Log likelihood	-87.225	-91.467	-234.216	-179.467	-287.107	-246.055	-165.938	-289.245
Mean VIF	1.34	2.75	2.75	2.76	2.75	2.75	2.75	2.76

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.

#### 4.3. Knowledge transformation activity

The main interest in this section is how various sources of knowledge contribute to innovation as well as how any hampering factors hinder innovation. Table 3 shows that IN\_RD has positive and significant effects on any type of innovation and innovation success. By contrast, EX\_RD's has no significant impacts on innovation and innovation success. Evidence that IN\_RD is the only source of knowledge that positively and significantly affects all types of innovation and innovation success may suggest that IN\_RD plays a more important role than the rest of the sources of knowledge. Therefore, based on this finding, Hypothesis 2a is supported.

Turning to informal knowledge, different sources of informal knowledge used in the innovation transformation activity have different impacts on types of innovation and innovation success. Among market/commercials networks, knowledge transformed from *customers* positively and significantly affects product innovation, product innovation new to the firm, marketing innovation and innovation success. While knowledge transformed from *competitors* positively and significantly affects product innovation new to the market, process innovation and marketing innovation. Surprisingly, knowledge from science institutions only influences process innovation and this finding differs compared from most previous studies that show a positive influence of science institutions on radical innovation. Knowledge that is generated from association (industry association and entrepreneurs) is more likely to influence innovation and innovation success in significant and negative ways. Open sources (*events*) contribute positively to product innovation, product innovation that new to the market, product innovation that new to the firms and innovation success.

In relation to firm resources, most variables have weak and negative effects on diverse types of innovation and innovation success. Only firms age and multi-national ownership influence innovation in significant and negative directions. Firm age has a weak negative and significant association with MKTGNOV. The same direction was found for the influence of multi-national firm status on ORGINOV.

Table 3. Knowledge transformation activity

INDEPENDENT VARIABLES	Model 1 PRODINOV	Model 2 PRODINN_N2M <sup>1</sup>	Model 3 PRODINN_N2F <sup>2</sup>	Model 4 PROCINOV	Model 5 ORGINOV	Model 6 MKTGINOV	Model 7 INN SUCCESS <sup>3</sup>
INTERNAL_RD	<b>.133***(.022)</b>	<b>.069***(.023)</b>	<b>.126***(.022)</b>	<b>.188***(.019)</b>	<b>.231***(.018)</b>	<b>.162***(.022)</b>	<b>8.342**(3.295)</b>
EXTERNAL_RD	.039(.065)	.077(.057)	.080(.067)	.093(.074)	.096(.074)	-.091(.069)	6.853(7.118)
<i>Market &amp; commercials</i>							
SUPPLIERS	-.027(.027)	-.026(.027)	-.021(.027)	-.004(.027)	-.007(.026)	.017(.027)	-5.139(3.724)
CUSTOMERS	<b>.062**(0.025)</b>	.039(.025)	<b>.053**(0.025)</b>	-.027(.025)	-.036(.025)	<b>.099***(.025)</b>	<b>6.122*(3.470)</b>
COMPETITORS	-.003(.025)	<b>.046*(.024)</b>	.004(.025)	<b>.042*(.024)</b>	.001(.025)	<b>.053**(0.026)</b>	3.970(3.364)
CONSULTANTS	.001(.051)	-.012(.048)	.009(.052)	-.075(.049)	-.002(.052)	.003(.053)	-5.513(6.529)
COMMLAB	.043(.053)	.013(.049)	.067(.054)	.060(.050)	-.004(.049)	.022(.054)	3.486(6.499)
<i>Science</i>							
UNIVERSITIES	.030(.063)	.059(.058)	.061(.065)	<b>-.123**(0.059)</b>	-.041(.061)	.036(.068)	6.438(7.874)
POLYTECHNIC	.053(.073)	.033(.068)	.001(.071)	<b>-.132*(0.068)</b>	.055(.066)	-.006(.070)	6.574(8.503)
GOVERNMENT_RD	-.098(.060)	-.030(.059)	-.073(.061)	<b>.109*(0.064)</b>	-.028(.060)	-.050(.064)	-1.260(7.652)
NON_PROFIT_RD	-.022(.022)	.026(.053)	-.032(.056)	<b>.149***(.057)</b>	-.045(.058)	.057(.061)	6.800(7.084)
<i>Associations</i>							
INVESTORS	.057(.057)	.036(.034)	<b>.068*(0.036)</b>	<b>.058*(0.035)</b>	.056(.035)	-.048(.036)	0.776(4.696)
IND_ASSOC.	-.056(.041)	<b>-.095**(0.039)</b>	<b>-.087**(0.041)</b>	-.036(.040)	.058(.043)	-.017(.044)	-8.185(5.473)
ENTREPRENEURS	<b>-.059*(.031)</b>	-.043(.031)	-.051(.031)	-.017(.030)	.013(.031)	-.049(.032)	<b>-6.954*(4.188)</b>
<i>Open resources</i>							
EVENTS	<b>.189***(.038)</b>	<b>.164***(.033)</b>	<b>.174***(.037)</b>	.028(.033)	.044(.035)	.026(.036)	<b>16.800***(4.387)</b>
SCIENCE_PUB.	-.033(.044)	-.047(.041)	-.010(.044)	-.022(.040)	-.040(.043)	-.012(.045)	-5.755(5.279)
INTERNET	-.039(.032)	-.029(.031)	-.040(.032)	-.024(.031)	.023(.032)	-.031(.034)	-2.148(4.210)
<i>Firm resources</i>							
SIZE	-.00002(.000)	-.00003(.000)	-.00001(.000)	.00004(.000)	-.00002(.000)	-.00001(.000)	-.001(0.004)
AGE	.00(.001)	.0001(.001)	.0002(.001)	-.001(.001)	.0003(.001)	<b>-.001*(.001)</b>	.009(0.114)
EXPORT	.0004(.000)	.001(.000)	.001(.000)	.00004(.000)	-.001(.000)	.00002(.000)	.056(0.054)
OWN_NATIONAL	.038(.062)	.001(.060)	.049(.062)	.037(.060)	-.064(.055)	.049(.059)	1.596(7.825)
OWN_MULTI	.006(.073)	-.049(.074)	.006(.073)	.007(.073)	<b>-.130*(.070)</b>	.011(.072)	-4.198(9.789)
OWN_JOIN	-	-	-	-	-	-	-
OPS_PLANT	.027(.039)	.010(.040)	.051(.040)	.004(.039)	-.014(.039)	.031(.039)	.601(5.286)

	OPS_HEAD	-	-	-	-	-	-	-
1	LOW_TECH	-	-	-	-	-	-	-
2	MED_LOW TECH	<b>.051(.029)*</b>	.036(.030)	<b>.058(.029)**</b>	-.009(.029)	.012(.030)	-.010(.029)	4.267(3.988)
3	MED_HIGH TECH	.036(.038)	<b>.063(.038)*</b>	.041(.038)	.014(.038)	-.046(.037)	.049(.037)	5.827(5.206)
4	HIGH_TECH	.106(.110)	.171(.118)	.130(.108)	<b>-.175(.095)*</b>	.039(.109)	.010(.122)	13.248(14.064)
5	EDU_UNDERHS	-.001(.001)	-.001(.001)	-.002(.001)	-.0001(.001)	-.0004(.001)	-.0002(.001)	-.235(.172)
6	EDU_HIGHSCHOOL	-.001(.001)	-.002(.001)	-.002(.001)	-.0003(.001)	-.0003(.001)	-.002(.001)	-.201(.182)
7	EDU_DIPLOMA	-.003(.003)	-.002(.002)	-.004(.002)	-.003(.002)	-.002(.003)	-.002(.003)	-.225(.330)
8	EDU_UNDERGRAD	-	-	-	-	-	-	-
9	RD_STAFF	-.001(.002)	.0003(.002)	-.002(.002)	-.001(.002)	-.001(.002)	.0001(.002)	.188(.226)
10								
11	Number of obs	1179	1179	1179	1179	1165	1170	1179
12	LR chi2(57)	685.65	546.38	652.18	641.39	572.46	720.65	517.02
13	Prob > chi2	.000	.000	.000	.000	.000	.000	.000
14	Pseudo R2	.439	.3862	.4241	.4327	.401	.4519	.1192
15	Log likelihood	-438.107	-434.124	-442.875	-420.422	-427.534	-437.063	-1909.790
16	Mean VIF	3.50	3.50	3.50	3.50	3.50	3.50	3.50

Note: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in model 1-6 are marginal effects generated from logit models  
<sup>1</sup>Product innovation new to the market; <sup>2</sup>Product innovations new to the firms; <sup>3</sup>Innovation success derived from Tobit regression

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3 The impact of internal R&D (IN\_RD) on all types of innovation and innovation success is  
4 positive and significant. There is only a marginal significant impact of external R&D (EX\_RD)  
5 on organisational innovation.  
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#### 10 4.4. Knowledge exploitation activity

11 Table 4 displays the statistical output of OLS regression for knowledge exploitation activity.  
12 Because data on sales and employee growth are not available in the IIS 2011, this study uses  
13 productivity as the only indicator of firm performance, as presented in Table 4. In the first  
14 model PRODINOV is excluded. Strikingly, PRODINOV\_NEW2MARKET and  
15 PRODINOV\_NEW2FIRM innovations as well as INNOVSUCCESS have no significant effect  
16 on firms' performance that is proxied by productivity. When both PRODINOV and  
17 INNOVSUCCESS are excluded (model 2), there is no significant influence of either  
18 PRODINOV\_NEW2MARKET or PRODINOV\_NEW2FIRMS on productivity. In the third  
19 model, in which PRODINOV\_NEW2MARKET and PRODINOV\_NEW2FIRMS are  
20 excluded, there is no significant effect of PRODINOV and INNOVSUCCESS on productivity.  
21 Another surprising finding is that, in contrast, non-product innovations including PROCINOV,  
22 ORGINOV and MKTGINOV, significantly affect productivity in all models. Positive  
23 associations were found between both PROCINOV and ORGINOV and productivity, while a  
24 negative association was found between MKTGINOV and productivity. The evidence that  
25 INNOVSUCCESS has negative and insignificant impact on productivity is in line with  
26 previous studies (Ganotakis and Love, 2012; Roper et al., 2008; Roper and Arvanitis, 2012).  
27 Based on these findings, Hypothesis 3 partially is supported.  
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41 Firm resources negatively and significantly affect productivity, but only in low-  
42 technology firms. Variables such as size, age, export and the lowest level of education have  
43 negative associations with productivity. In contrast, in high-tech firms, having employees with  
44 high school and undergraduate degrees is positively associated with productivity.  
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Table 4. Knowledge exploitation activity

INDEPENDENT VARIABLES	Model 1 PRODUCTIVITY	Model 2 PRODUCTIVITY	Model 3 PRODUCTIVITY
PRODINOV	-	-	268.160(716.413)
PRODINOV_NEW2MARKET	668.224(1122.881)	-289.371(832.420)	-
PRODINOV_NWE2FIRM	-45.167(820.431)	48.857(817.301)	-
PROCINOV	<b>1964.657***(631.219)</b>	<b>1985.895***(631.165)</b>	<b>1985.412***(629.213)</b>
ORGINOV	<b>2511.089***(631.492)</b>	<b>2578.718***(629.410)</b>	<b>2518.678***(632.025)</b>
MKTGINOV	<b>1756.931***(604.736)</b>	<b>-1767.292***(604.841)</b>	<b>-1746.373***(603.329)</b>
INNOVSUCCESS	-29.379(23.128)	-	-21.282(18.660)
<b><i>Firm resources</i></b>			
Size	-0.074(.184)	-0.077(.184)	-0.075(.184)
Age	-22.201(19.116)	-22.262(19.121)	-22.451(19.115)
Export	-7.785(9.670)	-7.583(9.672)	-7.678(9.661)
OWN_NATIONAL	362.853(1241.632)	371.125(1241.944)	351.187(1241.068)
OWN_MULTI	1109.779(1566.056)	1101.907(1566.458)	1076.938(1565.01)
OWN_JOIN	-	-	-
OPERATION_PLANT	-1003.043(879.703)	-986.841(879.843)	-997.590(879.377)
OPERATION_HEAD	-	-	-
LOW_TECH	-	-	-
MEDLOW_TECH	580.331(649.173)	580.257(649.345)	577.387(648.739)
MEDHIGH_TECH	<b>2005**(912.806)</b>	<b>2044.913**(912.506)</b>	<b>2025.741**(911.861)</b>
HIGH_TECH	2421.285(2542.052)	2457.057(2542.568)	2477.757(2539.589)
EDU_UNDERHS	-48.366(31.223)	-47.312(31.220)	-48.391(31.215)
EDU_HIGHSCHOOL	-43.934(33.014)	-43.345(33.020)	-44.058(33.000)
EDU_DIPLOMA	-44.996(58.843)	-44.698(58.858)	-45.006(58.821)
EDU_UNDERGRAD	-	-	-
RD_STAFF	11.331(37.141)	10.115(37.138)	11.454(37.121)
Obs.	1179	1179	1179
F ( )	2.92	3.00	3.07
Prob > F	.000	.000	.000
R <sup>2</sup>	.046	.044	.046
Adj. R <sup>2</sup>	.030	.030	.031
Root MSE	8272.30	8274.50	8270.00

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . The results are based on OLS regressions.

## 5. DISCUSSION AND CONCLUSIONS

This study investigates and models the IVC that encompasses knowledge sourcing, transformation and exploitation activities of Indonesia manufacturing firms using data from the IIS 2011. The literature on the IVC framework has been widely used to analyse inter-relationships among firm interaction, innovation, business growth and productivity in developed countries, however, based on the reviewed literature there is no empirical evidence on the IVC in the context of Indonesia. Therefore, this study sheds light on the nature of interrelationships within each stage and between linkages of the IVC performed by Indonesian firms.

Key findings of this study are as follows. First, in the first link of the IVC, this study finds the existence of strong synergistic relationships between internal R&D and external sources of knowledge as well as among external sources of knowledge. This may indicate a similar pattern of knowledge sourcing activity to that in developed countries, namely the implementation of “open innovation strategy”. The role of external networks tends to be less important when the firms already source knowledge for innovation from external R&D activities. External actors from market/commercial groups (i.e. customers and competitors) have important roles as knowledge providers if the firm also generates knowledge from internal R&D. In contrast, the firms’ interactions with scientific institutions tend to be of lesser importance. The firms that source knowledge from market/commercials network interact less with scientific institutions, but they do interact with their own networks, associations and open sources. A synergistic relationship can also be found among science institutions. In relation to formal cooperation, firms tend to restrict cooperation with firms within the same group and with suppliers when they perform internal or external R&D activities.

Second, in the second link of the IVC, internal R&D plays important roles and has strong positive impacts on all types of innovation and innovation success. External knowledge that shows similar patterns in shaping innovations mainly comes from informal knowledge from customers and competitors. Knowledge generated from scientific institutions makes no significant contribution to innovation and innovation success. Positive impacts on process innovation come only from government and non-profit R&D, while university and polytechnic sources contribute negatively to process innovation. This contradicts previous studies stating that novel and highly advanced innovation requires greater levels of R&D, patents or knowledge from science institutions such as universities and research centres (Amara and Landry, 2005; Tödting et al., 2009).

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3 Third, the final link of the IVC relates to the impact of innovation on productivity  
4 provides surprising results. In general, product innovations new to the market and new to the  
5 firm as well as innovation success have no significant impact on productivity. The fact that  
6 innovation success is negatively associated with productivity may prompt questions related to  
7 the quality of innovative products that may be not able to disrupt the market and this may  
8 severely impact the firms' sales and further impact productivity.  
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10 The finding that neither product innovations new to the market and new to the firm nor  
11 innovation success lead to productivity, perhaps due to the firms' efforts to detect and  
12 overcome any weak links in the IVC to boost productivity. First, sourcing activity that relies  
13 on synergy between internal R&D and external networks, mainly from market/commercial,  
14 automatically influences the minimum usage of other sources of knowledge such as scientific  
15 institutions that may provide additional added value for firms. In this sense, a diverse open  
16 innovation strategy may need to be implemented with the hope that the use of more diverse  
17 and better-quality sources of knowledge able to overcome the weak links in knowledge  
18 sourcing activities. Second, the low quality of firms' human resources may contribute to the  
19 success of knowledge sourcing, transformation and exploitation as indicated by no positive  
20 contributions to the three links of IVC. Third, diverse of innovation barriers that hamper  
21 Indonesian manufacturing firms may affect the success of the IVC activities. Lastly,  
22 environments external to the firms, or a weak conditional framework for innovation in  
23 Indonesia, may contribute indirectly to the success of the IVC activities.  
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38 Findings from this study are expected to enrich literature of innovation studies in the  
39 context of developing countries in several ways. First, the fact that non-technological  
40 innovation (i.e. marketing innovation) is the highest proportion of innovation produced by  
41 Indonesian manufacturing firms support and confirm previous studies that reveal most firms in  
42 in developing countries: tend to focus on market rather than technological innovation (Wamae,  
43 2009), beyond traditional focus on R&D (Srholec, 2011), and attempt to reach the  
44 technological frontier instead of achieving inventions that are new to the market (Hou and  
45 Mohnen, 2013). Second, the highest proportion of knowledge sourced by Indonesian  
46 manufacturing firms mainly from informal source of knowledge e.g. customers and  
47 competitors. This also confirms previous innovation studies in Indonesia that reveal innovation  
48 in Indonesian manufacturing sectors generally as the results of learning through "informal  
49 experiences" not through "formal scientific activity or R&D" (Aminullah, 2012; Aminullah et  
50 al., 2014).  
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### 5.1. Innovation policy implication

Based on the findings from the first and second links of the IVC, relevant innovation policies may be proposed. The fact that Indonesia faces problems related to scientific institutions such as “low public and private investment in R&D”, “a low-ranking higher education and training system” and “a small number of researchers and scientists for a country of its size” (OECD, 2013, p. 175), may present a problem for synergistic relationships between scientific institutions and other external agents. Further impact is clearly seen in the second link of the IVC in which the knowledge used from scientific institutions, both informally and formally, negatively impacts innovations. Therefore, government policy, for instance, promoting a triple helix strategy that involves university-industry-government interaction and partnership, may help address these challenges to improve knowledge transfer by integrating the three types of institutions. As argued by Tambunan (2005), triple helix implementation in Indonesia has been relatively slow. The Indonesian government initiated the development of incubators and science parks in 1990 with UNDP’s support, but the development of these incubators has been very slow (Simamora, 2009). Public scientific institutions such as techno parks may be used by Indonesian firms to generate knowledge from R&D activities when they lack sufficient internal funds.

### 5.2. Limitation of the study

Finally, limitations of this study need to be acknowledged. First, issues related to firms’ sectors has not been discussed in this study and as a result, sectors’ effects on the three links of IVC cannot be detected. The variation among firm sectors is only derived from the classification of technology intensity. Second, this study uses IIS 2011 data that is restricted to manufacturing firms. The comparison of the IVC activities between manufacturing and service firms may provide fruitful insight into innovation policies for Indonesia. Therefore, these issues should be studied in the future research. Third, this study is a cross-sectional in nature i.e. the study only portrays IVC based on IIS 2011 data, as a result dynamic of Indonesian manufacturing firms’ IVC is missing. Hence, future studies may address this limitation by conducting a longitudinal study. Fourth, this study lack of update insight on IVC of Indonesian firms since there is no update on innovation survey data.

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**02**

**Bukti Konfirmasi Lolos Initial  
Screening (Desk Evaluation)  
(29 Mei 2020)**

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## Journal of Asia Business Studies - Author update

1 message

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**Journal of Asia Business Studies** <onbehalfof@manuscriptcentral.com>

29 May 2020 at 03:15

Reply-To: sanjay.singh@adu.ac.ae

To: arif.hartono@uii.ac.id, 083110101@uii.ac.id, arif\_singa@uii.ac.id

28-May-2020

Dear Author(s),

It is a pleasure to inform you that your manuscript titled From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms (JABS-05-2020-0209) has passed initial screening and is now awaiting reviewer selection. The manuscript was submitted by Dr. Arif Hartono with you listed as a co-author. As you are listed as a co-author please log in to <https://mc.manuscriptcentral.com/jnlabs> and check that your account details are complete and correct, these details will be used should the paper be accepted for publication.

Yours sincerely,

Sanjay Kumar Singh

Editor-in-Chief, Journal of Asia Business Studies

[sanjay.singh@adu.ac.ae](mailto:sanjay.singh@adu.ac.ae)

**03**

**Bukti Konfirmasi Review dan Hasil  
Review Pertama – Major Revision  
(29 Juli 2020)**

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## Journal of Asia Business Studies - Decision on Manuscript ID JABS-05-2020-0209

2 messages

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Journal of Asia Business Studies <onbehalf@manuscriptcentral.com>

Reply-To: sanjay.singh@adu.ac.ae

To: arif.hartono@uii.ac.id, 083110101@uii.ac.id

29 July 2020 at 15:10

29-Jul-2020

Dear Dr. Hartono:

Manuscript ID JABS-05-2020-0209 entitled "From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms" which you submitted to the Journal of Asia Business Studies, has been reviewed. The comments of the reviewer(s) are included at the bottom of this letter.

The reviewer(s) and the AE have recommended major revisions to the submitted manuscript, before it can be considered for publication. Therefore, I invite you to respond to the reviewer(s)' comments and revise your manuscript. I shall also ask you to add 3-4 literature published in JABS from 2019 onward to further strengthen the introduction and literature review sections. In addition, I shall be interested in you to use the following literature to strengthen the literature review and discussion sections of your manuscript, as:

Gaur, A. S., Ma, H., & Ge, B. (2019). MNC strategy, knowledge transfer context, and knowledge flow in MNEs. *Journal of Knowledge Management*, 23(9), 1885-1900.  
Singh, D. Pattnaik, C., Lee, J. Y., & Gaur, A. S. 2019. Subsidiary staffing, cultural friction, and subsidiary performance: evidence from Korean subsidiaries in 63 countries. *Human Resource Management*, 58(2): 219-234.  
Yiu, D. W., Lam, L. W., Gaur, A. S., Lee, S., & Wong, C. S. 2018. Asian relevance, global impact: Asian management research entering a new era. *Asia Pacific Journal of Management*, 35 (3): 365-371.

To revise your manuscript, log into <https://mc.manuscriptcentral.com/jnlabs> and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision.

You will be unable to make your revisions on the originally submitted version of the manuscript. Instead, revise your manuscript using a word processing program and save it on your computer. Please also highlight the changes to your manuscript within the document by using the track changes mode in MS Word or by using bold or coloured text.

Once the revised manuscript is prepared, you can upload it and submit it through your Author Centre. The deadline for uploading a revised manuscript is 27-Sep-2020 from receiving this email. If it is not possible for you to resubmit your revision within this timeframe, we may have to consider your paper as a new submission.

When submitting your revised manuscript, you will be able to respond to the comments made by the reviewer(s) in the space provided. You can use this space to document any changes you make to the original manuscript. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response to the reviewer(s).

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Once again, thank you for submitting your manuscript to the Journal of Asia Business Studies and I look forward to receiving your revision.

Yours sincerely,

Dr. Sanjay Kumar Singh

Editor-in-Chief, Journal of Asia Business Studies

[sanjay.singh@adu.ac.ae](mailto:sanjay.singh@adu.ac.ae)

Associate Editor Comments:

Area Editor

Comments to Author::

Thank you for submitting your paper to the Journal of Asia Business Studies for publication consideration. It is clear that a great deal of effort went into this paper and we appreciate you entrusting your work with us.

In terms of process, once we received your manuscript, we sent it to scholars who are experts in this area of research. They have now completed their reviews of this paper. In addition, I read the paper and these reviews. My intention is not to act as an additional reviewer, but to make a decision that integrates the reviewers' feedback with JABS' standards and norms. Based on this review information I am sorry to inform you that JABS is not able to publish this work in its current form. However, I see the potential of your paper to make a contribution to the literature. Therefore, I am inviting you to revise and resubmit your paper.

Both reviewers raised important questions regarding theory, contribution and empirics. I agree with their assessment that both the literature review and research design are inadequate. In terms of theory development, it'll be useful if you can draw out the Indonesian context a bit more. For example, are the relationships proposed unique to Indonesia/ Asia or are these universal? How does it compare and contrast with what we already know from developed countries? More importantly, all hypotheses need to be stated more clearly (e.g., x lead to or is associated y). How are innovation success and firm performance distinct from each other? Is innovation success simply a new product is ready or is it success in the marketplace? If latter, then how is it distinct from firm performance?

In terms of empirics, you need to provide information on each of the measures used in the study. How are each of your measures computed? Some of this information can be included in an annex. Please provide more information on using old data. You mentioned the survey in 2014. Why was that not included in your study? What about endogeneity, i.e., are the factors described in your paper themselves influenced by something else, say foreign direct investment? Did you control for that? Please also develop on usefulness/policy implications beyond Indonesia, i.e., for business in Asia as a whole. Please do not end your paper with limitations. It needs to end with a short conclusion section.

Overall, while I see the potential of the paper, it does not currently provide enough information, especially in terms of research design, to judge its quality. It also requires major overhaul in theory development and writing in general. While I am happy to give you the opportunity to revise, I'll understand if you decide not to pursue that route. I hope that the comments from the reviewers would be helpful in the development of your work, as it is our intention at JABS that the review process is constructive and developmental for all authors regardless of the outcome. Thank you for the opportunity to review your work and for considering JABS as potential publication outlet. We hope that despite the outcome on this particular paper, you will continue to do so in the future. I wish you the best of luck in your continued research endeavors.

Reviewer(s)' Comments to Author:

Reviewer: 1

Recommendation: Major Revision

Comments:

Thank you for the opportunity to read this interesting paper. There are some areas where more work is needed to further enhance its contributions:

1- Overall framing can be improved by highlighting the unique context of the study. Also, would be good to provide theoretical support and justification for the research question(s) within the introduction part.

2- Conceptual part would benefit by adding more recent literature around global value chains and institutions. This will also help you to strengthen the argumentation leading to your hypotheses.

3- Methods and analysis- it would be helpful to provide more information whether there were any differences across the sample firms in terms of their knowledge acquisitions strategies?

4- Discussion and implications. In this section, it would be good to draw key implications of the results and compare and contrast them with the extant literature on this topic. What are the key contributions of this study to a particular theory such as knowledge based view or org learning? The future research direction section can be further enhanced by highlighted specific areas where more work is needed, and also include relevant literature in this section when you identify a potential area for future research.

Additional references that may help you to strengthen the paper:

Kano, L., Tsang, E.W., & Yeung, H.W.C. (2020). Global value chains: A review of the multi-disciplinary literature. *Journal of International Business Studies*, pp.1-46.

Khan, Z., Rao-Nicholson, R., & Tarba, S.Y., 2018. Global networks as a mode of balance for exploratory innovations in a late liberalizing economy. *Journal of World Business*, 53(3), 392-402.

McWilliam, S.E., Kim, J.K., Mudambi, R., & Nielsen, B.B. (2019). Global value chain governance: Intersections with international business. *Journal of World Business*, p.101067.

Ndubisi, N.O., Dayan, M., Yeniaras, V., & Al-hawari, M. (2019). The effects of complementarity of knowledge and capabilities on joint innovation capabilities and service innovation: The role of competitive intensity and demand uncertainty. *Industrial Marketing Management*.

Wang, L., Huo, D., & Motohashi, K. (2019). Coordination Mechanisms and Overseas Knowledge Acquisition for Chinese Suppliers: The Contingent Impact of Production Mode and Contractual Governance. *Journal of International Management*, 25(2), p.100653.

Good Luck!

Additional Questions:

Importance of the Topic/Issues Addressed to the Field of Asia Business: Important

Conceptual Rigour (Treatment of relevant literature, logical reasoning, etc.): Good

Methodological Rigor (Research design, sample, measures, and analysis) Skip if not applicable: Good

Clarity of the Objectives of the Paper: Good

Clarity of Presentation/Readability of the Paper: Good

Appropriateness of the Topic/Issues for the Journal of Asia Business Studies: Appropriate

Contribution of the Paper in its Current Form to Advancing Knowledge Regarding Asia Business: Important contribution

Contribution of the Paper to Advancing Knowledge Regarding Asia Business if revised along suggested lines: Important contribution

Reviewer: 2

Recommendation: Minor Revision

Comments:

Review is attached.

Additional Questions:

Importance of the Topic/Issues Addressed to the Field of Asia Business: Important

Conceptual Rigour (Treatment of relevant literature, logical reasoning, etc.): Minor problems

Methodological Rigor (Research design, sample, measures, and analysis) Skip if not applicable: Minor problems

Clarity of the Objectives of the Paper: Good

Clarity of Presentation/Readability of the Paper: Good

Appropriateness of the Topic/Issues for the Journal of Asia Business Studies: Appropriate

Contribution of the Paper in its Current Form to Advancing Knowledge Regarding Asia Business: Important contribution

Contribution of the Paper to Advancing Knowledge Regarding Asia Business if revised along suggested lines: Important contribution

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Arif Hartono <083110101@uii.ac.id>

To: "Arif Singapurwoko, MBA" <arif\_singa@uii.ac.id>

14 September 2020 at 13:30

Bukti penerimaan jurnal. Accepted with major revision.

[Quoted text hidden]

**04**

- **Bukti Dokumen Respons Kepada Reviewer**
- **Bukti Artikel Yang Disubmit Ulang (Resubmit)**
- **Bukti Konfirmasi Submit Review Putaran Pertama – R1 (26 September 2020)**



## **RESPONSES TO REVIEWERS' COMMENTS:**

Dear Editor in Chief of JABS,

We are very excited to have been given the opportunity to revise our manuscript. We carefully considered your comments as well as those offered by the two reviewers. Herein, we explain how we revised the paper based on those comments and recommendations in the following table. We want to extend our appreciation for taking the time and effort necessary to provide such insightful guidance.

Kind Regards,

Arif Hartono

No	Reviewer Comments	Responses	Page
	Reviewer 1 – Major Revision		
1	<p><b>Introduction section:</b> Overall framing can be improved by highlighting the unique context of the study. Also, would be good to provide theoretical support and justification for the research question(s) within the introduction part.</p>	<p>Many thanks for the suggestion regarding the introduction section. We keep the introduction section very short (one page) to avoid the number of words exceed 10,000. But we realise that important information that shapes the research novelty of the study is missing.</p> <p>Therefore, we have added 6 new paragraphs (including overall structure of the paper as suggested by reviewer 2) that contains justification on why conducting the study is important.</p> <p>We highlighted the additional information.</p>	2-4
2	<p><b>Literature review section:</b> Conceptual part would benefit by adding more recent literature around global value chains and institutions. This will also help you to strengthen the argumentation leading to your hypotheses</p>	<p>Many thanks for providing the list of recent studies on global value chains and institutions. However, the concept of innovation value chain (IVC) is different compared to global value chain (GVC).</p> <p>We have added recent articles on the issues of complementary relationship between internal and external knowledge to strengthen the argumentation leading to hypothesis 1 and 2b.</p> <p>We highlighted the additional information.</p>	4-5 6-7 8 9
3	<p><b>Methodology section:</b> Methods and analysis- it would be helpful to provide more information whether there were any differences across the sample firms in terms of their knowledge acquisitions strategies?</p>	<p>Many thanks for the suggestion. Unfortunately, the study did not intend to assess IVC across different types of industry classification since the proportion of firms in each industry classification is varied (see table 1 at the end of this section). The table shows that food and beverages firms outnumbered the distribution of sample by industry.</p>	
4	<p><b>Discussion section:</b> Discussion and implications. In this section, it would be good to draw key implications of the results and</p>	<p>We have addressed the reviewer feedback in the Discussion and Conclusions section.</p> <p>We highlighted the additional information.</p>	25-27

	compare and contrast them with the extant literature on this topic. What are the key contributions of this study to a particular theory such as knowledge-based view or org learning? The future research direction section can be further enhanced by highlighted specific areas where more work is needed, and also include relevant literature in this section when you identify a potential area for future research.		
	<b>Reviewer 2 – Minor Revision</b>		
1	<b>Introduction section:</b> In introduction section, author(s) should provide the overall structure of the paper.	Many thanks for the feedback. We have provided the overall structure of the paper at the end of introduction section.  We highlighted the additional information.	2-4
2	<b>Literature review section:</b> In Conceptual Foundation and Hypotheses Development section, author(s) have not provided any linkage to any theory while building the hypotheses.	In Conceptual Foundation and Hypotheses Development section, we briefly explained the link between IVC and innovation process. We also highlighted previous model and frameworks of innovation process and IVC.  We highlighted the additional information.	4-5 6-7 8 9
3	<b>Methodology section:</b> The major concern from my side is the time when data was collected. It was collected for 2009-2010. Almost a decade has been passed and there may have significant changes in the data. The author(s) need to provide clarification/justification/limitation with respect to this data.	Many thanks for the feedback. Of the three waves of innovation survey, the second wave of the survey (2011) has the greatest number of data compared to the rest of the surveys. Therefore, the 2011 innovation survey is used in this study.  We highlighted the additional information.	9
	In table 1 (Descriptive statistics), unit of measurement of items are missing.	We have addressed the feedback.  We highlighted the additional information.	12-13

	In section 4.2, author(s) mention that “Table 2 indicates a synergistic relationship between internal and external R&D and.....”. However, they have not mentioned how. Author(s) need to clarify this based on the table by providing detailed explanation.	We have addressed the feedback.  We highlighted the additional information.	13
4	<b>References:</b> At number of places, references used are not as per standards. So, author(s) need to rectify them.	Many thanks for the suggestion. We have complied JABS author guidelines (Emerald Harvard referencing style) that can be found in the below link:  <a href="https://www.emeraldgroupublishing.com/journal/jabs?distinct_id=174995c51c23e3-06f3a198f69594-333769-1fa400-174995c51c337b&amp;_ga=2.214867991.1424913300.1600987705-1558715388.1600300799#author-guidelines">https://www.emeraldgroupublishing.com/journal/jabs?distinct_id=174995c51c23e3-06f3a198f69594-333769-1fa400-174995c51c337b&amp;_ga=2.214867991.1424913300.1600987705-1558715388.1600300799#author-guidelines</a>	

Table 1 Distribution of sample by industry

ISIC Rev 3	Manufacture Sectors	Sample (1,179 firms) in %
Division 15	Food & beverages	26.21
Division 16	Tobacco products	5.00
Division 17	Textiles	10.69
Division 18	Wearing apparel; dressing and dyeing of fur	8.99
Division 19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	2.97
Division 20	Wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	5.00
Division 21	Paper and paper products	1.78
Division 22	Printing and publishing	3.39
Division 23	Coke, refined petroleum products, & nuclear fuel	0.08
Division 24	Chemicals & chemical products	3.50

Division 25	Rubber & plastics products	5.34
Division 26	Other non-metallic mineral products	8.31
Division 27	Basic metals	0.51
Division 28	Fabricated metal products, except machinery and equipment	3.14
Division 29	Machinery & equipment n.e.c	1.27
Division 30	Office, accounting & computing machinery	0.08
Division 31	Electrical machinery & apparatus n.e.c	0.93
Division 32	Radio, TV & communication equipment & apparatus	0.68
Division 33	Medical, precision & optical instruments, watches and clocks	0.17
Division 34	Motor vehicles, trailers & semi-trailers	1.19
Division 35	Other transport equipment	1.27
Division 36	Furniture; manufacturing n.e.c.	8.99
Division 37	Recycling	0.45



**From Knowledge Sourcing to Firms' Productivity:  
Investigating Innovation Value Chain of Indonesian  
Manufacturing Firms**

Journal:	<i>Journal of Asia Business Studies</i>
Manuscript ID	JABS-05-2020-0209.R1
Manuscript Type:	Research Paper
Keywords:	innovation value chain, productivity, manufacturing firms, Indonesia

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**RESPONSES TO REVIEWERS' COMMENTS:**

Dear Editor in Chief of JABS,

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Arif Hartono

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4	<p><b>Discussion section:</b> Discussion and implications. In this section, it would be good to draw key implications of the results and</p>	<p>We have addressed the reviewer feedback in the Discussion and Conclusions section.</p> <p>We highlighted the additional information.</p>	25-27



	compare and contrast them with the extant literature on this topic. What are the key contributions of this study to a particular theory such as knowledge-based view or org learning? The future research direction section can be further enhanced by highlighted specific areas where more work is needed, and also include relevant literature in this section when you identify a potential area for future research.		
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4	<p><b>References:</b></p> <p>At number of places, references used are not as per standards. So, author(s) need to rectify them.</p>	<p>Many thanks for the suggestion. We have complied JABS author guidelines (Emerald Harvard referencing style) that can be found in the below link:</p> <p><a href="https://www.emeraldgrouppublishing.com/journal/jabs?distinct_id=174995c51c23e3-06f3a198f69594-333769-1fa400-174995c51c337b&amp;_ga=2.214867991.1424913300.1600987705-1558715388.1600300799#author-guidelines">https://www.emeraldgrouppublishing.com/journal/jabs?distinct_id=174995c51c23e3-06f3a198f69594-333769-1fa400-174995c51c337b&amp;_ga=2.214867991.1424913300.1600987705-1558715388.1600300799#author-guidelines</a></p>	

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Division 35	Other transport equipment	1.27
Division 36	Furniture; manufacturing n.e.c.	8.99
Division 37	Recycling	0.45

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3 **From Knowledge Sourcing to Firms' Productivity:**  
4 **Investigating Innovation Value Chain of Indonesian Manufacturing Firms**  
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8 **Purpose** – The study investigates the innovation value chain (IVC) that encompasses knowledge  
9 sourcing, transformation, and exploitation activities among Indonesian manufacturing firms by using  
10 data from the Indonesia Innovation Survey (IIS).  
11

12 **Design/methodology/approach** – A simple approach of single equation Probit model, Logit  
13 regression, and Tobit regression are used in the first, second, and third stages of IVC consecutively.  
14

15 **Findings** – The study finds the existence of a synergistic relationship between internal and external  
16 sources of knowledge as well as among external sources of knowledge. In terms of the second link of  
17 the IVC, internal R&D plays an important role that positively influences knowledge transformation  
18 into all types of innovation and innovation success. External knowledge that has a similar pattern in  
19 shaping innovation mainly comes from market/commercials and open sources. Scientific institutions  
20 tend to contribute to innovation in a negative manner, and few positive impacts on process innovation  
21 are observed from government R&D and non-profit R&D institutions. Informal knowledge is more  
22 likely to influence technological than non-technological innovation.  
23

24 **Originality** – This study is different from the previous IVC studies due to the following reasons. First,  
25 in this study a broader source of knowledge is tested. Second, wider innovation (i.e. technological and  
26 non-technological innovation) is also assessed.  
27

28 **Research limitations** – Since Indonesia has only three waves of innovation surveys i.e. 2008, 2011,  
29 and 2014, hence update insight taken from the survey is not available.  
30

31 **Keywords:** innovation value chain, productivity, manufacturing firms, Indonesia  
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## 1. Introduction

Interest in innovation studies has been increasing in general, with no exception in the case of developing countries. However, innovation in the context of developing countries cannot necessarily be explained using the same concepts applied to developed countries, because developing countries are subject to different challenges in terms of the capital, infrastructure, intellectual and analytical foundations of innovation system analysis (Choi and Williams, 2013; Lorentzen, 2010; Metcalfe and Ramlogan, 2008; Mytelka, 2000). Da Silveira (2001) emphasises that it is important to study innovation in developing countries because most theories, approaches, mechanisms and technical changes associated with innovation that affect managerial practices and skills were developed based on evidence from developed countries. The relevancy and adaptability of any model, framework or construct of innovation studies that was developed, built and tested in developed countries needs to be re-evaluated prior to being implemented in developing countries. This study aims to extend previous studies of innovation value chains (IVC) conducted in developed economies, such as North America and Europe (Hansen and Birkinshaw, 2007), Ireland (Roper *et al.*, 2008) and the UK (Ganotakis and Love, 2012; Love *et al.*, 2011), by using innovation survey data of manufacturing firms in the developing economy of Indonesia.

According to Hansen and Birkinshaw (2007, p. 122), the IVC is “a sequential, three-phase process that involves idea generation, idea development, and the diffusion of developed concepts”. The IVC concept was derived from innovation research projects which interviewed 130 executives from 30 multi-national firms in North America and Europe. Extending Hansen and Birkinshaw’s (2007) work, innovation survey based IVC studies were conducted by other scholars (Doran and O’leary, 2011; Ganotakis and Love, 2012; Love *et al.*, 2011; Roper *et al.*, 2008; Roper and Arvanitis, 2012). Following these scholars, this study aims to investigate the IVCs of knowledge sourcing, transformation and exploitation activities performed by Indonesian manufacturing firms. This study focuses on the IVC in Indonesia context because to date, no previous study has looked at the IVC based on data derived from innovation surveys of Indonesian firms. This study intends to address previous studies’ imbalance and to provide a new empirical contribution to the understanding of IVC activity based on a firm-level analysis of Indonesian manufacturing firms.

In Indonesia context, previous studies that investigate knowledge sourcing and using activities limited on case studies in specific industry. For instances, collaboration and innovation adoption in small-scale industry clusters (e.g. Sandee and Rietveld, 2001); innovation and information flow in small-scale cottage industries in a rural area (Kristiansen, 2002); sources of knowledge in small furniture industries (Van Geenhuizen and Indarti, 2005); and innovation and cooperation activities of

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3 SMEs in food processing industry clusters (Najib and Kiminami, 2011). These studies reveal some  
4 important issues such as (1) the most innovation adopted is product innovation; (2) collaboration  
5 among producers (inter-firm cooperation) in SMEs clusters play important role in their innovation  
6 activities; (3) traditional knowledge sources such as in-house learning by doing and experiment,  
7 customers and competitors are the main knowledge sources in the innovation process; and (4) factors  
8 that hamper innovation activities is lack of: access to information on market and advanced technology,  
9 financial to fund innovation activities, and social capital development.

15 More examples on knowledge sourcing is a qualitative study that investigates the role of  
16 academia as external source of innovation in Indonesian automotive industry (Aminullah and Adnan,  
17 2012). The study found that consumers and competitors are the main sources of innovation in  
18 Indonesian automotive industry, while universities and academia have a weak contribution as the  
19 sources of innovation. Therefore, this study intends to address this unbalance and to provide a new  
20 empirical contribution on the understanding of the IVC activity based on firm-level analysis of  
21 Indonesian manufacturing firms. Furthermore, this study also intends to build the IVC model based on  
22 innovation activities of the Indonesian manufacturing firms that encompass the three IVC activities  
23 (i.e. knowledge sourcing, transformation and exploitation). From a practical perspective, findings of  
24 this study are expected can be used by policy makers at government and firm levels to identify  
25 innovation activities as well as to detect any weak links in the IVC; therefore, relevant innovation  
26 policy and strategy can be formulated to foster innovation in Indonesia.

36 This study is different compared to the previous IVC studies in several ways. First, in this study  
37 a wider range sources of knowledge that consists of (1) R&D activities (internal and external R&D)  
38 and (2) informal knowledge gains from market agents, scientific institutions, associations, and open  
39 sources. As argued by previous scholars that sourcing knowledge from diverse sources can increase  
40 the degree of innovation's novelty (Amara and Landry, 2005) and the difficulty to be replicated in  
41 order to generate sustainable competitive advantage (Henderson and Cockburn, 1996).

46 Second, a wider innovation classification such as organisational and marketing innovation are  
47 assessed (see Battisti and Stoneman (2010) for innovation classification), while most innovation  
48 survey-based the IVC studies in developed countries context tend to focus on traditional innovation  
49 i.e. product and process innovations (e.g. Doran and O'Leary, 2011, Ganotakis and Love, 2012, Love  
50 *et al.*, 2011, Roper *et al.*, 2008, Roper and Arvanitis, 2012a). As argued by Battisti and Stoneman  
51 (2010) that joint adoption of technological and non-technological innovations found to play a major  
52 role than rely on traditional or technological innovation as shown in a majority of innovation literature.  
53 In addition, in the context of developing countries, innovation activities tend to focus on the market  
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rather than on the technology (Wamae, 2009). This in line with the innovation activities in developing countries that emphasise on minor and incremental changes on existing products or process innovation as well as innovative approaches to organisation and marketing are a major part of innovation (OECD and Eurostat, 2005). Therefore, it is expected that the study provides different findings compared to the existing IVC studies.

Research questions relate to the IVC activities that are addressed in this study are as follows: (1) To what extent are the various knowledge sources activities used by Indonesian manufacturing firms? (2) To what extent the various knowledge sources are used in the knowledge transformation activity associated with diverse types of innovation? (3) To what extent do the different types of innovation and innovation success influence firm performance that is proxied by productivity?

The rest of the paper is organized as follows. In the next section conceptual foundation and hypotheses relate to the IVC activities are presented. In this section, distinction between knowledge sourcing, transformation and exploitation activities is discussed. Section 3 explains data and methods used in this study. Furthermore, section 3 describes the data, variables, and methods for testing the proposed hypotheses. Section 4 reports the results, and details to what extent the proposed hypotheses have been confirmed. The final section contains the discussion and conclusions.

## 2. Conceptual Foundation and Hypotheses Development

Previous studies have attempted to develop models and theoretical frameworks to capture the innovation process of firms. Previous models of innovation process in the industrially advanced countries have been developed, for instances five generation of innovation process (Rothwell, 1994), a stage-gate model of innovation (Cooper, 1989), and funnel model (Wheelwright and Clark, 1992). However, none of these models attempt to deal with the issue of developing countries catch up from behind the technology frontier, because in the catch-up case innovation occurs based on minor improvements to existing process and product designs (Hobday, 2005). Therefore, the models may not be relevant to the Indonesian context. The concept of IVC is concerned with the innovation process whereby firms source knowledge, transform this knowledge into innovation output, and finally exploit innovation output for performance gains (Hansen and Birkinshaw, 2007). Previous models of IVC in the industrially advanced countries have been developed. Using innovation survey data, the following scholars (e.g. Battisti and Stoneman, 2013; Doran and O'Leary, 2011; Ganotakis and Love, 2012b; Love *et al.*, 2011; Roper *et al.*, 2008) have drawn the IVC model. However, their models tend to focus on internal R&D activity and limited number of external linkages such as market and public R&D as the sources of knowledge. In addition, their models focused on traditional innovation (i.e. product and

process innovation), while in this study a wider innovation such as organisational and marketing innovation are included and analysed.

### 2.1. Knowledge sourcing activity

In the first link of the IVC, knowledge is sourced from both inside and outside the firms (Hansen and Birkinshaw, 2007). Therefore, the main task in this activity is to assemble the knowledge used for innovation (Roper *et al.*, 2008). In terms of the degree of externalisation, Frenz and Ietto-Gillies (2009, p. 1126) explain that internal R&D is the knowledge generated inside a firm, while knowledge from external R&D, from informal and open networks, and from cooperation activities are “external to the enterprise to various degrees, depending on their ownership and the contractual structures of the relationship between our enterprise and the other party or parties to the transfer”. Knowledge from external linkages can be differentiated based on the form of access, whether informal or formal, and the knowledge content being transferred (Monjon and Waelbroeck, 2003). Storper (1997) classified formal cooperation as that which involves more formalised interactions among firms. In contrast, informal interactions, which normally involve informal relations, “might explain the spatial concentration of innovative industries and activities” (Tödtling *et al.*, 2009, p. 61).

Informal linkages can include “personal contacts or communities of practice or simply arise in the normal course of business”, while formal linkages “can be organised by business organisations such as chambers of commerce, research associations, technology services companies, consultants, universities or public research organisations or sponsored by local, regional or central governments” (OECD/Eurostat, 2005, p. 79). Internal firm capabilities are necessary to access and absorb knowledge from informal linkages, while formal cooperation activity is associated with the use of knowledge resulting from access to resources and innovative capabilities of partners (Freitas *et al.*, 2011).

Several previous studies have investigated the interaction among sources of knowledge used for innovation activities. One of the main discussions in these studies is whether complementary or substitution relationships exist between internal and external knowledge sourcing strategies in innovation activities. Some scholars argue that studies of such relationships remain unclear and inconclusive (Hagedoorn and Wang, 2012; Schmiedeberg, 2008). On the one hand, some studies reveal a complementary relationship between internal R&D and external knowledge in knowledge sourcing activities (Cassiman and Veugelers, 2002; Hagedoorn and Wang, 2012; Roper *et al.*, 2008; Schmiedeberg, 2008; Veugelers and Cassiman, 2005). On the other hand, other empirical studies identify a substitution relationship in these activities (Hess and Rothaermel, 2011; Laursen and Salter, 2006; Love and Roper, 2001; Xu *et al.*, 2013). In this study, the term ‘complementarity’ is used



interchangeably with 'synergistic', which means that implementation of one strategy increases the marginal returns from another (Milgrom and Roberts, 1995).

Turning to the Indonesia context, there are a few insights related to synergistic or substitution strategies in innovation activities performed by Indonesian firms. In general, as in any other developing country, advanced knowledge of technology is accessed by importing from the advanced industrial countries, and the international technology transfer process mostly takes place in the private sector (Wie, 2005) because public support for R&D is minimal (Hill and Tandon, 2010). Wie (2005) identifies two major channels of international technology transfer to Indonesia: (1) a formal or market-mediated channel that includes FDI; technology licensing agreements; imports of capital goods; foreign education and training; turnkey plants; and technical consultancies, and (2) an informal or non-market mediated channel composed of technical assistance by foreign buyers and foreign vendors; copying or reverse engineering; information from trade journals; and technical information services provided by public agencies.

Apart from imported technology, the use of various sources of knowledge by Indonesian firms has also been studied. For example, Indonesian small furniture firms tend to generate knowledge through in-house learning by experimentation as well as from customers (Van Geenhuizen and Indarti, 2005). Cooperative activity was also found positively related to innovation in a cluster of Indonesian small food processors (Najib and Kiminami, 2011) and small scale roof tile firms (Sandee and Rietveld, 2001). Collaboration within Indonesian small firm clusters is also effective for sharing costs and risks (Sandee and Rietveld, 2001). As an example of an Indonesian high-technology industry, the automotive industry develops innovation mainly from inside the organisation and competitors are the main source of external knowledge to support the creation of new products in a competitive market (Aminullah and Adnan, 2012). On the other hand, universities and public research institutions contribute little external knowledge to the Indonesian automotive industry (Aminullah and Adnan, 2012). Although literature that discusses the involvement of external actors as sources of knowledge in the innovation process is scarce, a synergistic relationship between internal and external knowledge may exist to some extent.

Complementary relationship also exists between internal and external knowledge sourcing activities in recent studies. In the context of a developing economy, Majidpour (2017) finds that complementary relationship between Iranian firms' catch-up through indigenous R&D and overseas technology sources. Complementary relationships are also found between internal and external R&D in firms from high-technology industries in manufacturing firms across European countries (Paula and Da Silva, 2018). While, a complementary relationship also exists between Irish SMEs internal and

external knowledge sourcing activities, especially between R&D and linkages with customers and public knowledge sources (Doran *et al.*, 2019). Based on this, a hypothesis is proposed:

*H1 In knowledge sourcing activities, a synergistic relationship exists between internal R&D and external sources of knowledge.*

## 2.2. Knowledge transformation activity

In the second link of the IVC, different sources of knowledge used in the innovation activities are transformed or converted into different types of innovation (Hansen and Birkinshaw, 2007; Roper *et al.*, 2008). This involves innovation or knowledge production in which the success of knowledge transforming activities relies on the firms' knowledge sources (Griliches, 1992; Love and Roper, 1999). Therefore, the main issue addressed in this stage is the empirical assessment of the comparative impact of various sources of knowledge (e.g. R&D activities and informal knowledge) on different types of innovations (e.g. product, process, organisational, and marketing innovations).

Innovation is a complex phenomenon and normally firms use several sources of information simultaneously (Freitas *et al.*, 2011). The link between various sources of knowledge and the adoption of different innovations has been investigated (Amara and Landry, 2005; Srholec and Verspagen, 2012; Tödtling *et al.*, 2009). Previous scholars (Amara and Landry, 2005; Tödtling *et al.*, 2009) find that advanced innovations that are new to the market need a higher level of extended internal R&D, patent and more knowledge from universities, and research organisations to stimulate and support them. Meanwhile, less advanced innovations, such as business services (Tödtling *et al.*, 2009) and market innovations (Amara and Landry, 2005), require knowledge links with less research-based input.

A majority of previous IVC studies in advanced economies reveal that internal R&D activities are positively and significantly associated with innovation adoption (Doran and O'leary, 2011; Ganotakis and Love, 2012; Roper *et al.*, 2008; Roper and Arvanitis, 2012). Apart from the IVC studies, other studies in industrialised countries at the firm level show positive links among R&D, innovation and productivity (Griffith *et al.*, 2004, 2006; Mohnen *et al.*, 2006). Evidence from developing and newly industrialised countries also shows a positive association between R&D, innovation and productivity, with examples including Argentina (Chudnovsky *et al.*, 2006), Malaysia (Hegde and Shapira, 2007), China (Jefferson *et al.*, 2006) and Taiwan (Aw *et al.*, 2011). Firms that have higher levels of investment in R&D are more likely to introduce technological innovation as was found in Brazil (Raffo *et al.*, 2008) and Chile (Alvarez *et al.*, 2010). Based on this, a second hypothesis is proposed:

*H2a Internal R&D positively influences innovation and innovation success.*

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5 The use of informal knowledge as input for the innovation process comes mainly from external  
6 information sources gained without any formal arrangements (Garcia-Torres and Hollanders, 2009).  
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8 The informal link between certain actors and types of innovation has been investigated in previous  
9 studies. Past subjects of investigation have included the role and involvement of *customers* in the  
10 innovation process (Franke and Schreier, 2002; von Hippel and Katz, 2002; Joshi and Sharma, 2004);  
11 key *suppliers* and their roles in product innovation development (Amara and Landry, 2005; Nieto and  
12 Santamaría, 2007; Smith and Tranfield, 2005); the role of *competitors* in knowledge transfer and  
13 innovation (Malmberg and Maskell, 2002); and fostering advanced technological innovation  
14 (Gnyawali and Park, 2011). Open source information and knowledge from *scientific publications*  
15 proves beneficial for firms (Caloghirou *et al.*, 2004). Recent empirical evidence shows that different  
16 external sources of knowledge used by firms influence innovation adoption (Doran *et al.*, 2019; Simao  
17 and Franco, 2018).

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19 In the case of Indonesian firms, studies of informal knowledge usage for innovation have been  
20 conducted and the results show that different sources of external knowledge contribute to diverse  
21 benefits for the firms. External actors apart from the market, for example *foreign suppliers*, have very  
22 important roles in the development of technological capability and innovation in Indonesian firms  
23 (Wie, 2005). *Foreign buyers* also contribute technical and managerial assistance for many Indonesian  
24 SMEs (Wie, 2005). *Competitors* support the development of new products in the competitive market  
25 (Aminullah and Adnan, 2012). However, there is no single study in the Indonesia context that links  
26 diverse knowledge of innovation and adoption of different types of innovation with innovation success  
27 achieved by Indonesian manufacturing firms. In this study, informal knowledge derived from the IIS  
28 2011 is grouped into *market/commercials*, including suppliers, customers, competitors, consultants  
29 and commercial labs; *science institutions*, including universities, polytechnic institutes, government  
30 R&D and non-profit R&D; *associations*, including industry associations, investors and entrepreneurs;  
31 and *open sources*, including events, scientific publications and the internet. Therefore, another  
32 hypothesis is proposed:

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49 *H2b Different levels of informal knowledge influence innovation adoption differently.*

### 50 51 52 53 2.3. Knowledge exploitation activities

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55 The final link in the IVC is knowledge exploitation that generates value for the firm. Starting with the  
56 work of Geroski, Machin, and Reenen (1993), previous scholars such as (Ganotakis and Love, 2012;  
57 Love *et al.*, 2011; Roper *et al.*, 2008) argue that, in the knowledge exploitation stage, firm performance

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3 is affected by innovation output as the result of codified knowledge gained through knowledge  
4 sourcing activities. They state that innovation output needs to be determined prior to knowledge  
5 exploitation. Therefore, the main interest at this stage is how firms gain business productivity or  
6 profitability from the exploitation of adopted innovation. In this study, productivity (indicated by total  
7 sales/number of employees) is used to measure how innovation affects overall firms' performance.  
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12 Prior IVC studies find that innovation output in the form of process innovation (Doran *et al.*, 2019),  
13 product and process innovation (Ganotakis and Love, 2012; Roper *et al.*, 2008) significantly and  
14 positively influences innovation performance as measured by sales and employment growth.  
15 Surprisingly, both a negative impact (Roper *et al.*, 2008) and no relationship (Ganotakis and Love,  
16 2012) of product innovation success on productivity have been found. Therefore, in this study, the  
17 involvement of wider innovation, is expected to provide a different view compared to previous IVC  
18 studies. Hence, an additional hypothesis is proposed:  
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24 *H3 In knowledge exploitation activity, innovation and innovation success positively affects a firm's*  
25 *performance.*  
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### 29 3. DATA AND METHODS

#### 30 3.1. Data

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32 The empirical analysis in this study is derived from the Indonesia Innovation Survey (IIS) 2011 that  
33 covers 2009-2010. In terms of firm size, the IIS 2011 surveyed only medium (20-99 employees) and  
34 large (more than 99 employees) Indonesian manufacturing firms. The surveyed firms are classified  
35 based on the International Standard Industrial Classification (ISIC) Rev. 3.1. Multi-stage random  
36 sampling was used to collect data from 1,500 firms and a total of 1,375 questions were successfully  
37 collected. Of the returned questionnaires, 1,179 were usable. Face to face interviews with R&D or  
38 production managers were conducted to collect the data. The IIS 2011 used the Oslo Manual  
39 (OECD/Eurostat, 2005) as the guideline for collecting and interpreting innovation data and  
40 adjustments were made to facilitate innovation activities in Indonesia that may differ from those in  
41 developed economies. For example, the innovation activity and internal sources of knowledge  
42 variables in the IIS 2011 have broader categories than the same variables in the UK CIS. Unfortunately,  
43 Indonesia has three waves of innovation survey only i.e. 2008, 2011, and 2014 and no continuity of  
44 the survey. As a result, there is no update data on the innovation survey. Of the three waves of  
45 innovation survey, the second wave of the survey (2011) has the greatest number of data compared to  
46 the rest of the surveys. Therefore, the 2011 innovation survey is used in this study.  
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### 3.2. Methods

In the knowledge sourcing activity, the main issue that is addressed is the behaviour of Indonesian manufacturing firms in sourcing knowledge from various sources. More specifically, synergistic or substitution relationships among the three groups of knowledge are tested. Following Roper, Du, and Love (2008), a simple approach of single equation probit model is used to test Hypothesis 1 with the dependent variables being a series of sources of knowledge. This allows for a detailed analysis of the impact of 17 various knowledge sources.

In the knowledge transformation link, an innovation or knowledge production function is used to model the knowledge transformation activities (Geroski, 1990; Harris and Trainor, 1995). Logit regression is used to test Hypotheses 2 with the dependent variables being different types of innovation. Tobit regression is employed when the dependent variable is innovation success (i.e. the proportion of sales derived from product innovation new to the market) that has both upper and lower bounds (0 to 100%). In the knowledge exploitation stage, OLS regression is used to test Hypothesis 3, and the dependent variable is the firms' productivity, which is a measure of how innovation affects overall firm performance.

## 4. RESULTS

### 4.1. Descriptive statistics

Table 1 presents descriptive statistics for the IIS 2011. Following the 3<sup>rd</sup> Oslo Manual, the IIS 2011 defines innovation as “the implementation of a new or significantly improved product (good or services), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations” (OECD/Eurostat, 2005, p. 46). Based on the definition that covers broad range of possible innovations, the IIS 2011 then defines an innovative firm as a firm that performed any product, process, organisational or marketing innovation from 2009 to 2010. According to Table 1, the mean of productivity (total sales/number of employees) is approximately IDR 1.3 trillion. The highest proportion is marketing innovation (42.8%), while the lowest is organisational innovation (31%). The mean of product innovations that are new to the market is lower than the same innovations that are new to the firm, and account for 28.8% versus 35.8% respectively. The mean of innovation success as the proportion of launched products new to the market accounted for 8.43%. The fact that marketing innovation outnumbered other innovation is typical in developing countries that tend to focus on the market rather than on the technology (Wamae, 2009).

Turning to knowledge sourcing activities, approximately 29% of firms report generating their own knowledge from internal R&D, while only 3.2% of firms source knowledge from external R&D.

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3 Firms report market/commercials as more important than other sources of knowledge, including  
4 suppliers, competitors and customers which represent 19.1%, 22.5% and 34.4%, respectively. These  
5 are followed by open sources (internet) and associations (entrepreneurs) that account for 11.3% and  
6 14.6%, respectively. In contrast, less than 5% of firms source science-based knowledge from  
7 universities, polytechnic, government and non-profit R&D institutions.  
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11 The mean of firm size as indicated by the number of employees is nearly 175 people. Of surveyed  
12 firms, mature firms (more than 20 years) dominate in the IIS 2011 data. The proportion of national  
13 firms is significantly higher at 90%, compared to multi-nationals and joint ventures, at 6% and 4.2%,  
14 respectively. Most of the surveyed firms operate in their headquarters, not in the manufacturing plants  
15 (91% versus 9.2%). Labour education levels are low. More than 50% of employees have no high school  
16 degree, which indicates the low level of education of the firms' human resources. In contrast, less than  
17 5% of employees hold undergraduate degrees.  
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Table 1 Descriptive statistics (1179 firms)

VARIABLES	Obs.	Mean	SD	Min.	Max.
<b>Firm performance</b>					
Productivity (total sales/number of employee) (IDR)	1179	1312.096	8399.761	.088	125000
<b>Innovation performance</b>					
Innovation success (INNOVSUCCESS) (% PRODINOV_NEW2MARKET sales)	1179	8.43	16.99	0	100
<b>Innovation output</b>					
Product innovation (PRODINOV) (0/1)	1179	.377	.485	0	1
Product innovation new to the market (PRODINOV_NEW2MARKET) (0/1)	1179	.288	.453	0	1
Product innovation new to the firms (PRODINOV_NEW2FIRM) (0/1)	1179	.358	.480	0	1
Process innovation (PROCINOV) (0/1)	1179	.322	.468	0	1
Organisational innovation (ORGINOV) (0/1)	1179	.310	.463	0	1
Marketing innovation (MKTGINOV) (0/1)	1179	.428	.495	0	1
<b>R&amp;D Activities</b>					
Internal R&D-R&D activities (IN_RD) (0/1)	1179	.292	.455	0	1
External R&D-R&D activities (EX_RD) (0/1)	1179	.032	.177	0	1
<b>Market agents (highly important)</b>					
Suppliers (SUPPLIERS) (0/1)	1179	.191	.393	0	1
Customers (CUSTOMERS) (0/1)	1188	.344	.475	0	1
Competitors (COMPETITORS) (0/1)	1179	.225	.418	0	1
Consultant (CONSULTANTS) (0/1)	1179	.041	.198	0	1
Commercial labs (COMMLAB) (0/1)	1179	.042	.200	0	1
<b>Science institutions (highly important)</b>					
University (UNIVERSITIES) (0/1)	1179	.031	.174	0	1
Polytechnic (POLTECH) (0/1)	1179	.027	.163	0	1
Government R&D institutions (GOV_RD) (0/1)	1179	.041	.198	0	1
Non-profit R&D institutions (NONPROF_RD) (0/1)	1179	.036	.185	0	1
<b>Associations (highly important)</b>					
Investors (INVESTORS) (0/1)	1179	.091	.287	0	1
Industry Association (IND_ASSOC) (0/1)	1179	.065	.247	0	1
Entrepreneurs (ENTREPRENEURS) (0/1)	1179	.146	.353	0	1
<b>Open sources (highly important)</b>					
Events (EVENTS) (0/1)	1188	.109	.312	0	1
Science Publication (SCIENCE_PUB) (0/1)	1188	.067	.251	0	1
Internet (INTERNET) (0/1)	1179	.113	.316	0	1
<b>Firms Resources</b>					
Size (number of employee)	1179	174.608	1318.078	20	32977
Firms' age (years)	1179	21.077	12.704	0	84
Export (%)	1179	9.726	25.106	0	100
Ownership National (OWN_NATIONAL) (0/1)	1179	0.899	0.301	0	1
Ownership Multi National (OWN_MULTI) (0/1)	1179	0.059	0.235	0	1
Ownership Joint Venture (OWN_JOINT) (0/1)	1179	0.042	0.202	0	1
Operation Plant (OPS_PLANT) (0/1)	1179	0.092	0.289	0	1
Operation Head Quarter (OPS_HQ) (0/1)	1179	0.908	0.289	0	1
Education Under High school (EDU_UNDERHS) (%)	1179	56.247	36.423	0	100

Education High School (EDU_HS) (%)	1179	36.430	31.492	0	100
Education Diploma (EDU_DIPLOMA) (%)	1179	3.246	6.779	0	55
Education Under Graduate (EDU_UNDERGRAD) (%)	1179	4.077	8.623	0	90
Employees' proportion in R&D dept. (RD_STAFF) (%)	1179	2.986	6.717	0	57
Low technology (LOW_TECH) (0/1)	1179	.735	.442	0	1
Medium-low technology (MEDLOW_TECH) (0/1)	1179	.174	.379	0	1
Medium-high technology (MEDHIGH_TECH) (0/1)	1179	.082	.275	0	1
High technology (HIGH_TECH) (0/1)	1179	.009	.096	0	1

#### 4.2. Knowledge sourcing activity

The empirical analysis in the first stage of IVC follows the approach of Roper *et al.*, (2008) and it allows for a detailed analysis of the interdependence of various knowledge sources. The following equation is estimated using a series of probit models.

$$KS_{ji} = KS_{ki}\beta_0 + X_{1i}\beta_1 + \varepsilon_{1i} \quad \text{if } y_{0i} = 1$$

where  $KS_{ji}$  represents firm  $i$ 's knowledge sourcing activity  $j$  during the reference period.  $KS_{ki}$  represents firm  $i$ 's knowledge sourcing activity  $k$  where  $j \neq k$ ,  $X_{1i}$  is a vector of explanatory variables,  $\beta_{1i}$  is the associated coefficient vector, and  $\varepsilon_{1i}$  is the error term. When sourcing knowledge H1 suggests that a complementary/synergistic relationship exists between internal R&D and external knowledge sourcing activities. Therefore, if  $\beta_0 > 0$  this implies that firms which engage in one type of knowledge sourcing (e.g., R&D) are more likely to engage in other types of knowledge sourcing (e.g., customers, suppliers, and competitors). This provides a direct test of H1.

Table 2 indicates a synergistic relationship between internal and external R&D and this is in line with previous findings (Cassiman and Veugelers, 2002, 2006; Ganotakis and Love, 2012; Schmiedeberg, 2008). Firms are more likely to perform external R&D (EX\_RD) if they also generate their own knowledge from internal R&D (IN\_RD). The same relationship also exists between IN\_RD and external agents from market/commercials (CUSTOMERS, COMPETITORS and COMM\_LAB) and from associations (ASSOCIATIONS and ENTREPRENEURS). However, the firms interact less with external networks from science institutions and open sources. Firms also interact less with external actors if they already perform EX\_RD. Based on this finding, the first hypothesis is supported.

Turning to informal knowledge (see Table 2), it can be observed that firms that source knowledge from market/commercials tend to interact with other market/commercials networks,



1  
2  
3 associations and open sources. However, these firms interact less with scientific institutions,  
4 with the exception that firms sourcing knowledge from COMM\_LABS tend to interact with  
5 UNIVERSITIES and GOV\_RD. Firms that source knowledge from SUPPLIERS and  
6 COMPETITORS are more likely to source from ASSOCIATIONS. In addition, firms tend to  
7 source knowledge from open sources if they already source from CUSTOMERS. To sum up,  
8 in the market/commercials groups, synergistic relationships tend to exist among  
9 market/commercials; between market/commercials and associations; and between  
10 market/commercials and open sources networks.

11  
12 In relation to scientific institutions, a synergistic relationship can also be identified  
13 among the institutions and between the institutions and associations. However, there are few  
14 negative and significant associations, and these are shown only between POLTECH and  
15 INVESTORS and between UNIVERSITIES and SCIENCE\_PUB. This may indicate that firms  
16 that already source knowledge from POLTECH tend not to interact with INVESTORS, while  
17 firms that source knowledge from UNIVERSITIES tend to cite knowledge from  
18 SCIENCE\_PUB. Lastly, firms that source knowledge from associations and open source  
19 networks are more likely to interact with all external knowledge networks proportionally.

20  
21 Turning to control variables, exporters tend to rely on knowledge that is sourced from  
22 SUPPLIERS and ENTREPRENEURS. Both national and multi-national firms are similar in  
23 that they have positive and significant associations with ENTREPRENEURS. In contrast, both  
24 national and multi-national firms have negative and significant associations with INVESTORS  
25 and the INTERNET. It is striking that HIGH\_TECH firms do not have positive associations  
26 with R&D activities. A speculative reason for this phenomenon is that these firms tend to  
27 import advanced technology from advanced countries as shown in Wie (2005) study. However,  
28 it is important to note that all the coefficient values among firm resources and a wide range of  
29 sources of knowledge tend to show weak relationships.

Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge)

INDEPENDENT VARIABLES	Model 1 IN RD	Model 2 EXT RD	Model 3 SUPPLIER	Model 4 CUSTOM	Model 5 COMPET	Model 6 CONSUL	Model 7 COMMLAB	Model 8 UNIVERSITY	Model 9 POLTECH
INTERNAL_RD	-	<b>.088**(.017)</b>	-.021 (.029)	<b>.059**(.026)</b>	<b>.045**(.023)</b>	.018 (.011)	<b>.023**(.011)</b>	<b>.019**(.009)</b>	.006 (.008)
EXTERNAL_RD <sup>1</sup>	<b>.568**(.098)</b>	-	.012 (.065)	-.032 (.060)	.021 (.051)	-.002 (.021)	.019 (.020)	-.003 (.016)	.010 (.013)
<i>Market/Commercials</i>									
SUPPLIERS	-.023 (.030)	.006 (.013)	-	.031 (.028)	-.005 (.026)	-.008 (.014)	<b>.025**(.012)</b>	-.003 (.011)	.005 (.009)
CUSTOMERS	<b>.077**(.028)</b>	-.006 (.012)	.041 (.029)	-	<b>.287**(.018)</b>	<b>-.023*(.014)</b>	.000 (.013)	.006 (.010)	-.003 (.009)
COMPETITORS	.044 (.030)	.005 (.011)	-.004 (.032)	<b>.329**(.022)</b>	-	<b>.031**(.012)</b>	.016 (.012)	-.003 (.010)	.006 (.008)
CONSULTANT	.081 (.063)	-.003 (.019)	-.043 (.066)	<b>-.158**(.063)</b>	<b>.109**(.047)</b>	-	<b>.072**(.016)</b>	.008 (.014)	.008 (.012)
COMMLAB	.085 (.063)	.031 (.019)	<b>.121*(.062)</b>	-.017(.066)	.050 (.051)	<b>.069**(.016)</b>	-	<b>.042**(.013)</b>	-.005 (.012)
<i>Science</i>									
UNIVERSITIES	<b>.176**(.076)</b>	-.027 (.026)	.0004 (.077)	.023 (.077)	-.075 (.063)	.020 (.020)	<b>.065***(.019)</b>	-	<b>.042***(.011)</b>
POLYTECHNIC	-.036 (.083)	.015 (.025)	.046 (.084)	-.134 (.085)	.018 (.062)	-.003 (.023)	-.016 (.024)	<b>.047***(.015)</b>	-
GOV_RD	-.013 (.071)	<b>-.051*(.029)</b>	-.014 (.078)	-.038 (.073)	-.025 (.057)	.001 (.021)	<b>.036*(.021)</b>	<b>.024*(.013)</b>	<b>.037***(.011)</b>
NON_PROFITRD	-.012 (.072)	<b>.048**(.023)</b>	-.034 (.077)	<b>.224***(.078)</b>	-.037 (.055)	.030 (.020)	.021 (.020)	.012 (.013)	<b>.019*(.010)</b>
<i>Associations</i>									
INVESTORS	.033 (.045)	<b>.024*(.014)</b>	.017 (.045)	.045 (.045)	.031 (.035)	.013 (.014)	-.001 (.015)	<b>.019*(.011)</b>	-.015 (.011)
IND_ASSOC.	.051 (.050)	-.011 (.017)	-.043 (.053)	.031 (.054)	-.007 (.041)	<b>.030**(.015)</b>	.004 (.016)	<b>.025**(.011)</b>	.006 (.010)
ENTREPRENEURS	<b>.176***(.037)</b>	-.006 (.013)	-.021 (.040)	<b>.125***(.036)</b>	<b>.064**(.030)</b>	.003 (.014)	.012 (.014)	-.010 (.012)	.010 (.009)
<i>Open sources</i>									
EVENTS	-.003 (.043)	.004 (.015)	.041 (.043)	<b>.177***(.044)</b>	<b>.064**(.033)</b>	.001 (.015)	-.005 (.015)	.009 (.011)	-.002 (.009)
SCIENCE_PUB	-.026 (.053)	.0003 (.017)	-.060 (.053)	<b>.215***(.061)</b>	.039 (.039)	.018 (.016)	<b>.033**(.015)</b>	-.014 (.013)	<b>.029***(.010)</b>
INTERNET	<b>.229***(.037)</b>	.011 (.012)	.050 (.040)	<b>.177***(.037)</b>	-.048 (.031)	<b>.029**(.013)</b>	-.022 (.015)	-.004 (.011)	.009 (.008)
<i>Firm resources</i>									
SIZE	-.0002(.0003)	-.0003(.0003)	.0002(.0001)	-.0001(.0001)	-.0003(.0003)	-.0003(.0004)	-.0003(.0002)	-.0001(.0002)	-.0002(.0003)
AGE	-.00006(.001)	-.0003(.0004)	.001(.001)	.001(.001)	.0001(.001)	.0003(.0004)	-.001(.0005)	-.001(.0004)	.0002(.0003)
EXPORT	-.0003(.0005)	.00002(.0002)	<b>.001**(.0004)</b>	.0004(.0004)	-.0001(.0004)	.0002(.0002)	.0002(.0002)	-.0003(.0002)	.00003(.0001)

<sup>1</sup> External R&D in this study is grouped in R&D activities along with internal R&D, however, based on the degree of externalisation, external R&D, informal and open networks, and cooperation activities 'are external to the enterprise to various degrees, depending on their ownership and the contractual structures of the relationship between our enterprise and the other party or parties to the transfer' (Frenz and Ietto-Gillies, 2009, p. 1126).

OWN_NATIONAL	.098(.064)	.007(.030)	.034(.059)	-.029(.057)	-.003(.051)	.013(.030)	.042(.033)	-.002(.021)	.014(.024)
OWN_MULTI	.123(.077)	-.0002(.037)	.102(.072)	-.005(.071)	-.067(.068)	.017(.036)	-	.014(.024)	.004(.029)
OWN_JOIN	-	-	-	-	-	-	-	-	-
OPS_PLANT	-.002(.043)	-.020(.022)	.016(.041)	-.031(.040)	-.013(.038)	-.001(.019)	-.027(.027)	.009(.013)	.012(.011)
OPS_HEAD	-	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.071(.029)	.012(.016)	.032(.031)	.027(.029)	-.032(.027)	.025(.016)	.007(.014)	<b>-.024***(.008)</b>	.010(.012)
MEDHIGH_TECH	.004(.044)	<b>-.025**(.010)</b>	.005(.042)	.036(.041)	-.036(.037)	-.006(.017)	.014(.023)	-.001(.015)	.008(.016)
HIGH_TECH	-.049(.109)	-	-.045(.095)	.188(.137)	-.095(.082)	-	-	.002(.037)	-
EDU_UNDERHS	-.0003(.001)	-.001(.001)	-.0004(.001)	-.0005(.001)	-.001(.001)	-.001(.001)	.001(.001)	-.0002(.0005)	.001(.001)
EDU_HIGHSCHOOL	-.0004(.002)	-.001(.001)	.001(.001)	-.0002(.001)	-.001(.001)	-.001(.001)	.001(.001)	-.0003(.001)	.0005(.001)
EDU_DIPLOMA	-.001(.003)	-.0004(.001)	.001(.003)	.001(.003)	.000(.002)	.000(.001)	.001(.001)	-.0002(.001)	.0004(.001)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-	-
RD_STAFF	.0001(.002)	<b>-.002*(.001)</b>	<b>.006***(.002)</b>	-.002(.002)	.000(.002)	.000(.001)	.000(.001)	-.0002(.001)	.000(.001)
Observation	1,179	1,168	1,179	1,179	1,179	1,168	1,119	1,179	1,168
LR chi2(29)	297.2	98.16	53.52	498.23	352.76	136.41	154.75	154.13	162.17
Prob > chi2	.000	.000	.0037	.000	.000	.000	.000	.000	.000
Pseudo R2	.209	.293	.047	.327	.281	.341	.385	.469	.553
Log likelihood	-563.198	-118.462	-547.930	-511.940	-451.881	-132.001	-123.827	-87.424	-65.588
Mean VIF	2.76	2.77	2.78	2.74	2.75	2.76	2.76	2.75	2.75

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.

Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge) (continued)

INDEPENDENT VARIABLES	Model 10 GOV_RD	Model 11 NPROFIT_RD	Model 12 INVESTOR	Model 13 TRADE ASSOC	Model 14 ENTREPRENEUR	Model 15 EVENTS	Model 16 SCIENCE_PUB	Model 17 INTERNET
INTERNAL_RD	.004 (.009)	.001 (.010)	.025 (.015)	<b>.030**(.013)</b>	<b>.087***(.016)</b>	.010 (.016)	.003 (.013)	<b>.112***(.016)</b>
EXTERNAL_RD	-.022 (.018)	<b>.030*(.017)</b>	<b>.048*(.028)</b>	-.011 (.025)	-.020 (.035)	.014 (.031)	.010 (.025)	.030 (.032)
<b>Market/commercials</b>								
SUPPLIERS	-.001 (.011)	-.007 (.012)	.004 (.017)	-.009 (.015)	-.014 (.020)	.017 (.018)	-.020 (.015)	.025 (.020)
CUSTOMERS	.002 (.010)	<b>.041***(.013)</b>	<b>.037**(.017)</b>	.013 (.015)	<b>.084***(.018)</b>	<b>.078***(.018)</b>	<b>.071***(.016)</b>	<b>.087***(.018)</b>
COMPETITORS	-.003 (.009)	-.010 (.010)	.016 (.016)	<b>.024*(.014)</b>	<b>.047***(.017)</b>	<b>.039**(.016)</b>	.019 (.013)	-.009 (.018)
CONSULTANT	-.000004 (.015)	.008 (.017)	.012 (.028)	<b>.042**(.021)</b>	.020 (.035)	-.003 (.031)	.019 (.022)	<b>.080**(.033)</b>
COMMLAB	<b>.023*(.014)</b>	.010 (.015)	-.009 (.028)	-.012 (.023)	.045 (.033)	-.005 (.030)	<b>.048**(.021)</b>	-.039 (.037)
<b>Science institutions</b>								
UNIVERSITIES	<b>.023*(.013)</b>	.013 (.015)	<b>.065**(.032)</b>	<b>.045*(.024)</b>	-.030 (.042)	.029 (.035)	<b>-.045*(.027)</b>	-.019 (.040)
POLYTECHNIC	<b>.050***(.015)</b>	.019 (.016)	<b>-.105**(.042)</b>	.001 (.027)	<b>.079*(.044)</b>	-.031 (.036)	<b>.081***(.024)</b>	.044 (.041)
GOV_RD	-	<b>.071***(.015)</b>	<b>.130***(.030)</b>	.032 (.022)	-.036 (.038)	.046 (.031)	.000 (.024)	.055 (.038)
NON_PROFITRD	<b>.061***(.012)</b>	-	.009 (.024)	<b>.036**(.017)</b>	-.029 (.028)	-.005 (.022)	.015 (.017)	-.028 (.029)
<b>Associations</b>								
INVESTORS	<b>.043***(.011)</b>	-.001 (.013)	-	<b>.046***(.015)</b>	<b>.164***(.021)</b>	<b>.058**(.023)</b>	.024 (.017)	.013 (.023)
IND_ASSOC.	.013 (.010)	<b>.022*(.012)</b>	<b>.058***(.021)</b>	-	<b>.085***(.020)</b>	<b>.077***(.018)</b>	-.017 (.016)	<b>.072***(.020)</b>
ENTREPRENEURS	-.010 (.011)	-.001 (.012)	<b>.123***(.017)</b>	.018 (.015)	-	.009 (.030)	.029 (.021)	-.062 (.040)
<b>Open sources</b>								
EVENTS	.016 (.010)	.002 (.012)	-.018 (.031)	.026 (.022)	-.010 (.039)	-	<b>.096***(.013)</b>	.033 (.023)
SCIENCE_PUB	-.0001 (.011)	<b>.026**(.012)</b>	-.019 (.021)	<b>.036**(.015)</b>	<b>.099***(.022)</b>	<b>.145***(.019)</b>	-	<b>.057**(.025)</b>
INTERNET	<b>.019*(.010)</b>	-.015 (.013)	.008 (.018)	<b>.034**(.014)</b>	.039 (.027)	.030 (.019)	-.007 (.016)	-
<b>Firm resources</b>								
SIZE	.00001(.00003)	-.00001(.00003)	.00002(.00001)	-.00001(.00002)	-.00004(.00003)	.00002(.00001)	-.00002(.00001)	.00003(.00001)
AGE	-.0004 (.0004)	.0001 (.0004)	.0002(.001)	-.001(.0005)	.001(.001)	-.001(.001)	-.0002(.0005)	-.0004 (.001)
EXPORT	-.00003 (.0002)	-.0002 (.0002)	-.00001(.0003)	.0002(.0002)	<b>.001**(.0003)</b>	-.0003(.0003)	-.0002(.0002)	-.00001(.0003)
OWN_NATIONAL	.022(.025)	-.01 (.020)	<b>-.061**(.031)</b>	.033(.035)	<b>.105**(.048)</b>	-.047(.033)	.008(.029)	<b>-.067*(.035)</b>
OWN_MULTI	.003(.030)	.007(.025)	<b>-.078**(.042)</b>	<b>.069*(.039)</b>	<b>.105*(.056)</b>	-.030(.043)	-.009(.039)	-.054(.045)
OWN_JOIN	-	-	-	-	-	-	-	-

OPS_PLANT	-.016(.020)	.002(.017)	-.030(.027)	-.021(.024)	.042(.027)	-.008(.027)	.005(.021)	.005(.028)
OPS_HEAD	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.006(.011)	<b>.0100(.010)**</b>	-.005(.018)	.002(.016)	.023(.023)	-.026(.019)	-.011(.016)	.014(.022)
MEDHIGH_TECH	.001(.015)	-	.018 (.029)	<b>.048(.028)*</b>	-.0003(.029)	-.027	.027(.025)	.027(.031)
HIGH_TECH	.0111(.103)	-.005(.034)	-.055 (.037)	.049(.076)	.015(.072)	.082 (.090)	-	-.038(.061)
EDU_UNDERHS	-.0004(.0004)	.001(.001)	-.001(.001)	.001(.001)	-.0001(.001)	.002(.001)	-.001(.001)	.000(.001)
EDU_HIGHSCHOOL	-.0004(.0005)	.001(.001)	-.001(.001)	.002(.001)	.0003 (.001)	.002 (.001)	<b>-.001*(.001)</b>	.000(.001)
EDU_DIPLOMA	-.0003(.001)	.002(.001)	-.0001(.002)	.001(.002)	-.002 (.002)	.002 (.002)	-.001 (.001)	.000(.002)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-
RD_STAFF	-.0004(.001)	.001(.001)	.001(.001)	.001(.001)	-.0004(.001)	.00 (.001)	.0002 (.001)	-.002(.001)
Observation	1179	1082	1179	1179	1179	1179	1168	1179
LR chi2(29)	226.89	172.32	249.06	210.13	405.55	326.27	251.48	252.34
Prob > chi2	.000	.000	.000	.000	.000	.000	.000	.000
Pseudo R2	.565	.485	.347	.369	.414	.399	.431	.304
Log likelihood	-87.225	-91.467	-234.216	-179.467	-287.107	-246.055	-165.938	-289.245
Mean VIF	1.34	2.75	2.75	2.76	2.75	2.75	2.75	2.76

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.

#### 4.3. Knowledge transformation activity

The main interest in this section is how various sources of knowledge contribute to innovation. Table 3 shows that IN\_RD has positive and significant effects on any type of innovation and innovation success. By contrast, EX\_RD's has no significant impacts on innovation and innovation success. Evidence that IN\_RD is the only source of knowledge that positively and significantly affects all types of innovation and innovation success may suggest that IN\_RD plays a more important role than the rest of the sources of knowledge. Therefore, based on this finding, Hypothesis 2a is supported.

Turning to informal knowledge, different sources of informal knowledge used in the innovation transformation activity have different impacts on types of innovation and innovation success. Among market/commercials networks, knowledge transformed from *customers* positively and significantly affects product innovation, product innovation new to the firm, marketing innovation and innovation success. While knowledge transformed from *competitors* positively and significantly affects product innovation new to the market, process innovation and marketing innovation. Surprisingly, knowledge from science institutions only influences process innovation and this finding differs compared from most previous studies that show a positive influence of science institutions on radical innovation. Knowledge that is generated from association (industry association and entrepreneurs) is more likely to influence innovation and innovation success in significant and negative ways. Open sources (*events*) contribute positively to product innovation, product innovation that new to the market, product innovation that new to the firms and innovation success.

In relation to firm resources, most variables have weak and negative effects on diverse types of innovation and innovation success. Only firms age and multi-national ownership influence innovation in significant and negative directions. Firm age has a weak negative and significant association with MKTGINOV. The same direction was found for the influence of multi-national firm status on ORGINOV.

Table 3. Knowledge transformation activity

INDEPENDENT VARIABLES	Model 1 PRODINOV	Model 2 PRODINN_N2M <sup>1</sup>	Model 3 PRODINN_N2F <sup>2</sup>	Model 4 PROCINOV	Model 5 ORGINOV	Model 6 MKTGINOV	Model 7 INN SUCCESS <sup>3</sup>
INTERNAL_RD	<b>.133***(.022)</b>	<b>.069***(.023)</b>	<b>.126***(.022)</b>	<b>.188***(.019)</b>	<b>.231***(.018)</b>	<b>.162***(.022)</b>	<b>8.342**(3.295)</b>
EXTERNAL_RD	.039(.065)	.077(.057)	.080(.067)	.093(.074)	.096(.074)	-.091(.069)	6.853(7.118)
<i>Market &amp; commercials</i>							
SUPPLIERS	-.027(.027)	-.026(.027)	-.021(.027)	-.004(.027)	-.007(.026)	.017(.027)	-5.139(3.724)
CUSTOMERS	<b>.062**(0.025)</b>	.039(.025)	<b>.053**(0.025)</b>	-.027(.025)	-.036(.025)	<b>.099***(.025)</b>	<b>6.122*(3.470)</b>
COMPETITORS	-.003(.025)	<b>.046*(.024)</b>	.004(.025)	<b>.042*(.024)</b>	.001(.025)	<b>.053**(0.026)</b>	3.970(3.364)
CONSULTANTS	.001(.051)	-.012(.048)	.009(.052)	-.075(.049)	-.002(.052)	.003(.053)	-5.513(6.529)
COMMLAB	.043(.053)	.013(.049)	.067(.054)	.060(.050)	-.004(.049)	.022(.054)	3.486(6.499)
<i>Science</i>							
UNIVERSITIES	.030(.063)	.059(.058)	.061(.065)	<b>-.123**(0.059)</b>	-.041(.061)	.036(.068)	6.438(7.874)
POLYTECHNIC	.053(.073)	.033(.068)	.001(.071)	<b>-.132*(0.068)</b>	.055(.066)	-.006(.070)	6.574(8.503)
GOVERNMENT_RD	-.098(.060)	-.030(.059)	-.073(.061)	<b>.109*(0.064)</b>	-.028(.060)	-.050(.064)	-1.260(7.652)
NON_PROFIT_RD	-.022(.022)	.026(.053)	-.032(.056)	<b>.149***(.057)</b>	-.045(.058)	.057(.061)	6.800(7.084)
<i>Associations</i>							
INVESTORS	.057(.057)	.036(.034)	<b>.068*(0.036)</b>	<b>.058*(0.035)</b>	.056(.035)	-.048(.036)	0.776(4.696)
IND_ASSOC.	-.056(.041)	<b>-.095**(0.039)</b>	<b>-.087**(0.041)</b>	-.036(.040)	.058(.043)	-.017(.044)	-8.185(5.473)
ENTREPRENEURS	<b>-.059*(.031)</b>	-.043(.031)	-.051(.031)	-.017(.030)	.013(.031)	-.049(.032)	<b>-6.954*(4.188)</b>
<i>Open resources</i>							
EVENTS	<b>.189***(.038)</b>	<b>.164***(.033)</b>	<b>.174***(.037)</b>	.028(.033)	.044(.035)	.026(.036)	<b>16.800***(4.387)</b>
SCIENCE_PUB.	-.033(.044)	-.047(.041)	-.010(.044)	-.022(.040)	-.040(.043)	-.012(.045)	-5.755(5.279)
INTERNET	-.039(.032)	-.029(.031)	-.040(.032)	-.024(.031)	.023(.032)	-.031(.034)	-2.148(4.210)
<i>Firm resources</i>							
SIZE	-.00002(.000)	-.00003(.000)	-.00001(.000)	.00004(.000)	-.00002(.000)	-.00001(.000)	-.001(0.004)
AGE	.00(.001)	.0001(.001)	.0002(.001)	-.001(.001)	.0003(.001)	<b>-.001*(.001)</b>	.009(0.114)
EXPORT	.0004(.000)	.001(.000)	.001(.000)	.00004(.000)	-.001(.000)	.00002(.000)	.056(0.054)
OWN_NATIONAL	.038(.062)	.001(.060)	.049(.062)	.037(.060)	-.064(.055)	.049(.059)	1.596(7.825)
OWN_MULTI	.006(.073)	-.049(.074)	.006(.073)	.007(.073)	<b>-.130*(.070)</b>	.011(.072)	-4.198(9.789)
OWN_JOIN	-	-	-	-	-	-	-
OPS_PLANT	.027(.039)	.010(.040)	.051(.040)	.004(.039)	-.014(.039)	.031(.039)	.601(5.286)

OPS_HEAD	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-
MED_LOW TECH	<b>.051(.029)*</b>	.036(.030)	<b>.058(.029)**</b>	-.009(.029)	.012(.030)	-.010(.029)	4.267(3.988)
MED_HIGH TECH	.036(.038)	<b>.063(.038)*</b>	.041(.038)	.014(.038)	-.046(.037)	.049(.037)	5.827(5.206)
HIGH_TECH	.106(.110)	.171(.118)	.130(.108)	<b>-.175(.095)*</b>	.039(.109)	.010(.122)	13.248(14.064)
EDU_UNDERHS	-.001(.001)	-.001(.001)	-.002(.001)	-.0001(.001)	-.0004(.001)	-.0002(.001)	-.235(.172)
EDU_HIGHSCHOOL	-.001(.001)	-.002(.001)	-.002(.001)	-.0003(.001)	-.0003(.001)	-.002(.001)	-.201(.182)
EDU_DIPLOMA	-.003(.003)	-.002(.002)	-.004(.002)	-.003(.002)	-.002(.003)	-.002(.003)	-.225(.330)
EDU_UNDERGRAD	-	-	-	-	-	-	-
RD_STAFF	-.001(.002)	.0003(.002)	-.002(.002)	-.001(.002)	-.001(.002)	.0001(.002)	.188(.226)
Number of obs	1179	1179	1179	1179	1165	1170	1179
LR chi2(57)	685.65	546.38	652.18	641.39	572.46	720.65	517.02
Prob > chi2	.000	.000	.000	.000	.000	.000	.000
Pseudo R2	.439	.3862	.4241	.4327	.401	.4519	.1192
Log likelihood	-438.107	-434.124	-442.875	-420.422	-427.534	-437.063	-1909.790
Mean VIF	3.50	3.50	3.50	3.50	3.50	3.50	3.50

Note: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in model 1-6 are marginal effects generated from logit models  
<sup>1</sup>Product innovation new to the market; <sup>2</sup>Product innovations new to the firms; <sup>3</sup>Innovation success derived from Tobit regression



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3 The impact of internal R&D (IN\_RD) on all types of innovation and innovation success is  
4 positive and significant. There is only a marginal significant impact of external R&D (EX\_RD)  
5 on organisational innovation.  
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#### 10 4.4. Knowledge exploitation activity

11 Table 4 displays the statistical output of OLS regression for knowledge exploitation activity.  
12 Because data on sales and employee growth are not available in the IIS 2011, this study uses  
13 productivity as the only indicator of firm performance, as presented in Table 4. In the first  
14 model PRODINOV is excluded. Strikingly, PRODINOV\_NEW2MARKET and  
15 PRODINOV\_NEW2FIRM innovations as well as INNOVSUCCESS have no significant effect  
16 on firms' performance that is proxied by productivity. When both PRODINOV and  
17 INNOVSUCCESS are excluded (model 2), there is no significant influence of either  
18 PRODINOV\_NEW2MARKET or PRODINOV\_NEW2FIRMS on productivity. In the third  
19 model, in which PRODINOV\_NEW2MARKET and PRODINOV\_NEW2FIRMS are  
20 excluded, there is no significant effect of PRODINOV and INNOVSUCCESS on productivity.  
21 Another surprising finding is that, in contrast, non-product innovations including PROCINOV,  
22 ORGINOV and MKTGINOV, significantly affect productivity in all models. Positive  
23 associations were found between both PROCINOV and ORGINOV and productivity, while a  
24 negative association was found between MKTGINOV and productivity. The evidence that  
25 INNOVSUCCESS has negative and insignificant impact on productivity is in line with  
26 previous studies (Ganotakis and Love, 2012; Roper *et al.*, 2008; Roper and Arvanitis, 2012).  
27 Based on these findings, Hypothesis 3 partially is supported.  
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40 Firm resources negatively and significantly affect productivity, but only in low-  
41 technology firms. Variables such as size, age, export and the lowest level of education have  
42 negative associations with productivity. In contrast, in high-tech firms, having employees with  
43 high school and undergraduate degrees is positively associated with productivity.  
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Table 4. Knowledge exploitation activity

INDEPENDENT VARIABLES	Model 1 PRODUCTIVITY	Model 2 PRODUCTIVITY	Model 3 PRODUCTIVITY
PRODINOV	-	-	268.160(716.413)
PRODINOV_NEW2MARKET	668.224(1122.881)	-289.371(832.420)	-
PRODINOV_NWE2FIRM	-45.167(820.431)	48.857(817.301)	-
PROCINOV	<b>1964.657***(631.219)</b>	<b>1985.895***(631.165)</b>	<b>1985.412***(629.213)</b>
ORGINOV	<b>2511.089***(631.492)</b>	<b>2578.718***(629.410)</b>	<b>2518.678***(632.025)</b>
MKTGINOV	<b>1756.931***(604.736)</b>	<b>-1767.292***(604.841)</b>	<b>-1746.373***(603.329)</b>
INNOVSUCCESS	-29.379(23.128)	-	-21.282(18.660)
<b><i>Firm resources</i></b>			
Size	-0.074(.184)	-0.077(.184)	-0.075(.184)
Age	-22.201(19.116)	-22.262(19.121)	-22.451(19.115)
Export	-7.785(9.670)	-7.583(9.672)	-7.678(9.661)
OWN_NATIONAL	362.853(1241.632)	371.125(1241.944)	351.187(1241.068)
OWN_MULTI	1109.779(1566.056)	1101.907(1566.458)	1076.938(1565.01)
OWN_JOIN	-	-	-
OPERATION_PLANT	-1003.043(879.703)	-986.841(879.843)	-997.590(879.377)
OPERATION_HEAD	-	-	-
LOW_TECH	-	-	-
MEDLOW_TECH	580.331(649.173)	580.257(649.345)	577.387(648.739)
MEDHIGH_TECH	<b>2005**(912.806)</b>	<b>2044.913**(912.506)</b>	<b>2025.741**(911.861)</b>
HIGH_TECH	2421.285(2542.052)	2457.057(2542.568)	2477.757(2539.589)
EDU_UNDERHS	-48.366(31.223)	-47.312(31.220)	-48.391(31.215)
EDU_HIGHSCHOOL	-43.934(33.014)	-43.345(33.020)	-44.058(33.000)
EDU_DIPLOMA	-44.996(58.843)	-44.698(58.858)	-45.006(58.821)
EDU_UNDERGRAD	-	-	-
RD_STAFF	11.331(37.141)	10.115(37.138)	11.454(37.121)
Obs.	1179	1179	1179
F ( )	2.92	3.00	3.07
Prob > F	.000	.000	.000
R <sup>2</sup>	.046	.044	.046
Adj. R <sup>2</sup>	.030	.030	.031
Root MSE	8272.30	8274.50	8270.00

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . The results are based on OLS regressions.

## 5. DISCUSSION AND CONCLUSIONS

This study investigates and models the IVC that encompasses knowledge sourcing, transformation and exploitation activities of Indonesia manufacturing firms using data from the IIS 2011. The literature on the IVC framework has been widely used to analyse interrelationships among firm interaction, innovation, business growth and productivity in developed countries, however, based on the reviewed literature there is no empirical evidence on the IVC in the context of Indonesia. From theoretical point of view, this study contributes on innovation process framework development by uncovered the nature of interrelationships within each stage and between linkages of the IVC performed by Indonesian firms.

Key findings of this study are as follows. First, in the first link of the IVC, this study finds the existence of strong synergistic relationships between internal R&D and external sources of knowledge as well as among external sources of knowledge. This may indicate a similar pattern of knowledge sourcing activity to that in developed countries, namely the implementation of “open innovation strategy”. The role of external networks tends to be less important when the firms already source knowledge for innovation from external R&D activities. External actors from market/commercial groups (i.e. customers and competitors) have important roles as knowledge providers if the firm also generates knowledge from internal R&D. In contrast, the firms’ interactions with scientific institutions tend to be of lesser importance. The firms that source knowledge from market/commercials network interact less with scientific institutions, but they do interact with their own networks, associations and open sources. A synergistic relationship can also be found among science institutions. In relation to formal cooperation, firms tend to restrict cooperation with firms within the same group and with suppliers when they perform internal or external R&D activities. This finding supports the recent studies on complementary relationship between internal and external knowledge sourcing activities (Bogers and Lhuillery, 2018; Doran *et al.*, 2019; Majidpour, 2017; Paula and Da Silva, 2018).

Second, in the second link of the IVC, internal R&D plays important roles and has strong positive impacts on all types of innovation and innovation success. External knowledge that shows similar patterns in shaping innovations mainly comes from informal knowledge from customers and competitors. Knowledge generated from scientific institutions makes no significant contribution to innovation and innovation success. Positive impacts on process innovation come only from government and non-profit R&D, while university and polytechnic sources contribute negatively to process innovation. This contradicts previous studies stating that novel and highly advanced innovation requires greater levels of R&D, patents or

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3 knowledge from science institutions such as universities and research centres (Amara and  
4 Landry, 2005; Tödting *et al.*, 2009).

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6 Third, the final link of the IVC relates to the impact of innovation on productivity  
7 provides surprising results. In general, product innovations new to the market and new to the  
8 firm as well as innovation success have no significant impact on productivity. The fact that  
9 innovation success is negatively associated with productivity may prompt questions related to  
10 the quality of innovative products that may be not able to disrupt the market and this may  
11 severely impact the firms' sales and further impact productivity.  
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17 The finding that neither product innovations new to the market and new to the firm nor  
18 innovation success lead to productivity, perhaps due to the firms' efforts to detect and  
19 overcome any weak links in the IVC to boost productivity. First, sourcing activity that relies  
20 on synergy between internal R&D and external networks, mainly from market/commercials,  
21 automatically influences the minimum usage of other sources of knowledge such as scientific  
22 institutions that may provide additional added value for firms. In this sense, a diverse open  
23 innovation strategy may need to be implemented with the hope that the use of more diverse  
24 and better-quality sources of knowledge able to overcome the weak links in knowledge  
25 sourcing activities. Second, the low quality of firms' human resources may contribute to the  
26 success of knowledge sourcing, transformation and exploitation as indicated by no positive  
27 contributions to the three links of IVC. Third, diverse of innovation barriers that hamper  
28 Indonesian manufacturing firms may affect the success of the IVC activities. Lastly,  
29 environments external to the firms, or a weak conditional framework for innovation in  
30 Indonesia, may contribute indirectly to the success of the IVC activities.  
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41 Findings from this study are expected to enrich literature of innovation studies, especially  
42 innovation process framework in the context of developing countries, in several ways. First,  
43 the fact that non-technological innovation (i.e. marketing innovation) is the highest proportion  
44 of innovation produced by Indonesian manufacturing firms support and confirm previous  
45 studies that reveal most firms in in developing countries: tend to focus on market rather than  
46 technological innovation (Wamae, 2009), beyond traditional focus on R&D (Srholec, 2011),  
47 and attempt to reach the technological frontier instead of achieving inventions that are new to  
48 the market (Hou and Mohnen, 2013). Second, the highest proportion of knowledge sourced by  
49 Indonesian manufacturing firms mainly from informal source of knowledge e.g. customers and  
50 competitors. This also confirms previous innovation studies in Indonesia that reveal innovation  
51 in Indonesian manufacturing sectors generally as the results of learning through "informal  
52 experiences" not through "formal scientific activity or R&D" (Aminullah, 2012; Aminullah *et*  
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3 *al.*, 2014). Third, this study also confirms the existence of complementary or synergy  
4 relationships between internal and external knowledge sourcing activities that has been tested  
5 as part of innovation process framework in most studies conducted in developed economies.  
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### 10 5.1. Innovation policy implication

11 Based on the findings from the first and second links of the IVC, relevant innovation policies  
12 may be proposed. The fact that Indonesia faces problems related to scientific institutions such  
13 as “low public and private investment in R&D”, “a low-ranking higher education and training  
14 system” and “a small number of researchers and scientists for a country of its size” (OECD,  
15 2013, p. 175), may present a problem for synergistic relationships between scientific  
16 institutions and other external agents. Further impact is clearly seen in the second link of the  
17 IVC in which the knowledge used from scientific institutions, both informally and formally,  
18 negatively impacts innovations. Therefore, government policy, for instance, promoting a triple  
19 helix strategy that involves university-industry-government interaction and partnership, may  
20 help address these challenges to improve knowledge transfer by integrating the three types of  
21 institutions. As argued by Tambunan (2005), triple helix implementation in Indonesia has been  
22 relatively slow. The Indonesian government initiated the development of incubators and  
23 science parks in 1990 with UNDP’s support, but the development of these incubators has been  
24 very slow (Simamora, 2009). Public scientific institutions such as techno parks may be used  
25 by Indonesian firms to generate knowledge from R&D activities when they lack sufficient  
26 internal funds. In relation to synergistic relationship between internal R&D and a wide range  
27 of external sources of knowledge, this study also suggests that rather than engaging exclusively  
28 in either R&D or external linkages, firms may adopt a hybrid strategy of leveraging knowledge  
29 from both sources of knowledge in the innovation process. It is believed that the proposed  
30 policies implication also relevant for firms in developing economies since Firms in emerging  
31 economies tend to experience substantial institutional, resources and capability barriers that  
32 affect successful innovation (Fu *et al.*, 2014).  
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### 51 5.2. Limitation of the study

52 Finally, limitations of this study need to be acknowledged. First, issues related to firms’ sectors  
53 has not been discussed in this study and as a result, sectors’ effects on the three links of IVC  
54 cannot be detected. The variation among firm sectors is only derived from the classification of  
55 technology intensity. Second, this study uses IIS 2011 data that is restricted to manufacturing  
56 firms. The comparison of the IVC activities between manufacturing and service firms may  
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3 provide fruitful insight into innovation policies for Indonesia. Therefore, these issues should  
4 be studied in the future research. Third, this study is a cross-sectional in nature i.e. the study  
5 only portrays IVC based on IIS 2011 data, as a result dynamic of Indonesian manufacturing  
6 firms' IVC is missing. Hence, future studies may address this limitation by conducting a  
7 longitudinal study. Fourth, this study lack of update insight on IVC of Indonesian firms since  
8 there is no update on innovation survey data. Lastly, specific issues related to each stage of the  
9 IVC importantly should be explored. In the knowledge sourcing activity stage, the issue related  
10 to formal cooperation with various external partners has not been addressed, hence it is  
11 recommended to test it in the future studies. In addition, factors that may hinder the success of  
12 the IVC i.e. innovation barriers are not yet investigated. Since it is limited insight on the linking  
13 innovation barriers into the IVC activity.  
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**Journal of Asia Business Studies - JABS-05-2020-0209.R1**

1 message

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**Journal of Asia Business Studies** <onbehalf@manuscriptcentral.com>

26 September 2020 at 23:02

Reply-To: sanjay.singh@adu.ac.ae

To: arif.hartono@uii.ac.id, 083110101@uii.ac.id

26-Sep-2020

Dear Dr. Hartono,

Your manuscript entitled "From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms" has been successfully submitted online and is presently being given full consideration for publication in the Journal of Asia Business Studies.

Your manuscript ID is JABS-05-2020-0209.R1.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to ScholarOne Manuscripts at <https://mc.manuscriptcentral.com/jnlabs> and edit your user information as appropriate.

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Thank you for submitting your manuscript to the Journal of Asia Business Studies.

Yours sincerely,  
Journal of Asia Business Studies Editorial Office

**05**

**Bukti konfirmasi hasil review kedua –  
Minor Revision dan Artikel revisi kedua  
(12 Desember 2020)**

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**Journal of Asia Business Studies - Decision on Manuscript ID JABS-05-2020-0209.R1**

1 message

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**Journal of Asia Business Studies** <onbehalf@manuscriptcentral.com>

12 November 2020 at 05:44

Reply-To: profsanjaysingh16@gmail.com

To: arif.hartono@uii.ac.id, 083110101@uii.ac.id

11-Nov-2020

Dear Dr. Hartono:

Manuscript ID JABS-05-2020-0209.R1 entitled "From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms" which you submitted to the Journal of Asia Business Studies, has been reviewed. The comments of the reviewer(s) are included at the bottom of this letter.

The AE has recommended revisions to the submitted manuscript, before it can be considered for publication. Therefore, I invite you to respond to the AE's comments and revise your manuscript.

To revise your manuscript, log into <https://mc.manuscriptcentral.com/jnlabs> and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision.

You will be unable to make your revisions on the originally submitted version of the manuscript. Instead, revise your manuscript using a word processing program and save it on your computer. Please also highlight the changes to your manuscript within the document by using the track changes mode in MS Word or by using bold or coloured text.

Once the revised manuscript is prepared, you can upload it and submit it through your Author Centre. The deadline for uploading a revised manuscript is 11-Dec-2020 from receiving this email. If it is not possible for you to resubmit your revision within this timeframe, we may have to consider your paper as a new submission.

When submitting your revised manuscript, you will be able to respond to the comments made by the reviewer(s) in the space provided. You can use this space to document any changes you make to the original manuscript. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response to the reviewer(s).

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Once again, thank you for submitting your manuscript to the Journal of Asia Business Studies and I look forward to receiving your revision.

Yours sincerely,  
Dr. Sanjay Singh  
Editor-in-Chief, Journal of Asia Business Studies  
[profsanjaysingh16@gmail.com](mailto:profsanjaysingh16@gmail.com)

**Associate Editor Comments:**

Area Editor

Comments to Author::

Thanks for making the changes as recommended by the review team. As a result, your paper is much stronger. I recommend making following minor changes:

1. End the paper with a concluding paragraph (not limitations).
2. Go over the paper and remove any typos, grammatical errors and informal language. Please also remove highlights.
3. Instead of using acronym after acronym in the text (e.g., para 4.4), spell out in plain English.
4. Include robustness tests from 2014 data in your response letter. Or provide an explanation why this is not possible.
5. In abstract, remove data waves as limitations and replace it with other limitations from the limitations section, which seem far more consequential.

**Reviewer(s)' Comments to Author:**

Reviewer: 1

Recommendation: Accept

**Comments:**

Thanks for addressing my comments.

**Additional Questions:**

Importance of the Topic/Issues Addressed to the Field of Asia Business: Important

Conceptual Rigour (Treatment of relevant literature, logical reasoning, etc.): Good

Methodological Rigor (Research design, sample, measures, and analysis) Skip if not applicable: Good

Clarity of the Objectives of the Paper: Good

Clarity of Presentation/Readability of the Paper: Good

Appropriateness of the Topic/Issues for the Journal of Asia Business Studies: Appropriate

Contribution of the Paper in its Current Form to Advancing Knowledge Regarding Asia Business: Important contribution

Contribution of the Paper to Advancing Knowledge Regarding Asia Business if revised along suggested lines: Important contribution

Reviewer: 2

Recommendation: Accept

**Comments:**

Thanks for incorporating the required changes.

**Additional Questions:**

Importance of the Topic/Issues Addressed to the Field of Asia Business: Important

Conceptual Rigour (Treatment of relevant literature, logical reasoning, etc.): Good

Methodological Rigor (Research design, sample, measures, and analysis) Skip if not applicable: Good

Clarity of the Objectives of the Paper: Good

Clarity of Presentation/Readability of the Paper: Good

Appropriateness of the Topic/Issues for the Journal of Asia Business Studies: Appropriate

Contribution of the Paper in its Current Form to Advancing Knowledge Regarding Asia Business: Important contribution

Contribution of the Paper to Advancing Knowledge Regarding Asia Business if revised along suggested lines: Important contribution





**From Knowledge Sourcing to Firms' Productivity:  
Investigating Innovation Value Chain of Indonesian  
Manufacturing Firms**

Journal:	<i>Journal of Asia Business Studies</i>
Manuscript ID	JABS-05-2020-0209.R2
Manuscript Type:	Research Paper
Keywords:	innovation value chain, productivity, manufacturing firms, Indonesia

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**RESPONSES TO REVIEWERS' COMMENTS:**

Dear Editor in Chief of JABS,

We are very excited to have been given the opportunity to revise our manuscript. We carefully considered your comments as well as those offered by the two reviewers. Herein, we explain how we revised the paper based on those comments and recommendations in the following table. We want to extend our appreciation for taking the time and effort necessary to provide such insightful guidance.

Kind Regards,

Arif Hartono

No	Reviewer Comments	Responses	Page
1	<p><b>Reviewer 1 – Major Revision</b></p> <p><b>Introduction section:</b> Overall framing can be improved by highlighting the unique context of the study. Also, would be good to provide theoretical support and justification for the research question(s) within the introduction part.</p>	<p>Many thanks for the suggestion regarding the introduction section. We keep the introduction section very short (one page) to avoid the number of words exceed 10,000. But we realise that important information that shapes the research novelty of the study is missing.</p> <p>Therefore, we have added 6 new paragraphs (including overall structure of the paper as suggested by reviewer 2) that contains justification on why conducting the study is important.</p> <p>We highlighted the additional information.</p>	2-4
2	<p><b>Literature review section:</b> Conceptual part would benefit by adding more recent literature around global value chains and institutions. This will also help you to strengthen the argumentation leading to your hypotheses</p>	<p>Many thanks for providing the list of recent studies on global value chains and institutions. However, the concept of innovation value chain (IVC) is different compared to global value chain (GVC).</p> <p>We have added recent articles on the issues of complementary relationship between internal and external knowledge to strengthen the argumentation leading to hypothesis 1 and 2b.</p> <p>We highlighted the additional information.</p>	4-5 6-7 8 9
3	<p><b>Methodology section:</b> Methods and analysis- it would be helpful to provide more information whether there were any differences across the sample firms in terms of their knowledge acquisitions strategies?</p>	<p>Many thanks for the suggestion. Unfortunately, the study did not intend to assess IVC across different types of industry classification since the proportion of firms in each industry classification is varied (see table 1 at the end of this section). The table shows that food and beverages firms outnumbered the distribution of sample by industry.</p>	
4	<p><b>Discussion section:</b> Discussion and implications. In this section, it would be good to draw key implications of the results and</p>	<p>We have addressed the reviewer feedback in the Discussion and Conclusions section.</p> <p>We highlighted the additional information.</p>	25-27

	compare and contrast them with the extant literature on this topic. What are the key contributions of this study to a particular theory such as knowledge-based view or org learning? The future research direction section can be further enhanced by highlighted specific areas where more work is needed, and also include relevant literature in this section when you identify a potential area for future research.		
	<b>Reviewer 2 – Minor Revision</b>		
1	<b>Introduction section:</b> In introduction section, author(s) should provide the overall structure of the paper.	Many thanks for the feedback. We have provided the overall structure of the paper at the end of introduction section.  We highlighted the additional information.	2-4
2	<b>Literature review section:</b> In Conceptual Foundation and Hypotheses Development section, author(s) have not provided any linkage to any theory while building the hypotheses.	In Conceptual Foundation and Hypotheses Development section, we briefly explained the link between IVC and innovation process. We also highlighted previous model and frameworks of innovation process and IVC.  We highlighted the additional information.	4-5 6-7 8 9
3	<b>Methodology section:</b> The major concern from my side is the time when data was collected. It was collected for 2009-2010. Almost a decade has been passed and there may have significant changes in the data. The author(s) need to provide clarification/justification/limitation with respect to this data.	Many thanks for the feedback. Of the three waves of innovation survey, the second wave of the survey (2011) has the greatest number of data compared to the rest of the surveys. Therefore, the 2011 innovation survey is used in this study.  We highlighted the additional information.	9
	In table 1 (Descriptive statistics), unit of measurement of items are missing.	We have addressed the feedback.  We highlighted the additional information.	12-13

	<p>In section 4.2, author(s) mention that “Table 2 indicates a synergistic relationship between internal and external R&amp;D and.....”.</p> <p>However, they have not mentioned how. Author(s) need to clarify this based on the table by providing detailed explanation.</p>	<p>We have addressed the feedback.</p> <p>We highlighted the additional information.</p>	13
4	<p><b>References:</b></p> <p>At number of places, references used are not as per standards. So, author(s) need to rectify them.</p>	<p>Many thanks for the suggestion. We have complied JABS author guidelines (Emerald Harvard referencing style) that can be found in the below link:</p> <p><a href="https://www.emeraldgrouppublishing.com/journal/jabs?distinct_id=174995c51c23e3-06f3a198f69594-333769-1fa400-174995c51c337b&amp;_ga=2.214867991.1424913300.1600987705-1558715388.1600300799#author-guidelines">https://www.emeraldgrouppublishing.com/journal/jabs?distinct_id=174995c51c23e3-06f3a198f69594-333769-1fa400-174995c51c337b&amp;_ga=2.214867991.1424913300.1600987705-1558715388.1600300799#author-guidelines</a></p>	

Table 1 Distribution of sample by industry

ISIC Rev 3	Manufacture Sectors	Sample (1,179 firms) in %
Division 15	Food & beverages	26.21
Division 16	Tobacco products	5.00
Division 17	Textiles	10.69
Division 18	Wearing apparel; dressing and dyeing of fur	8.99
Division 19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	2.97
Division 20	Wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	5.00
Division 21	Paper and paper products	1.78
Division 22	Printing and publishing	3.39
Division 23	Coke, refined petroleum products, & nuclear fuel	0.08
Division 24	Chemicals & chemical products	3.50

Division 25	Rubber & plastics products	5.34
Division 26	Other non-metallic mineral products	8.31
Division 27	Basic metals	0.51
Division 28	Fabricated metal products, except machinery and equipment	3.14
Division 29	Machinery & equipment n.e.c	1.27
Division 30	Office, accounting & computing machinery	0.08
Division 31	Electrical machinery & apparatus n.e.c	0.93
Division 32	Radio, TV & communication equipment & apparatus	0.68
Division 33	Medical, precision & optical instruments, watches and clocks	0.17
Division 34	Motor vehicles, trailers & semi-trailers	1.19
Division 35	Other transport equipment	1.27
Division 36	Furniture; manufacturing n.e.c.	8.99
Division 37	Recycling	0.45

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3 **From Knowledge Sourcing to Firms' Productivity:**  
4 **Investigating Innovation Value Chain of Indonesian Manufacturing Firms**  
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8 **Purpose** – The study investigates the innovation value chain (IVC) that encompasses knowledge  
9 sourcing, transformation, and exploitation activities among Indonesian manufacturing firms by using  
10 data from the Indonesia Innovation Survey (IIS).  
11

12 **Design/methodology/approach** – A simple approach of single equation Probit model, Logit  
13 regression, and Tobit regression are used in the first, second, and third stages of IVC consecutively.  
14

15 **Findings** – The study finds the existence of a synergistic relationship between internal and external  
16 sources of knowledge as well as among external sources of knowledge. In terms of the second link of  
17 the IVC, internal R&D plays an important role that positively influences knowledge transformation  
18 into all types of innovation and innovation success. External knowledge that has a similar pattern in  
19 shaping innovation mainly comes from market/commercials and open sources. Scientific institutions  
20 tend to contribute to innovation in a negative manner, and few positive impacts on process innovation  
21 are observed from government R&D and non-profit R&D institutions. Informal knowledge is more  
22 likely to influence technological than non-technological innovation.  
23

24 **Originality** – This study is different from the previous IVC studies due to the following reasons. First,  
25 in this study a broader source of knowledge is tested. Second, wider innovation (i.e. technological and  
26 non-technological innovation) is also assessed.  
27

28 **Research limitations** – Since Indonesia has only three waves of innovation surveys i.e. 2008, 2011,  
29 and 2014, hence update insight taken from the survey is not available.  
30

31 **Keywords:** innovation value chain, productivity, manufacturing firms, Indonesia  
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## 1. Introduction

Interest in innovation studies has been increasing in general, with no exception in the case of developing countries. However, innovation in the context of developing countries cannot necessarily be explained using the same concepts applied to developed countries, because developing countries are subject to different challenges in terms of the capital, infrastructure, intellectual and analytical foundations of innovation system analysis (Choi and Williams, 2013; Lorentzen, 2010; Metcalfe and Ramlogan, 2008; Mytelka, 2000). Da Silveira (2001) emphasises that it is important to study innovation in developing countries because most theories, approaches, mechanisms and technical changes associated with innovation that affect managerial practices and skills were developed based on evidence from developed countries. The relevancy and adaptability of any model, framework or construct of innovation studies that was developed, built and tested in developed countries needs to be re-evaluated prior to being implemented in developing countries. This study aims to extend previous studies of innovation value chains (IVC) conducted in developed economies, such as North America and Europe (Hansen and Birkinshaw, 2007), Ireland (Roper *et al.*, 2008) and the UK (Ganotakis and Love, 2012; Love *et al.*, 2011), by using innovation survey data of manufacturing firms in the developing economy of Indonesia.

According to Hansen and Birkinshaw (2007, p. 122), the IVC is “a sequential, three-phase process that involves idea generation, idea development, and the diffusion of developed concepts”. The IVC concept was derived from innovation research projects which interviewed 130 executives from 30 multi-national firms in North America and Europe. Extending Hansen and Birkinshaw’s (2007) work, innovation survey based IVC studies were conducted by other scholars (Doran and O’leary, 2011; Ganotakis and Love, 2012; Love *et al.*, 2011; Roper *et al.*, 2008; Roper and Arvanitis, 2012). Following these scholars, this study aims to investigate the IVCs of knowledge sourcing, transformation and exploitation activities performed by Indonesian manufacturing firms. This study focuses on the IVC in Indonesia context because to date, no previous study has looked at the IVC based on data derived from innovation surveys of Indonesian firms. This study intends to address previous studies’ imbalance and to provide a new empirical contribution to the understanding of IVC activity based on a firm-level analysis of Indonesian manufacturing firms.

In Indonesia context, previous studies that investigate knowledge sourcing and using activities limited on case studies in specific industry. For instances, collaboration and innovation adoption in small-scale industry clusters (e.g. Sandee and Rietveld, 2001); innovation and information flow in small-scale cottage industries in a rural area (Kristiansen, 2002); sources of knowledge in small furniture industries (Van Geenhuizen and Indarti, 2005); and innovation and cooperation activities of



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3 SMEs in food processing industry clusters (Najib and Kiminami, 2011). These studies reveal some  
4 important issues such as (1) the most innovation adopted is product innovation; (2) collaboration  
5 among producers (inter-firm cooperation) in SMEs clusters play important role in their innovation  
6 activities; (3) traditional knowledge sources such as in-house learning by doing and experiment,  
7 customers and competitors are the main knowledge sources in the innovation process; and (4) factors  
8 that hamper innovation activities is lack of: access to information on market and advanced technology,  
9 financial to fund innovation activities, and social capital development.

15 More examples on knowledge sourcing is a qualitative study that investigates the role of  
16 academia as external source of innovation in Indonesian automotive industry (Aminullah and Adnan,  
17 2012). The study found that consumers and competitors are the main sources of innovation in  
18 Indonesian automotive industry, while universities and academia have a weak contribution as the  
19 sources of innovation. Therefore, this study intends to address this unbalance and to provide a new  
20 empirical contribution on the understanding of the IVC activity based on firm-level analysis of  
21 Indonesian manufacturing firms. Furthermore, this study also intends to build the IVC model based on  
22 innovation activities of the Indonesian manufacturing firms that encompass the three IVC activities  
23 (i.e. knowledge sourcing, transformation and exploitation). From a practical perspective, findings of  
24 this study are expected can be used by policy makers at government and firm levels to identify  
25 innovation activities as well as to detect any weak links in the IVC; therefore, relevant innovation  
26 policy and strategy can be formulated to foster innovation in Indonesia.

36 This study is different compared to the previous IVC studies in several ways. First, in this study  
37 a wider range sources of knowledge that consists of (1) R&D activities (internal and external R&D)  
38 and (2) informal knowledge gains from market agents, scientific institutions, associations, and open  
39 sources. As argued by previous scholars that sourcing knowledge from diverse sources can increase  
40 the degree of innovation's novelty (Amara and Landry, 2005) and the difficulty to be replicated in  
41 order to generate sustainable competitive advantage (Henderson and Cockburn, 1996).

46 Second, a wider innovation classification such as organisational and marketing innovation are  
47 assessed (see Battisti and Stoneman (2010) for innovation classification), while most innovation  
48 survey-based the IVC studies in developed countries context tend to focus on traditional innovation  
49 i.e. product and process innovations (e.g. Doran and O'Leary, 2011, Ganotakis and Love, 2012, Love  
50 *et al.*, 2011, Roper *et al.*, 2008, Roper and Arvanitis, 2012a). As argued by Battisti and Stoneman  
51 (2010) that joint adoption of technological and non-technological innovations found to play a major  
52 role than rely on traditional or technological innovation as shown in a majority of innovation literature.  
53 In addition, in the context of developing countries, innovation activities tend to focus on the market  
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3 rather than on the technology (Wamae, 2009). This in line with the innovation activities in developing  
4 countries that emphasise on minor and incremental changes on existing products or process innovation  
5 as well as innovative approaches to organisation and marketing are a major part of innovation (OECD  
6 and Eurostat, 2005). Therefore, it is expected that the study provides different findings compared to  
7 the existing IVC studies.  
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12 Research questions relate to the IVC activities that are addressed in this study are as follows: (1)  
13 To what extent are the various knowledge sources activities used by Indonesian manufacturing firms?  
14 (2) To what extent the various knowledge sources are used in the knowledge transformation activity  
15 associated with diverse types of innovation? (3) To what extent do the different types of innovation  
16 and innovation success influence firm performance that is proxied by productivity?  
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21 The rest of the paper is organized as follows. In the next section conceptual foundation and  
22 hypotheses relate to the IVC activities are presented. In this section, distinction between knowledge  
23 sourcing, transformation and exploitation activities is discussed. Section 3 explains data and methods  
24 used in this study. Furthermore, section 3 describes the data, variables, and methods for testing the  
25 proposed hypotheses. Section 4 reports the results, and details to what extent the proposed hypotheses  
26 have been confirmed. The final section contains the discussion and conclusions.  
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## 31 32 33 **2. Conceptual Foundation and Hypotheses Development**

34 Previous studies have attempted to develop models and theoretical frameworks to capture the  
35 innovation process of firms. Previous models of innovation process in the industrially advanced  
36 countries have been developed, for instances five generation of innovation process (Rothwell, 1994),  
37 a stage-gate model of innovation (Cooper, 1989), and funnel model (Wheelwright and Clark, 1992).  
38 However, none of these models attempt to deal with the issue of developing countries catch up from  
39 behind the technology frontier, because in the catch-up case innovation occurs based on minor  
40 improvements to existing process and product designs (Hobday, 2005). Therefore, the models may not  
41 be relevant to the Indonesian context. The concept of IVC is concerned with the innovation process  
42 whereby firms source knowledge, transform this knowledge into innovation output, and finally exploit  
43 innovation output for performance gains (Hansen and Birkinshaw, 2007). Previous models of IVC in  
44 the industrially advanced countries have been developed. Using innovation survey data, the following  
45 scholars (e.g. Battisti and Stoneman, 2013; Doran and O'Leary, 2011; Ganotakis and Love, 2012b;  
46 Love *et al.*, 2011; Roper *et al.*, 2008) have drawn the IVC model. However, their models tend to focus  
47 on internal R&D activity and limited number of external linkages such as market and public R&D as  
48 the sources of knowledge. In addition, their models focused on traditional innovation (i.e. product and  
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3 process innovation), while in this study a wider innovation such as organisational and marketing  
4 innovation are included and analysed.  
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### 8 **2.1. Knowledge sourcing activity**

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10 In the first link of the IVC, knowledge is sourced from both inside and outside the firms (Hansen and  
11 Birkinshaw, 2007). Therefore, the main task in this activity is to assemble the knowledge used for  
12 innovation (Roper *et al.*, 2008). In terms of the degree of externalisation, Frenz and Ietto-Gillies (2009,  
13 p. 1126) explain that internal R&D is the knowledge generated inside a firm, while knowledge from  
14 external R&D, from informal and open networks, and from cooperation activities are “external to the  
15 enterprise to various degrees, depending on their ownership and the contractual structures of the  
16 relationship between our enterprise and the other party or parties to the transfer”. Knowledge from  
17 external linkages can be differentiated based on the form of access, whether informal or formal, and  
18 the knowledge content being transferred (Monjon and Waelbroeck, 2003). Storper (1997) classified  
19 formal cooperation as that which involves more formalised interactions among firms. In contrast,  
20 informal interactions, which normally involve informal relations, “might explain the spatial  
21 concentration of innovative industries and activities” (Tödtling *et al.*, 2009, p. 61).  
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30 Informal linkages can include “personal contacts or communities of practice or simply arise in  
31 the normal course of business”, while formal linkages “can be organised by business organisations  
32 such as chambers of commerce, research associations, technology services companies, consultants,  
33 universities or public research organisations or sponsored by local, regional or central governments”  
34 (OECD/Eurostat, 2005, p. 79). Internal firm capabilities are necessary to access and absorb knowledge  
35 from informal linkages, while formal cooperation activity is associated with the use of knowledge  
36 resulting from access to resources and innovative capabilities of partners (Freitas *et al.*, 2011).  
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43 Several previous studies have investigated the interaction among sources of knowledge used for  
44 innovation activities. One of the main discussions in these studies is whether complementary or  
45 substitution relationships exist between internal and external knowledge sourcing strategies in  
46 innovation activities. Some scholars argue that studies of such relationships remain unclear and  
47 inconclusive (Hagedoorn and Wang, 2012; Schmiedeberg, 2008). On the one hand, some studies reveal  
48 a complementary relationship between internal R&D and external knowledge in knowledge sourcing  
49 activities (Cassiman and Veugelers, 2002; Hagedoorn and Wang, 2012; Roper *et al.*, 2008;  
50 Schmiedeberg, 2008; Veugelers and Cassiman, 2005). On the other hand, other empirical studies  
51 identify a substitution relationship in these activities (Hess and Rothaermel, 2011; Laursen and Salter,  
52 2006; Love and Roper, 2001; Xu *et al.*, 2013). In this study, the term ‘complementarity’ is used  
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interchangeably with 'synergistic', which means that implementation of one strategy increases the marginal returns from another (Milgrom and Roberts, 1995).

Turning to the Indonesia context, there are a few insights related to synergistic or substitution strategies in innovation activities performed by Indonesian firms. In general, as in any other developing country, advanced knowledge of technology is accessed by importing from the advanced industrial countries, and the international technology transfer process mostly takes place in the private sector (Wie, 2005) because public support for R&D is minimal (Hill and Tandon, 2010). Wie (2005) identifies two major channels of international technology transfer to Indonesia: (1) a formal or market-mediated channel that includes FDI; technology licensing agreements; imports of capital goods; foreign education and training; turnkey plants; and technical consultancies, and (2) an informal or non-market mediated channel composed of technical assistance by foreign buyers and foreign vendors; copying or reverse engineering; information from trade journals; and technical information services provided by public agencies.

Apart from imported technology, the use of various sources of knowledge by Indonesian firms has also been studied. For example, Indonesian small furniture firms tend to generate knowledge through in-house learning by experimentation as well as from customers (Van Geenhuizen and Indarti, 2005). Cooperative activity was also found positively related to innovation in a cluster of Indonesian small food processors (Najib and Kiminami, 2011) and small scale roof tile firms (Sandee and Rietveld, 2001). Collaboration within Indonesian small firm clusters is also effective for sharing costs and risks (Sandee and Rietveld, 2001). As an example of an Indonesian high-technology industry, the automotive industry develops innovation mainly from inside the organisation and competitors are the main source of external knowledge to support the creation of new products in a competitive market (Aminullah and Adnan, 2012). On the other hand, universities and public research institutions contribute little external knowledge to the Indonesian automotive industry (Aminullah and Adnan, 2012). Although literature that discusses the involvement of external actors as sources of knowledge in the innovation process is scarce, a synergistic relationship between internal and external knowledge may exist to some extent.

Complementary relationship also exists between internal and external knowledge sourcing activities in recent studies. In the context of a developing economy, Majidpour (2017) finds that complementary relationship between Iranian firms' catch-up through indigenous R&D and overseas technology sources. Complementary relationships are also found between internal and external R&D in firms from high-technology industries in manufacturing firms across European countries (Paula and Da Silva, 2018). While, a complementary relationship also exists between Irish SMEs internal and

external knowledge sourcing activities, especially between R&D and linkages with customers and public knowledge sources (Doran *et al.*, 2019). Based on this, a hypothesis is proposed:

*H1 In knowledge sourcing activities, a synergistic relationship exists between internal R&D and external sources of knowledge.*

## 2.2. Knowledge transformation activity

In the second link of the IVC, different sources of knowledge used in the innovation activities are transformed or converted into different types of innovation (Hansen and Birkinshaw, 2007; Roper *et al.*, 2008). This involves innovation or knowledge production in which the success of knowledge transforming activities relies on the firms' knowledge sources (Griliches, 1992; Love and Roper, 1999). Therefore, the main issue addressed in this stage is the empirical assessment of the comparative impact of various sources of knowledge (e.g. R&D activities and informal knowledge) on different types of innovations (e.g. product, process, organisational, and marketing innovations).

Innovation is a complex phenomenon and normally firms use several sources of information simultaneously (Freitas *et al.*, 2011). The link between various sources of knowledge and the adoption of different innovations has been investigated (Amara and Landry, 2005; Srholec and Verspagen, 2012; Tödtling *et al.*, 2009). Previous scholars (Amara and Landry, 2005; Tödtling *et al.*, 2009) find that advanced innovations that are new to the market need a higher level of extended internal R&D, patent and more knowledge from universities, and research organisations to stimulate and support them. Meanwhile, less advanced innovations, such as business services (Tödtling *et al.*, 2009) and market innovations (Amara and Landry, 2005), require knowledge links with less research-based input.

A majority of previous IVC studies in advanced economies reveal that internal R&D activities are positively and significantly associated with innovation adoption (Doran and O'leary, 2011; Ganotakis and Love, 2012; Roper *et al.*, 2008; Roper and Arvanitis, 2012). Apart from the IVC studies, other studies in industrialised countries at the firm level show positive links among R&D, innovation and productivity (Griffith *et al.*, 2004, 2006; Mohnen *et al.*, 2006). Evidence from developing and newly industrialised countries also shows a positive association between R&D, innovation and productivity, with examples including Argentina (Chudnovsky *et al.*, 2006), Malaysia (Hegde and Shapira, 2007), China (Jefferson *et al.*, 2006) and Taiwan (Aw *et al.*, 2011). Firms that have higher levels of investment in R&D are more likely to introduce technological innovation as was found in Brazil (Raffo *et al.*, 2008) and Chile (Alvarez *et al.*, 2010). Based on this, a second hypothesis is proposed:

*H2a Internal R&D positively influences innovation and innovation success.*

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5 The use of informal knowledge as input for the innovation process comes mainly from external  
6 information sources gained without any formal arrangements (Garcia-Torres and Hollanders, 2009).  
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8 The informal link between certain actors and types of innovation has been investigated in previous  
9 studies. Past subjects of investigation have included the role and involvement of *customers* in the  
10 innovation process (Franke and Schreier, 2002; von Hippel and Katz, 2002; Joshi and Sharma, 2004);  
11 key *suppliers* and their roles in product innovation development (Amara and Landry, 2005; Nieto and  
12 Santamaría, 2007; Smith and Tranfield, 2005); the role of *competitors* in knowledge transfer and  
13 innovation (Malmberg and Maskell, 2002); and fostering advanced technological innovation  
14 (Gnyawali and Park, 2011). Open source information and knowledge from *scientific publications*  
15 proves beneficial for firms (Caloghirou *et al.*, 2004). Recent empirical evidence shows that different  
16 external sources of knowledge used by firms influence innovation adoption (Doran *et al.*, 2019; Simao  
17 and Franco, 2018).

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19 In the case of Indonesian firms, studies of informal knowledge usage for innovation have been  
20 conducted and the results show that different sources of external knowledge contribute to diverse  
21 benefits for the firms. External actors apart from the market, for example *foreign suppliers*, have very  
22 important roles in the development of technological capability and innovation in Indonesian firms  
23 (Wie, 2005). *Foreign buyers* also contribute technical and managerial assistance for many Indonesian  
24 SMEs (Wie, 2005). *Competitors* support the development of new products in the competitive market  
25 (Aminullah and Adnan, 2012). However, there is no single study in the Indonesia context that links  
26 diverse knowledge of innovation and adoption of different types of innovation with innovation success  
27 achieved by Indonesian manufacturing firms. In this study, informal knowledge derived from the IIS  
28 2011 is grouped into *market/commercials*, including suppliers, customers, competitors, consultants  
29 and commercial labs; *science institutions*, including universities, polytechnic institutes, government  
30 R&D and non-profit R&D; *associations*, including industry associations, investors and entrepreneurs;  
31 and *open sources*, including events, scientific publications and the internet. Therefore, another  
32 hypothesis is proposed:

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49 *H2b Different levels of informal knowledge influence innovation adoption differently.*

### 50 51 52 53 2.3. Knowledge exploitation activities

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55 The final link in the IVC is knowledge exploitation that generates value for the firm. Starting with the  
56 work of Geroski, Machin, and Reenen (1993), previous scholars such as (Ganotakis and Love, 2012;  
57 Love *et al.*, 2011; Roper *et al.*, 2008) argue that, in the knowledge exploitation stage, firm performance

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3 is affected by innovation output as the result of codified knowledge gained through knowledge  
4 sourcing activities. They state that innovation output needs to be determined prior to knowledge  
5 exploitation. Therefore, the main interest at this stage is how firms gain business productivity or  
6 profitability from the exploitation of adopted innovation. In this study, productivity (indicated by total  
7 sales/number of employees) is used to measure how innovation affects overall firms' performance.  
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12 Prior IVC studies find that innovation output in the form of process innovation (Doran *et al.*, 2019),  
13 product and process innovation (Ganotakis and Love, 2012; Roper *et al.*, 2008) significantly and  
14 positively influences innovation performance as measured by sales and employment growth.  
15 Surprisingly, both a negative impact (Roper *et al.*, 2008) and no relationship (Ganotakis and Love,  
16 2012) of product innovation success on productivity have been found. Therefore, in this study, the  
17 involvement of wider innovation, is expected to provide a different view compared to previous IVC  
18 studies. Hence, an additional hypothesis is proposed:  
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24 *H3 In knowledge exploitation activity, innovation and innovation success positively affects a firm's*  
25 *performance.*  
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### 29 3. DATA AND METHODS

#### 30 3.1. Data

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32 The empirical analysis in this study is derived from the Indonesia Innovation Survey (IIS) 2011 that  
33 covers 2009-2010. In terms of firm size, the IIS 2011 surveyed only medium (20-99 employees) and  
34 large (more than 99 employees) Indonesian manufacturing firms. The surveyed firms are classified  
35 based on the International Standard Industrial Classification (ISIC) Rev. 3.1. Multi-stage random  
36 sampling was used to collect data from 1,500 firms and a total of 1,375 questions were successfully  
37 collected. Of the returned questionnaires, 1,179 were usable. Face to face interviews with R&D or  
38 production managers were conducted to collect the data. The IIS 2011 used the Oslo Manual  
39 (OECD/Eurostat, 2005) as the guideline for collecting and interpreting innovation data and  
40 adjustments were made to facilitate innovation activities in Indonesia that may differ from those in  
41 developed economies. For example, the innovation activity and internal sources of knowledge  
42 variables in the IIS 2011 have broader categories than the same variables in the UK CIS. Unfortunately,  
43 Indonesia has three waves of innovation survey only i.e. 2008, 2011, and 2014 and no continuity of  
44 the survey. As a result, there is no update data on the innovation survey. Of the three waves of  
45 innovation survey, the second wave of the survey (2011) has the greatest number of data compared to  
46 the rest of the surveys. Therefore, the 2011 innovation survey is used in this study.  
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### 3.2. Methods

In the knowledge sourcing activity, the main issue that is addressed is the behaviour of Indonesian manufacturing firms in sourcing knowledge from various sources. More specifically, synergistic or substitution relationships among the three groups of knowledge are tested. Following Roper, Du, and Love (2008), a simple approach of single equation probit model is used to test Hypothesis 1 with the dependent variables being a series of sources of knowledge. This allows for a detailed analysis of the impact of 17 various knowledge sources.

In the knowledge transformation link, an innovation or knowledge production function is used to model the knowledge transformation activities (Geroski, 1990; Harris and Trainor, 1995). Logit regression is used to test Hypotheses 2 with the dependent variables being different types of innovation. Tobit regression is employed when the dependent variable is innovation success (i.e. the proportion of sales derived from product innovation new to the market) that has both upper and lower bounds (0 to 100%). In the knowledge exploitation stage, OLS regression is used to test Hypothesis 3, and the dependent variable is the firms' productivity, which is a measure of how innovation affects overall firm performance.

## 4. RESULTS

### 4.1. Descriptive statistics

Table 1 presents descriptive statistics for the IIS 2011. Following the 3<sup>rd</sup> Oslo Manual, the IIS 2011 defines innovation as "the implementation of a new or significantly improved product (good or services), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD/Eurostat, 2005, p. 46). Based on the definition that covers broad range of possible innovations, the IIS 2011 then defines an innovative firm as a firm that performed any product, process, organisational or marketing innovation from 2009 to 2010. According to Table 1, the mean of productivity (total sales/number of employees) is approximately IDR 1.3 trillion. The highest proportion is marketing innovation (42.8%), while the lowest is organisational innovation (31%). The mean of product innovations that are new to the market is lower than the same innovations that are new to the firm, and account for 28.8% versus 35.8% respectively. The mean of innovation success as the proportion of launched products new to the market accounted for 8.43%. The fact that marketing innovation outnumbered other innovation is typical in developing countries that tend to focus on the market rather than on the technology (Wamae, 2009).

Turning to knowledge sourcing activities, approximately 29% of firms report generating their own knowledge from internal R&D, while only 3.2% of firms source knowledge from external R&D.



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3 Firms report market/commercials as more important than other sources of knowledge, including  
4 suppliers, competitors and customers which represent 19.1%, 22.5% and 34.4%, respectively. These  
5 are followed by open sources (internet) and associations (entrepreneurs) that account for 11.3% and  
6 14.6%, respectively. In contrast, less than 5% of firms source science-based knowledge from  
7 universities, polytechnic, government and non-profit R&D institutions.  
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11 The mean of firm size as indicated by the number of employees is nearly 175 people. Of surveyed  
12 firms, mature firms (more than 20 years) dominate in the IIS 2011 data. The proportion of national  
13 firms is significantly higher at 90%, compared to multi-nationals and joint ventures, at 6% and 4.2%,  
14 respectively. Most of the surveyed firms operate in their headquarters, not in the manufacturing plants  
15 (91% versus 9.2%). Labour education levels are low. More than 50% of employees have no high school  
16 degree, which indicates the low level of education of the firms' human resources. In contrast, less than  
17 5% of employees hold undergraduate degrees.  
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Table 1 Descriptive statistics (1179 firms)

VARIABLES	Obs.	Mean	SD	Min.	Max.
<b>Firm performance</b>					
Productivity (total sales/number of employee) (IDR)	1179	1312.096	8399.761	.088	125000
<b>Innovation performance</b>					
Innovation success (INNOVSUCCESS) (% PRODINOV_NEW2MARKET sales)	1179	8.43	16.99	0	100
<b>Innovation output</b>					
Product innovation (PRODINOV) (0/1)	1179	.377	.485	0	1
Product innovation new to the market (PRODINOV_NEW2MARKET) (0/1)	1179	.288	.453	0	1
Product innovation new to the firms (PRODINOV_NEW2FIRM) (0/1)	1179	.358	.480	0	1
Process innovation (PROCINOV) (0/1)	1179	.322	.468	0	1
Organisational innovation (ORGINOV) (0/1)	1179	.310	.463	0	1
Marketing innovation (MKTGINOV) (0/1)	1179	.428	.495	0	1
<b>R&amp;D Activities</b>					
Internal R&D-R&D activities (IN_RD) (0/1)	1179	.292	.455	0	1
External R&D-R&D activities (EX_RD) (0/1)	1179	.032	.177	0	1
<b>Market agents (highly important)</b>					
Suppliers (SUPPLIERS) (0/1)	1179	.191	.393	0	1
Customers (CUSTOMERS) (0/1)	1188	.344	.475	0	1
Competitors (COMPETITORS) (0/1)	1179	.225	.418	0	1
Consultant (CONSULTANTS) (0/1)	1179	.041	.198	0	1
Commercial labs (COMMLAB) (0/1)	1179	.042	.200	0	1
<b>Science institutions (highly important)</b>					
University (UNIVERSITIES) (0/1)	1179	.031	.174	0	1
Polytechnic (POLTECH) (0/1)	1179	.027	.163	0	1
Government R&D institutions (GOV_RD) (0/1)	1179	.041	.198	0	1
Non-profit R&D institutions (NONPROF_RD) (0/1)	1179	.036	.185	0	1
<b>Associations (highly important)</b>					
Investors (INVESTORS) (0/1)	1179	.091	.287	0	1
Industry Association (IND_ASSOC) (0/1)	1179	.065	.247	0	1
Entrepreneurs (ENTREPRENEURS) (0/1)	1179	.146	.353	0	1
<b>Open sources (highly important)</b>					
Events (EVENTS) (0/1)	1188	.109	.312	0	1
Science Publication (SCIENCE_PUB) (0/1)	1188	.067	.251	0	1
Internet (INTERNET) (0/1)	1179	.113	.316	0	1
<b>Firms Resources</b>					
Size (number of employee)	1179	174.608	1318.078	20	32977
Firms' age (years)	1179	21.077	12.704	0	84
Export (%)	1179	9.726	25.106	0	100
Ownership National (OWN_NATIONAL) (0/1)	1179	0.899	0.301	0	1
Ownership Multi National (OWN_MULTI) (0/1)	1179	0.059	0.235	0	1
Ownership Joint Venture (OWN_JOINT) (0/1)	1179	0.042	0.202	0	1
Operation Plant (OPS_PLANT) (0/1)	1179	0.092	0.289	0	1
Operation Head Quarter (OPS_HQ) (0/1)	1179	0.908	0.289	0	1
Education Under High school (EDU_UNDERHS) (%)	1179	56.247	36.423	0	100

Education High School (EDU_HS) (%)	1179	36.430	31.492	0	100
Education Diploma (EDU_DIPLOMA) (%)	1179	3.246	6.779	0	55
Education Under Graduate (EDU_UNDERGRAD) (%)	1179	4.077	8.623	0	90
Employees' proportion in R&D dept. (RD_STAFF) (%)	1179	2.986	6.717	0	57
Low technology (LOW_TECH) (0/1)	1179	.735	.442	0	1
Medium-low technology (MEDLOW_TECH) (0/1)	1179	.174	.379	0	1
Medium-high technology (MEDHIGH_TECH) (0/1)	1179	.082	.275	0	1
High technology (HIGH_TECH) (0/1)	1179	.009	.096	0	1

#### 4.2. Knowledge sourcing activity

The empirical analysis in the first stage of IVC follows the approach of Roper *et al.*, (2008) and it allows for a detailed analysis of the interdependence of various knowledge sources. The following equation is estimated using a series of probit models.

$$KS_{ji} = KS_{ki}\beta_0 + X_{1i}\beta_1 + \varepsilon_{1i} \quad \text{if } y_{0i} = 1$$

where  $KS_{ji}$  represents firm  $i$ 's knowledge sourcing activity  $j$  during the reference period.  $KS_{ki}$  represents firm  $i$ 's knowledge sourcing activity  $k$  where  $j \neq k$ ,  $X_{1i}$  is a vector of explanatory variables,  $\beta_{1i}$  is the associated coefficient vector, and  $\varepsilon_{1i}$  is the error term. When sourcing knowledge H1 suggests that a complementary/synergistic relationship exists between internal R&D and external knowledge sourcing activities. Therefore, if  $\beta_0 > 0$  this implies that firms which engage in one type of knowledge sourcing (e.g., R&D) are more likely to engage in other types of knowledge sourcing (e.g., customers, suppliers, and competitors). This provides a direct test of H1.

Table 2 indicates a synergistic relationship between internal and external R&D and this is in line with previous findings (Cassiman and Veugelers, 2002, 2006; Ganotakis and Love, 2012; Schmiedeberg, 2008). Firms are more likely to perform external R&D (EX\_RD) if they also generate their own knowledge from internal R&D (IN\_RD). The same relationship also exists between IN\_RD and external agents from market/commercials (CUSTOMERS, COMPETITORS and COMM\_LAB) and from associations (ASSOCIATIONS and ENTREPRENEURS). However, the firms interact less with external networks from science institutions and open sources. Firms also interact less with external actors if they already perform EX\_RD. Based on this finding, the first hypothesis is supported.

Turning to informal knowledge (see Table 2), it can be observed that firms that source knowledge from market/commercials tend to interact with other market/commercials networks,

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3 associations and open sources. However, these firms interact less with scientific institutions,  
4 with the exception that firms sourcing knowledge from COMM\_LABS tend to interact with  
5 UNIVERSITIES and GOV\_RD. Firms that source knowledge from SUPPLIERS and  
6 COMPETITORS are more likely to source from ASSOCIATIONS. In addition, firms tend to  
7 source knowledge from open sources if they already source from CUSTOMERS. To sum up,  
8 in the market/commercials groups, synergistic relationships tend to exist among  
9 market/commercials; between market/commercials and associations; and between  
10 market/commercials and open sources networks.

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12 In relation to scientific institutions, a synergistic relationship can also be identified  
13 among the institutions and between the institutions and associations. However, there are few  
14 negative and significant associations, and these are shown only between POLTECH and  
15 INVESTORS and between UNIVERSITIES and SCIENCE\_PUB. This may indicate that firms  
16 that already source knowledge from POLTECH tend not to interact with INVESTORS, while  
17 firms that source knowledge from UNIVERSITIES tend to cite knowledge from  
18 SCIENCE\_PUB. Lastly, firms that source knowledge from associations and open source  
19 networks are more likely to interact with all external knowledge networks proportionally.

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21 Turning to control variables, exporters tend to rely on knowledge that is sourced from  
22 SUPPLIERS and ENTREPRENEURS. Both national and multi-national firms are similar in  
23 that they have positive and significant associations with ENTREPRENEURS. In contrast, both  
24 national and multi-national firms have negative and significant associations with INVESTORS  
25 and the INTERNET. It is striking that HIGH\_TECH firms do not have positive associations  
26 with R&D activities. A speculative reason for this phenomenon is that these firms tend to  
27 import advanced technology from advanced countries as shown in Wie (2005) study. However,  
28 it is important to note that all the coefficient values among firm resources and a wide range of  
29 sources of knowledge tend to show weak relationships.

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Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge)

INDEPENDENT VARIABLES	Model 1 IN RD	Model 2 EXT RD	Model 3 SUPPLIER	Model 4 CUSTOM	Model 5 COMPET	Model 6 CONSUL	Model 7 COMMLAB	Model 8 UNIVERSITY	Model 9 POLTECH
INTERNAL_RD	-	<b>.088***(.017)</b>	-.021 (.029)	<b>.059**(.026)</b>	<b>.045**(.023)</b>	.018 (.011)	<b>.023**(.011)</b>	<b>.019**(.009)</b>	.006 (.008)
EXTERNAL_RD <sup>1</sup>	<b>.568***(.098)</b>	-	.012 (.065)	-.032 (.060)	.021 (.051)	-.002 (.021)	.019 (.020)	-.003 (.016)	.010 (.013)
<i>Market/Commercials</i>									
SUPPLIERS	-.023 (.030)	.006 (.013)	-	.031 (.028)	-.005 (.026)	-.008 (.014)	<b>.025**(.012)</b>	-.003 (.011)	.005 (.009)
CUSTOMERS	<b>.077***(.028)</b>	-.006 (.012)	.041 (.029)	-	<b>.287***(.018)</b>	<b>-.023*(.014)</b>	.000 (.013)	.006 (.010)	-.003 (.009)
COMPETITORS	.044 (.030)	.005 (.011)	-.004 (.032)	<b>.329***(.022)</b>	-	<b>.031***(.012)</b>	.016 (.012)	-.003 (.010)	.006 (.008)
CONSULTANT	.081 (.063)	-.003 (.019)	-.043 (.066)	<b>-.158**(.063)</b>	<b>.109**(.047)</b>	-	<b>.072***(.016)</b>	.008 (.014)	.008 (.012)
COMMLAB	.085 (.063)	.031 (.019)	<b>.121*(.062)</b>	-.017(.066)	.050 (.051)	<b>.069***(.016)</b>	-	<b>.042***(.013)</b>	-.005 (.012)
<i>Science</i>									
UNIVERSITIES	<b>.176**(.076)</b>	-.027 (.026)	.0004 (.077)	.023 (.077)	-.075 (.063)	.020 (.020)	<b>.065***(.019)</b>	-	<b>.042***(.011)</b>
POLYTECHNIC	-.036 (.083)	.015 (.025)	.046 (.084)	-.134 (.085)	.018 (.062)	-.003 (.023)	-.016 (.024)	<b>.047***(.015)</b>	-
GOV_RD	-.013 (.071)	<b>-.051*(.029)</b>	-.014 (.078)	-.038 (.073)	-.025 (.057)	.001 (.021)	<b>.036*(.021)</b>	<b>.024*(.013)</b>	<b>.037***(.011)</b>
NON_PROFITRD	-.012 (.072)	<b>.048**(.023)</b>	-.034 (.077)	<b>.224***(.078)</b>	-.037 (.055)	.030 (.020)	.021 (.020)	.012 (.013)	<b>.019*(.010)</b>
<i>Associations</i>									
INVESTORS	.033 (.045)	<b>.024*(.014)</b>	.017 (.045)	.045 (.045)	.031 (.035)	.013 (.014)	-.001 (.015)	<b>.019*(.011)</b>	-.015 (.011)
IND_ASSOC.	.051 (.050)	-.011 (.017)	-.043 (.053)	.031 (.054)	-.007 (.041)	<b>.030**(.015)</b>	.004 (.016)	<b>.025**(.011)</b>	.006 (.010)
ENTREPRENEURS	<b>.176***(.037)</b>	-.006 (.013)	-.021 (.040)	<b>.125***(.036)</b>	<b>.064**(.030)</b>	.003 (.014)	.012 (.014)	-.010 (.012)	.010 (.009)
<i>Open sources</i>									
EVENTS	-.003 (.043)	.004 (.015)	.041 (.043)	<b>.177***(.044)</b>	<b>.064**(.033)</b>	.001 (.015)	-.005 (.015)	.009 (.011)	-.002 (.009)
SCIENCE_PUB	-.026 (.053)	.0003 (.017)	-.060 (.053)	<b>.215***(.061)</b>	.039 (.039)	.018 (.016)	<b>.033**(.015)</b>	-.014 (.013)	<b>.029***(.010)</b>
INTERNET	<b>.229***(.037)</b>	.011 (.012)	.050 (.040)	<b>.177***(.037)</b>	-.048 (.031)	<b>.029**(.013)</b>	-.022 (.015)	-.004 (.011)	.009 (.008)
<i>Firm resources</i>									
SIZE	-.0002(.0003)	-.0003(.0003)	.0002(.0001)	-.0001(.0001)	-.0003(.0003)	-.0003(.0004)	-.0003(.0002)	-.0001(.0002)	-.0002(.0003)
AGE	-.00006(.001)	-.0003(.0004)	.001(.001)	.001(.001)	.0001(.001)	.0003(.0004)	-.001(.0005)	-.001(.0004)	.0002(.0003)
EXPORT	-.0003(.0005)	.00002(.0002)	<b>.001**(.0004)</b>	.0004(.0004)	-.0001(.0004)	.0002(.0002)	.0002(.0002)	-.0003(.0002)	.00003(.0001)

<sup>1</sup> External R&D in this study is grouped in R&D activities along with internal R&D, however, based on the degree of externalisation, external R&D, informal and open networks, and cooperation activities 'are external to the enterprise to various degrees, depending on their ownership and the contractual structures of the relationship between our enterprise and the other party or parties to the transfer' (Frenz and Ietto-Gillies, 2009, p. 1126).

OWN_NATIONAL	.098(.064)	.007(.030)	.034(.059)	-.029(.057)	-.003(.051)	.013(.030)	.042(.033)	-.002(.021)	.014(.024)
OWN_MULTI	.123(.077)	-.0002(.037)	.102(.072)	-.005(.071)	-.067(.068)	.017(.036)	-	.014(.024)	.004(.029)
OWN_JOIN	-	-	-	-	-	-	-	-	-
OPS_PLANT	-.002(.043)	-.020(.022)	.016(.041)	-.031(.040)	-.013(.038)	-.001(.019)	-.027(.027)	.009(.013)	.012(.011)
OPS_HEAD	-	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.071(.029)	.012(.016)	.032(.031)	.027(.029)	-.032(.027)	.025(.016)	.007(.014)	<b>-.024***(.008)</b>	.010(.012)
MEDHIGH_TECH	.004(.044)	<b>-.025**(.010)</b>	.005(.042)	.036(.041)	-.036(.037)	-.006(.017)	.014(.023)	-.001(.015)	.008(.016)
HIGH_TECH	-.049(.109)	-	-.045(.095)	.188(.137)	-.095(.082)	-	-	.002(.037)	-
EDU_UNDERHS	-.0003(.001)	-.001(.001)	-.0004(.001)	-.0005(.001)	-.001(.001)	-.001(.001)	.001(.001)	-.0002(.0005)	.001(.001)
EDU_HIGHSCHOOL	-.0004(.002)	-.001(.001)	.001(.001)	-.0002(.001)	-.001(.001)	-.001(.001)	.001(.001)	-.0003(.001)	.0005(.001)
EDU_DIPLOMA	-.001(.003)	-.0004(.001)	.001(.003)	.001(.003)	.000(.002)	.000(.001)	.001(.001)	-.0002(.001)	.0004(.001)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-	-
RD_STAFF	.0001(.002)	<b>-.002*(.001)</b>	<b>.006***(.002)</b>	-.002(.002)	.000(.002)	.000(.001)	.000(.001)	-.0002(.001)	.000(.001)
Observation	1,179	1,168	1,179	1,179	1,179	1,168	1,119	1,179	1,168
LR chi2(29)	297.2	98.16	53.52	498.23	352.76	136.41	154.75	154.13	162.17
Prob > chi2	.000	.000	.0037	.000	.000	.000	.000	.000	.000
Pseudo R2	.209	.293	.047	.327	.281	.341	.385	.469	.553
Log likelihood	-563.198	-118.462	-547.930	-511.940	-451.881	-132.001	-123.827	-87.424	-65.588
Mean VIF	2.76	2.77	2.78	2.74	2.75	2.76	2.76	2.75	2.75

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.

Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge) (continued)

INDEPENDENT VARIABLES	Model 10 GOV_RD	Model 11 NPROFIT_RD	Model 12 INVESTOR	Model 13 TRADE ASSOC	Model 14 ENTREPRENEUR	Model 15 EVENTS	Model 16 SCIENCE PUB	Model 17 INTERNET
INTERNAL_RD	.004 (.009)	.001 (.010)	.025 (.015)	<b>.030**(.013)</b>	<b>.087***(.016)</b>	.010 (.016)	.003 (.013)	<b>.112***(.016)</b>
EXTERNAL_RD	-.022 (.018)	<b>.030*(.017)</b>	<b>.048*(.028)</b>	-.011 (.025)	-.020 (.035)	.014 (.031)	.010 (.025)	.030 (.032)
<i>Market/commercials</i>								
SUPPLIERS	-.001 (.011)	-.007 (.012)	.004 (.017)	-.009 (.015)	-.014 (.020)	.017 (.018)	-.020 (.015)	.025 (.020)
CUSTOMERS	.002 (.010)	<b>.041***(.013)</b>	<b>.037**(.017)</b>	.013 (.015)	<b>.084***(.018)</b>	<b>.078***(.018)</b>	<b>.071***(.016)</b>	<b>.087***(.018)</b>
COMPETITORS	-.003 (.009)	-.010 (.010)	.016 (.016)	<b>.024*(.014)</b>	<b>.047***(.017)</b>	<b>.039**(.016)</b>	.019 (.013)	-.009 (.018)
CONSULTANT	-.000004 (.015)	.008 (.017)	.012 (.028)	<b>.042**(.021)</b>	.020 (.035)	-.003 (.031)	.019 (.022)	<b>.080**(.033)</b>
COMMLAB	<b>.023*(.014)</b>	.010 (.015)	-.009 (.028)	-.012 (.023)	.045 (.033)	-.005 (.030)	<b>.048**(.021)</b>	-.039 (.037)
<i>Science institutions</i>								
UNIVERSITIES	<b>.023*(.013)</b>	.013 (.015)	<b>.065**(.032)</b>	<b>.045*(.024)</b>	-.030 (.042)	.029 (.035)	<b>-.045*(.027)</b>	-.019 (.040)
POLYTECHNIC	<b>.050***(.015)</b>	.019 (.016)	<b>-.105**(.042)</b>	.001 (.027)	<b>.079*(.044)</b>	-.031 (.036)	<b>.081***(.024)</b>	.044 (.041)
GOV_RD	-	<b>.071***(.015)</b>	<b>.130***(.030)</b>	.032 (.022)	-.036 (.038)	.046 (.031)	.000 (.024)	.055 (.038)
NON_PROFITRD	<b>.061***(.012)</b>	-	.009 (.024)	<b>.036**(.017)</b>	-.029 (.028)	-.005 (.022)	.015 (.017)	-.028 (.029)
<i>Associations</i>								
INVESTORS	<b>.043***(.011)</b>	-.001 (.013)	-	<b>.046***(.015)</b>	<b>.164***(.021)</b>	<b>.058**(.023)</b>	.024 (.017)	.013 (.023)
IND_ASSOC.	.013 (.010)	<b>.022*(.012)</b>	<b>.058***(.021)</b>	-	<b>.085***(.020)</b>	<b>.077***(.018)</b>	-.017 (.016)	<b>.072***(.020)</b>
ENTREPRENEURS	-.010 (.011)	-.001 (.012)	<b>.123***(.017)</b>	.018 (.015)	-	.009 (.030)	.029 (.021)	-.062 (.040)
<i>Open sources</i>								
EVENTS	.016 (.010)	.002 (.012)	-.018 (.031)	.026 (.022)	-.010 (.039)	-	<b>.096***(.013)</b>	.033 (.023)
SCIENCE_PUB	-.0001 (.011)	<b>.026**(.012)</b>	-.019 (.021)	<b>.036**(.015)</b>	<b>.099***(.022)</b>	<b>.145***(.019)</b>	-	<b>.057**(.025)</b>
INTERNET	<b>.019*(.010)</b>	-.015 (.013)	.008 (.018)	<b>.034**(.014)</b>	.039 (.027)	.030 (.019)	-.007 (.016)	-
<i>Firm resources</i>								
SIZE	.00001(.00003)	-.00001(.00003)	.00002(.00001)	-.00001(.00002)	-.00004(.00003)	.00002(.00001)	-.00002(.00001)	.00003(.00001)
AGE	-.0004 (.0004)	.0001 (.0004)	.0002(.001)	-.001(.0005)	.001(.001)	-.001(.001)	-.0002(.0005)	-.0004 (.001)
EXPORT	-.00003 (.0002)	-.0002 (.0002)	-.00001(.0003)	.0002(.0002)	<b>.001**(.0003)</b>	-.0003(.0003)	-.0002(.0002)	-.00001(.0003)
OWN_NATIONAL	.022(.025)	-.01 (.020)	<b>-.061**(.031)</b>	.033(.035)	<b>.105**(.048)</b>	-.047(.033)	.008(.029)	<b>-.067*(.035)</b>
OWN_MULTI	.003(.030)	.007(.025)	<b>-.078**(.042)</b>	<b>.069*(.039)</b>	<b>.105*(.056)</b>	-.030(.043)	-.009(.039)	-.054(.045)
OWN_JOIN	-	-	-	-	-	-	-	-

OPS_PLANT	-.016(.020)	.002(.017)	-.030(.027)	-.021(.024)	.042(.027)	-.008(.027)	.005(.021)	.005(.028)
OPS_HEAD	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.006(.011)	<b>.0100(.010)**</b>	-.005(.018)	.002(.016)	.023(.023)	-.026(.019)	-.011(.016)	.014(.022)
MEDHIGH_TECH	.001(.015)	-	.018 (.029)	<b>.048(.028)*</b>	-.0003(.029)	-.027	.027(.025)	.027(.031)
HIGH_TECH	.0111(.103)	-.005(.034)	-.055 (.037)	.049(.076)	.015(.072)	.082 (.090)	-	-.038(.061)
EDU_UNDERHS	-.0004(.0004)	.001(.001)	-.001(.001)	.001(.001)	-.0001(.001)	.002(.001)	-.001(.001)	.000(.001)
EDU_HIGHSCHOOL	-.0004(.0005)	.001(.001)	-.001(.001)	.002(.001)	.0003 (.001)	.002 (.001)	<b>-.001*(.001)</b>	.000(.001)
EDU_DIPLOMA	-.0003(.001)	.002(.001)	-.0001(.002)	.001(.002)	-.002 (.002)	.002 (.002)	-.001 (.001)	.000(.002)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-
RD_STAFF	-.0004(.001)	.001(.001)	.001(.001)	.001(.001)	-.0004(.001)	.00 (.001)	.0002 (.001)	-.002(.001)
Observation	1179	1082	1179	1179	1179	1179	1168	1179
LR chi2(29)	226.89	172.32	249.06	210.13	405.55	326.27	251.48	252.34
Prob > chi2	.000	.000	.000	.000	.000	.000	.000	.000
Pseudo R2	.565	.485	.347	.369	.414	.399	.431	.304
Log likelihood	-87.225	-91.467	-234.216	-179.467	-287.107	-246.055	-165.938	-289.245
Mean VIF	1.34	2.75	2.75	2.76	2.75	2.75	2.75	2.76

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.



#### 4.3. Knowledge transformation activity

The main interest in this section is how various sources of knowledge contribute to innovation. Table 3 shows that IN\_RD has positive and significant effects on any type of innovation and innovation success. By contrast, EX\_RD's has no significant impacts on innovation and innovation success. Evidence that IN\_RD is the only source of knowledge that positively and significantly affects all types of innovation and innovation success may suggest that IN\_RD plays a more important role than the rest of the sources of knowledge. Therefore, based on this finding, Hypothesis 2a is supported.

Turning to informal knowledge, different sources of informal knowledge used in the innovation transformation activity have different impacts on types of innovation and innovation success. Among market/commercials networks, knowledge transformed from *customers* positively and significantly affects product innovation, product innovation new to the firm, marketing innovation and innovation success. While knowledge transformed from *competitors* positively and significantly affects product innovation new to the market, process innovation and marketing innovation. Surprisingly, knowledge from science institutions only influences process innovation and this finding differs compared from most previous studies that show a positive influence of science institutions on radical innovation. Knowledge that is generated from association (industry association and entrepreneurs) is more likely to influence innovation and innovation success in significant and negative ways. Open sources (*events*) contribute positively to product innovation, product innovation that new to the market, product innovation that new to the firms and innovation success.

In relation to firm resources, most variables have weak and negative effects on diverse types of innovation and innovation success. Only firms age and multi-national ownership influence innovation in significant and negative directions. Firm age has a weak negative and significant association with MKTG INOV. The same direction was found for the influence of multi-national firm status on ORGINOV.

Table 3. Knowledge transformation activity

INDEPENDENT VARIABLES	Model 1 PRODINOV	Model 2 PRODINN_N2M <sup>1</sup>	Model 3 PRODINN_N2F <sup>2</sup>	Model 4 PROCINOV	Model 5 ORGINOV	Model 6 MKTGINOV	Model 7 INN SUCCESS <sup>3</sup>
INTERNAL_RD	<b>.133***(.022)</b>	<b>.069***(.023)</b>	<b>.126***(.022)</b>	<b>.188***(.019)</b>	<b>.231***(.018)</b>	<b>.162***(.022)</b>	<b>8.342**(3.295)</b>
EXTERNAL_RD	.039(.065)	.077(.057)	.080(.067)	.093(.074)	.096(.074)	-.091(.069)	6.853(7.118)
<i>Market &amp; commercials</i>							
SUPPLIERS	-.027(.027)	-.026(.027)	-.021(.027)	-.004(.027)	-.007(.026)	.017(.027)	-5.139(3.724)
CUSTOMERS	<b>.062**(0.025)</b>	.039(.025)	<b>.053**(0.025)</b>	-.027(.025)	-.036(.025)	<b>.099***(.025)</b>	<b>6.122*(3.470)</b>
COMPETITORS	-.003(.025)	<b>.046*(.024)</b>	.004(.025)	<b>.042*(.024)</b>	.001(.025)	<b>.053**(0.026)</b>	3.970(3.364)
CONSULTANTS	.001(.051)	-.012(.048)	.009(.052)	-.075(.049)	-.002(.052)	.003(.053)	-5.513(6.529)
COMMLAB	.043(.053)	.013(.049)	.067(.054)	.060(.050)	-.004(.049)	.022(.054)	3.486(6.499)
<i>Science</i>							
UNIVERSITIES	.030(.063)	.059(.058)	.061(.065)	<b>-.123**(0.059)</b>	-.041(.061)	.036(.068)	6.438(7.874)
POLYTECHNIC	.053(.073)	.033(.068)	.001(.071)	<b>-.132*(0.068)</b>	.055(.066)	-.006(.070)	6.574(8.503)
GOVERNMENT_RD	-.098(.060)	-.030(.059)	-.073(.061)	<b>.109*(0.064)</b>	-.028(.060)	-.050(.064)	-1.260(7.652)
NON_PROFIT_RD	-.022(.022)	.026(.053)	-.032(.056)	<b>.149***(.057)</b>	-.045(.058)	.057(.061)	6.800(7.084)
<i>Associations</i>							
INVESTORS	.057(.057)	.036(.034)	<b>.068*(0.036)</b>	<b>.058*(0.035)</b>	.056(.035)	-.048(.036)	0.776(4.696)
IND_ASSOC.	-.056(.041)	<b>-.095**(0.039)</b>	<b>-.087**(0.041)</b>	-.036(.040)	.058(.043)	-.017(.044)	-8.185(5.473)
ENTREPRENEURS	<b>-.059*(.031)</b>	-.043(.031)	-.051(.031)	-.017(.030)	.013(.031)	-.049(.032)	<b>-6.954*(4.188)</b>
<i>Open resources</i>							
EVENTS	<b>.189***(.038)</b>	<b>.164***(.033)</b>	<b>.174***(.037)</b>	.028(.033)	.044(.035)	.026(.036)	<b>16.800***(4.387)</b>
SCIENCE_PUB.	-.033(.044)	-.047(.041)	-.010(.044)	-.022(.040)	-.040(.043)	-.012(.045)	-5.755(5.279)
INTERNET	-.039(.032)	-.029(.031)	-.040(.032)	-.024(.031)	.023(.032)	-.031(.034)	-2.148(4.210)
<i>Firm resources</i>							
SIZE	-.00002(.000)	-.00003(.000)	-.00001(.000)	.00004(.000)	-.00002(.000)	-.00001(.000)	-.001(0.004)
AGE	.00(.001)	.0001(.001)	.0002(.001)	-.001(.001)	.0003(.001)	<b>-.001*(.001)</b>	.009(0.114)
EXPORT	.0004(.000)	.001(.000)	.001(.000)	.00004(.000)	-.001(.000)	.00002(.000)	.056(0.054)
OWN_NATIONAL	.038(.062)	.001(.060)	.049(.062)	.037(.060)	-.064(.055)	.049(.059)	1.596(7.825)
OWN_MULTI	.006(.073)	-.049(.074)	.006(.073)	.007(.073)	<b>-.130*(.070)</b>	.011(.072)	-4.198(9.789)
OWN_JOIN	-	-	-	-	-	-	-
OPS_PLANT	.027(.039)	.010(.040)	.051(.040)	.004(.039)	-.014(.039)	.031(.039)	.601(5.286)

	OPS_HEAD	-	-	-	-	-	-	-
1	LOW_TECH	-	-	-	-	-	-	-
2	MED_LOW TECH	<b>.051(.029)*</b>	.036(.030)	<b>.058(.029)**</b>	-.009(.029)	.012(.030)	-.010(.029)	4.267(3.988)
3	MED_HIGH TECH	.036(.038)	<b>.063(.038)*</b>	.041(.038)	.014(.038)	-.046(.037)	.049(.037)	5.827(5.206)
4	HIGH_TECH	.106(.110)	.171(.118)	.130(.108)	<b>-.175(.095)*</b>	.039(.109)	.010(.122)	13.248(14.064)
5	EDU_UNDERHS	-.001(.001)	-.001(.001)	-.002(.001)	-.0001(.001)	-.0004(.001)	-.0002(.001)	-.235(.172)
6	EDU_HIGHSCHOOL	-.001(.001)	-.002(.001)	-.002(.001)	-.0003(.001)	-.0003(.001)	-.002(.001)	-.201(.182)
7	EDU_DIPLOMA	-.003(.003)	-.002(.002)	-.004(.002)	-.003(.002)	-.002(.003)	-.002(.003)	-.225(.330)
8	EDU_UNDERGRAD	-	-	-	-	-	-	-
9	RD_STAFF	-.001(.002)	.0003(.002)	-.002(.002)	-.001(.002)	-.001(.002)	.0001(.002)	.188(.226)
10								
11	Number of obs	1179	1179	1179	1179	1165	1170	1179
12	LR chi2(57)	685.65	546.38	652.18	641.39	572.46	720.65	517.02
13	Prob > chi2	.000	.000	.000	.000	.000	.000	.000
14	Pseudo R2	.439	.3862	.4241	.4327	.401	.4519	.1192
15	Log likelihood	-438.107	-434.124	-442.875	-420.422	-427.534	-437.063	-1909.790
16	Mean VIF	3.50	3.50	3.50	3.50	3.50	3.50	3.50

Note: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in model 1-6 are marginal effects generated from logit models  
<sup>1</sup>Product innovation new to the market; <sup>2</sup>Product innovations new to the firms; <sup>3</sup>Innovation success derived from Tobit regression

1  
2  
3 The impact of internal R&D (IN\_RD) on all types of innovation and innovation success is  
4 positive and significant. There is only a marginal significant impact of external R&D (EX\_RD)  
5 on organisational innovation.  
6  
7  
8  
9

#### 10 4.4. Knowledge exploitation activity

11 Table 4 displays the statistical output of OLS regression for knowledge exploitation activity.  
12 Because data on sales and employee growth are not available in the IIS 2011, this study uses  
13 productivity as the only indicator of firm performance, as presented in Table 4. In the first  
14 model PRODINOV is excluded. Strikingly, PRODINOV\_NEW2MARKET and  
15 PRODINOV\_NEW2FIRM innovations as well as INNOVSUCCESS have no significant effect  
16 on firms' performance that is proxied by productivity. When both PRODINOV and  
17 INNOVSUCCESS are excluded (model 2), there is no significant influence of either  
18 PRODINOV\_NEW2MARKET or PRODINOV\_NEW2FIRMS on productivity. In the third  
19 model, in which PRODINOV\_NEW2MARKET and PRODINOV\_NEW2FIRMS are  
20 excluded, there is no significant effect of PRODINOV and INNOVSUCCESS on productivity.  
21 Another surprising finding is that, in contrast, non-product innovations including PROCINOV,  
22 ORGINOV and MKTGINOV, significantly affect productivity in all models. Positive  
23 associations were found between both PROCINOV and ORGINOV and productivity, while a  
24 negative association was found between MKTGINOV and productivity. The evidence that  
25 INNOVSUCCESS has negative and insignificant impact on productivity is in line with  
26 previous studies (Ganotakis and Love, 2012; Roper *et al.*, 2008; Roper and Arvanitis, 2012).  
27 Based on these findings, Hypothesis 3 partially is supported.  
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40 Firm resources negatively and significantly affect productivity, but only in low-  
41 technology firms. Variables such as size, age, export and the lowest level of education have  
42 negative associations with productivity. In contrast, in high-tech firms, having employees with  
43 high school and undergraduate degrees is positively associated with productivity.  
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Table 4. Knowledge exploitation activity

INDEPENDENT VARIABLES	Model 1 PRODUCTIVITY	Model 2 PRODUCTIVITY	Model 3 PRODUCTIVITY
PRODINOV	-	-	268.160(716.413)
PRODINOV_NEW2MARKET	668.224(1122.881)	-289.371(832.420)	-
PRODINOV_NWE2FIRM	-45.167(820.431)	48.857(817.301)	-
PROCINOV	<b>1964.657***(631.219)</b>	<b>1985.895***(631.165)</b>	<b>1985.412***(629.213)</b>
ORGINOV	<b>2511.089***(631.492)</b>	<b>2578.718***(629.410)</b>	<b>2518.678***(632.025)</b>
MKTGINOV	<b>1756.931***(604.736)</b>	<b>-1767.292***(604.841)</b>	<b>-1746.373***(603.329)</b>
INNOVSUCCESS	-29.379(23.128)	-	-21.282(18.660)
<b><i>Firm resources</i></b>			
Size	-0.074(.184)	-0.077(.184)	-0.075(.184)
Age	-22.201(19.116)	-22.262(19.121)	-22.451(19.115)
Export	-7.785(9.670)	-7.583(9.672)	-7.678(9.661)
OWN_NATIONAL	362.853(1241.632)	371.125(1241.944)	351.187(1241.068)
OWN_MULTI	1109.779(1566.056)	1101.907(1566.458)	1076.938(1565.01)
OWN_JOIN	-	-	-
OPERATION_PLANT	-1003.043(879.703)	-986.841(879.843)	-997.590(879.377)
OPERATION_HEAD	-	-	-
LOW_TECH	-	-	-
MEDLOW_TECH	580.331(649.173)	580.257(649.345)	577.387(648.739)
MEDHIGH_TECH	<b>2005**(912.806)</b>	<b>2044.913**(912.506)</b>	<b>2025.741**(911.861)</b>
HIGH_TECH	2421.285(2542.052)	2457.057(2542.568)	2477.757(2539.589)
EDU_UNDERHS	-48.366(31.223)	-47.312(31.220)	-48.391(31.215)
EDU_HIGHSCHOOL	-43.934(33.014)	-43.345(33.020)	-44.058(33.000)
EDU_DIPLOMA	-44.996(58.843)	-44.698(58.858)	-45.006(58.821)
EDU_UNDERGRAD	-	-	-
RD_STAFF	11.331(37.141)	10.115(37.138)	11.454(37.121)
Obs.	1179	1179	1179
F ( )	2.92	3.00	3.07
Prob > F	.000	.000	.000
R <sup>2</sup>	.046	.044	.046
Adj. R <sup>2</sup>	.030	.030	.031
Root MSE	8272.30	8274.50	8270.00

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . The results are based on OLS regressions.

## 5. DISCUSSION AND CONCLUSIONS

This study investigates and models the IVC that encompasses knowledge sourcing, transformation and exploitation activities of Indonesia manufacturing firms using data from the IIS 2011. The literature on the IVC framework has been widely used to analyse interrelationships among firm interaction, innovation, business growth and productivity in developed countries, however, based on the reviewed literature there is no empirical evidence on the IVC in the context of Indonesia. From theoretical point of view, this study contributes on innovation process framework development by uncovered the nature of interrelationships within each stage and between linkages of the IVC performed by Indonesian firms.

Key findings of this study are as follows. First, in the first link of the IVC, this study finds the existence of strong synergistic relationships between internal R&D and external sources of knowledge as well as among external sources of knowledge. This may indicate a similar pattern of knowledge sourcing activity to that in developed countries, namely the implementation of “open innovation strategy”. The role of external networks tends to be less important when the firms already source knowledge for innovation from external R&D activities. External actors from market/commercial groups (i.e. customers and competitors) have important roles as knowledge providers if the firm also generates knowledge from internal R&D. In contrast, the firms’ interactions with scientific institutions tend to be of lesser importance. The firms that source knowledge from market/commercials network interact less with scientific institutions, but they do interact with their own networks, associations and open sources. A synergistic relationship can also be found among science institutions. In relation to formal cooperation, firms tend to restrict cooperation with firms within the same group and with suppliers when they perform internal or external R&D activities. This finding supports the recent studies on complementary relationship between internal and external knowledge sourcing activities (Bogers and Lhuillery, 2018; Doran *et al.*, 2019; Majidpour, 2017; Paula and Da Silva, 2018).

Second, in the second link of the IVC, internal R&D plays important roles and has strong positive impacts on all types of innovation and innovation success. External knowledge that shows similar patterns in shaping innovations mainly comes from informal knowledge from customers and competitors. Knowledge generated from scientific institutions makes no significant contribution to innovation and innovation success. Positive impacts on process innovation come only from government and non-profit R&D, while university and polytechnic sources contribute negatively to process innovation. This contradicts previous studies stating that novel and highly advanced innovation requires greater levels of R&D, patents or

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3 knowledge from science institutions such as universities and research centres (Amara and  
4 Landry, 2005; Tödting *et al.*, 2009).

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6 Third, the final link of the IVC relates to the impact of innovation on productivity  
7 provides surprising results. In general, product innovations new to the market and new to the  
8 firm as well as innovation success have no significant impact on productivity. The fact that  
9 innovation success is negatively associated with productivity may prompt questions related to  
10 the quality of innovative products that may be not able to disrupt the market and this may  
11 severely impact the firms' sales and further impact productivity.  
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17 The finding that neither product innovations new to the market and new to the firm nor  
18 innovation success lead to productivity, perhaps due to the firms' efforts to detect and  
19 overcome any weak links in the IVC to boost productivity. First, sourcing activity that relies  
20 on synergy between internal R&D and external networks, mainly from market/commercials,  
21 automatically influences the minimum usage of other sources of knowledge such as scientific  
22 institutions that may provide additional added value for firms. In this sense, a diverse open  
23 innovation strategy may need to be implemented with the hope that the use of more diverse  
24 and better-quality sources of knowledge able to overcome the weak links in knowledge  
25 sourcing activities. Second, the low quality of firms' human resources may contribute to the  
26 success of knowledge sourcing, transformation and exploitation as indicated by no positive  
27 contributions to the three links of IVC. Third, diverse of innovation barriers that hamper  
28 Indonesian manufacturing firms may affect the success of the IVC activities. Lastly,  
29 environments external to the firms, or a weak conditional framework for innovation in  
30 Indonesia, may contribute indirectly to the success of the IVC activities.  
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41 Findings from this study are expected to enrich literature of innovation studies, especially  
42 innovation process framework in the context of developing countries, in several ways. First,  
43 the fact that non-technological innovation (i.e. marketing innovation) is the highest proportion  
44 of innovation produced by Indonesian manufacturing firms support and confirm previous  
45 studies that reveal most firms in in developing countries: tend to focus on market rather than  
46 technological innovation (Wamae, 2009), beyond traditional focus on R&D (Srholec, 2011),  
47 and attempt to reach the technological frontier instead of achieving inventions that are new to  
48 the market (Hou and Mohnen, 2013). Second, the highest proportion of knowledge sourced by  
49 Indonesian manufacturing firms mainly from informal source of knowledge e.g. customers and  
50 competitors. This also confirms previous innovation studies in Indonesia that reveal innovation  
51 in Indonesian manufacturing sectors generally as the results of learning through "informal  
52 experiences" not through "formal scientific activity or R&D" (Aminullah, 2012; Aminullah *et*  
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3 *al.*, 2014). Third, this study also confirms the existence of complementary or synergy  
4 relationships between internal and external knowledge sourcing activities that has been tested  
5 as part of innovation process framework in most studies conducted in developed economies.  
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### 10 5.1. Innovation policy implication

11 Based on the findings from the first and second links of the IVC, relevant innovation policies  
12 may be proposed. The fact that Indonesia faces problems related to scientific institutions such  
13 as “low public and private investment in R&D”, “a low-ranking higher education and training  
14 system” and “a small number of researchers and scientists for a country of its size” (OECD,  
15 2013, p. 175), may present a problem for synergistic relationships between scientific  
16 institutions and other external agents. Further impact is clearly seen in the second link of the  
17 IVC in which the knowledge used from scientific institutions, both informally and formally,  
18 negatively impacts innovations. Therefore, government policy, for instance, promoting a triple  
19 helix strategy that involves university-industry-government interaction and partnership, may  
20 help address these challenges to improve knowledge transfer by integrating the three types of  
21 institutions. As argued by Tambunan (2005), triple helix implementation in Indonesia has been  
22 relatively slow. The Indonesian government initiated the development of incubators and  
23 science parks in 1990 with UNDP’s support, but the development of these incubators has been  
24 very slow (Simamora, 2009). Public scientific institutions such as techno parks may be used  
25 by Indonesian firms to generate knowledge from R&D activities when they lack sufficient  
26 internal funds. In relation to synergistic relationship between internal R&D and a wide range  
27 of external sources of knowledge, this study also suggests that rather than engaging exclusively  
28 in either R&D or external linkages, firms may adopt a hybrid strategy of leveraging knowledge  
29 from both sources of knowledge in the innovation process. It is believed that the proposed  
30 policies implication also relevant for firms in developing economies since Firms in emerging  
31 economies tend to experience substantial institutional, resources and capability barriers that  
32 affect successful innovation (Fu *et al.*, 2014).  
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### 51 5.2. Limitation of the study

52 Finally, limitations of this study need to be acknowledged. First, issues related to firms’ sectors  
53 has not been discussed in this study and as a result, sectors’ effects on the three links of IVC  
54 cannot be detected. The variation among firm sectors is only derived from the classification of  
55 technology intensity. Second, this study uses IIS 2011 data that is restricted to manufacturing  
56 firms. The comparison of the IVC activities between manufacturing and service firms may  
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3 provide fruitful insight into innovation policies for Indonesia. Therefore, these issues should  
4 be studied in the future research. Third, this study is a cross-sectional in nature i.e. the study  
5 only portrays IVC based on IIS 2011 data, as a result dynamic of Indonesian manufacturing  
6 firms' IVC is missing. Hence, future studies may address this limitation by conducting a  
7 longitudinal study. Fourth, this study lack of update insight on IVC of Indonesian firms since  
8 there is no update on innovation survey data. Lastly, specific issues related to each stage of the  
9 IVC importantly should be explored. In the knowledge sourcing activity stage, the issue related  
10 to formal cooperation with various external partners has not been addressed, hence it is  
11 recommended to test it in the future studies. In addition, factors that may hinder the success of  
12 the IVC i.e. innovation barriers are not yet investigated. Since it is limited insight on the linking  
13 innovation barriers into the IVC activity.  
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Dear Editor in Chief of JABS

We thank you for the minor comments on our manuscript. Herein, we explain how we revised the paper based on those comments and recommendations in the following table.

Kind Regards,  
Arif Hartono

No	Comments	Responses
1	End the paper with a concluding paragraph (not limitations)	Many thanks for the feedback. We have addressed the reviewer feedback. Please see discussion and conclusion section.
2	Go over the paper and remove any typos, grammatical errors and informal language. Please also remove highlights.	Many thanks for the feedback. We have carefully checked the paper thoroughly.
3	Instead of using acronym after acronym in the text (e.g., para 4.4), spell out in plain English.	Many thanks for the input. We have addressed the reviewer feedback. Please see section 4 (Result section).
4	Include robustness tests from 2014 data in your response letter. Or provide an explanation why this is not possible.	Many thanks for the suggestion. We have addressed the reviewer feedback. Please see additional explanation in the last paragraph of 3.1. Data.
5	In abstract, remove data waves as limitations and replace it with other limitations from the limitations section, which seem far more consequential.	Many thanks for the suggestion. We have addressed the reviewer feedback. Please see the abstract section.



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## **From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms**

**Purpose** – The study investigates the innovation value chain (IVC) that encompasses knowledge sourcing, transformation, and exploitation activities among Indonesian manufacturing firms by using data from the Indonesia Innovation Survey (IIS).

**Design/methodology/approach** – A simple approach of single equation Probit model, Logit regression, and Tobit regression are used in the first, second, and third stages of IVC consecutively.

**Findings** – The study finds the existence of a synergistic relationship between internal and external sources of knowledge as well as among external sources of knowledge. In terms of the second link of the IVC, internal R&D plays an important role that positively influences knowledge transformation into all types of innovation and innovation success. External knowledge that has a similar pattern in shaping innovation mainly comes from market and open sources. Scientific institutions tend to contribute to innovation negatively, and few positive impacts on process innovation are observed from government R&D and non-profit R&D institutions. Informal knowledge is more likely to influence technological than non-technological innovation.

**Originality** – This study is different from the previous IVC studies due to the following reasons. First, in this study, a broader source of knowledge is tested. Second, the wider innovation (technological and non-technological innovation) is also assessed.

**Research limitations** – Finally, the limitations of this study need to be acknowledged. Issues related to firms' sectors have not been discussed in this study and as a result, sectors' effects on the three links of IVC cannot be detected. This study is a cross-sectional in nature, as a result, the dynamic of Indonesian manufacturing firms' IVC is missing. Hence, future studies may address this limitation by conducting a longitudinal study.

**Keywords:** innovation value chain, productivity, manufacturing firms, Indonesia

## 1. Introduction

Interest in innovation studies has been increasing in general, with no exception in the case of developing countries. However, innovation in the context of developing countries cannot necessarily be explained using the same concepts applied to developed countries, because developing countries are subject to different challenges in terms of the capital, infrastructure, intellectual and analytical foundations of innovation system analysis (Choi and Williams, 2013; Lorentzen, 2010; Metcalfe and Ramlogan, 2008; Mytelka, 2000). Da Silveira (2001) emphasises that it is important to study innovation in developing countries because most theories, approaches, mechanisms and technical changes associated with innovation that affect managerial practices and skills were developed based on evidence from developed countries. The relevancy and adaptability of any model, framework or construct of innovation studies that was developed, built and tested in developed countries need to be re-evaluated before being implemented in developing countries. This study aims to extend previous studies of innovation value chains (IVC) conducted in developed economies, such as North America and Europe (Hansen and Birkinshaw, 2007), Ireland (Roper *et al.*, 2008) and the UK (Ganotakis and Love, 2012; Love *et al.*, 2011), by using innovation survey data of manufacturing firms in the developing economy of Indonesia.

According to Hansen and Birkinshaw (2007, p. 122), the IVC is “a sequential, three-phase process that involves idea generation, idea development, and the diffusion of developed concepts”. The IVC concept was derived from innovation research projects which interviewed 130 executives from 30 multi-national firms in North America and Europe. Extending Hansen and Birkinshaw’s (2007) work, innovation survey-based IVC studies were conducted by other scholars (Doran and O’leary, 2011; Ganotakis and Love, 2012; Love *et al.*, 2011; Roper *et al.*, 2008; Roper and Arvanitis, 2012). Following these scholars, this study aims to investigate the IVCs of knowledge sourcing, transformation and exploitation activities performed by Indonesian manufacturing firms. This study focuses on the IVC in Indonesia context because to date, no previous study has looked at the IVC based on data derived from innovation surveys of Indonesian firms. This study intends to address previous studies’ imbalance and to provide a new empirical contribution to the understanding of IVC activity based on a firm-level analysis of Indonesian manufacturing firms.

In Indonesia context, previous studies that investigate knowledge sourcing and using activities limited on case studies in a specific industry. For instances, collaboration and innovation adoption in small-scale industry clusters (e.g. Sandee and Rietveld, 2001); innovation and information flow in small-scale cottage industries in a rural area (Kristiansen, 2002); sources of knowledge in small furniture industries (Van Geenhuizen and Indarti, 2005); and innovation and cooperation activities of SMEs in food processing industry clusters (Najib and Kiminami, 2011). These studies reveal some important issues such as (1) the most innovation adopted is product innovation; (2) collaboration among producers (inter-firm cooperation) in SMEs clusters play important role in their innovation activities; (3) traditional knowledge sources such as in-house learning by doing and experiment, customers and competitors are the main knowledge sources in the innovation process; and (4) factors that hamper innovation activities is lack of access to information on market and advanced technology, financial to fund innovation activities, and social capital development.

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3 More examples of knowledge sourcing is a qualitative study that investigates the role of  
4 academia as an external source of innovation in the Indonesian automotive industry (Aminullah  
5 and Adnan, 2012). The study found that consumers and competitors are the main sources of  
6 innovation in the Indonesian automotive industry, while universities and academia have a weak  
7 contribution as the sources of innovation. Therefore, this study intends to address this  
8 unbalance and to provide a new empirical contribution to the understanding of the IVC activity  
9 based on firm-level analysis of Indonesian manufacturing firms. Furthermore, this study also  
10 intends to build the IVC model based on innovation activities of the Indonesian manufacturing  
11 firms that encompass the three IVC activities (i.e. knowledge sourcing, transformation and  
12 exploitation). From a practical perspective, findings of this study are expected can be used by  
13 policymakers at government and firm levels to identify innovation activities as well as to detect  
14 any weak links in the IVC; therefore, relevant innovation policy and strategy can be formulated  
15 to foster innovation in Indonesia.  
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20 This study is different compared to the previous IVC studies in several ways. First, in  
21 this study a wider range sources of knowledge that consists of (1) R&D activities (internal and  
22 external R&D) and (2) informal knowledge gains from market agents, scientific institutions,  
23 associations, and open sources. As argued by previous scholars that sourcing knowledge from  
24 diverse sources can increase the degree of innovation's novelty (Amara and Landry, 2005) and  
25 the difficulty to be replicated to generate sustainable competitive advantage (Henderson and  
26 Cockburn, 1996).  
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30 Second, a wider innovation classification such as organisational and marketing  
31 innovation are assessed (see Battisti and Stoneman (2010) for innovation classification), while  
32 most innovation survey-based the IVC studies in developed countries context tend to focus on  
33 product and process innovations (e.g. Doran and O'Leary, 2011, Ganotakis and Love, 2012,  
34 Love *et al.*, 2011, Roper *et al.*, 2008, Roper and Arvanitis, 2012a). In the context of developing  
35 countries, innovation activities tend to focus on the market rather than on technology (Wamae,  
36 2009). Innovation activities in developing countries that emphasise on minor and incremental  
37 changes on existing products or process innovation as well as innovative approaches to  
38 organisation and marketing is a major part of innovation (OECD and Eurostat, 2005).  
39 Therefore, it is expected that the study provides different findings compared to the existing  
40 IVC studies.  
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44 Research questions related to the IVC activities that are addressed in this study are as  
45 follows: (1) To what extent are the various knowledge sources activities used by Indonesian  
46 manufacturing firms? (2) To what extent the various knowledge sources are used in the  
47 knowledge transformation activity associated with diverse types of innovation? (3) To what  
48 extent do the different types of innovation and innovation success influence firm performance  
49 that is proxied by productivity?  
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52 The rest of the paper is organized as follows. In the next section, the conceptual  
53 foundation and hypotheses relate to the IVC activities are presented. In this section, the  
54 distinction between knowledge sourcing, transformation and exploitation activities is  
55 discussed. Section 3 explains the data and methods used in this study. Furthermore, section 3  
56 describes the data, variables, and methods for testing the proposed hypotheses. Section 4  
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reports the results, and details to what extent the proposed hypotheses have been confirmed. The final section contains a discussion and conclusions.

## 2. Conceptual Foundation and Hypotheses Development

Previous studies have attempted to develop models and theoretical frameworks to capture the innovation process of firms. Previous models of the innovation process in the industrially advanced countries have been developed, for instances five generations of the innovation process (Rothwell, 1994), a stage-gate model of innovation (Cooper, 1989), and funnel model (Wheelwright and Clark, 1992). However, none of these models attempts to deal with the issue of developing countries catch up from behind the technology frontier, because in the catch-up case innovation occurs based on minor improvements to existing process and product designs (Hobday, 2005). Therefore, the models may not be relevant to the Indonesian context. The concept of IVC is concerned with the innovation process whereby firms source knowledge, transform this knowledge into innovation output and finally exploit innovation output for performance gains (Hansen and Birkinshaw, 2007). Previous models of IVC in the industrially advanced countries have been developed. Using innovation survey data, the following scholars (Battisti and Stoneman, 2013; Doran and O'Leary, 2011; Ganotakis and Love, 2012b; Love *et al.*, 2011; Roper *et al.*, 2008) have drawn the IVC model. However, their models tend to focus on internal R&D activity and a limited number of external linkages such as market and public R&D as the sources of knowledge. In addition, their models focused on technological innovation (such as product and process innovation), while in this study a wider innovation such as organisational and marketing innovation are included and analysed.

### 2.1. Knowledge sourcing activity

In the first link of the IVC, knowledge is sourced from both inside and outside the firms (Hansen and Birkinshaw, 2007). Therefore, the main task in this activity is to assemble the knowledge used for innovation (Roper *et al.*, 2008). In terms of the degree of externalisation, Frenz and Ietto-Gillies (2009, p. 1126) explain that internal R&D is the knowledge generated inside a firm, while knowledge from external R&D, from informal and open networks, and cooperation activities are “external to the enterprise to various degrees, depending on their ownership and the contractual structures of the relationship between our enterprise and the other party or parties to the transfer”. Knowledge from external linkages can be differentiated based on the form of access, whether informal or formal, and the knowledge content being transferred (Monjon and Waelbroeck, 2003). Storper (1997) classified formal cooperation as that which involves more formalised interactions among firms. In contrast, informal interactions, which normally involve informal relations, “might explain the spatial concentration of innovative industries and activities” (Tödtling *et al.*, 2009, p. 61).

Informal linkages can include “personal contacts or communities of practice or simply arise in the normal course of business”, while formal linkages “can be organised by business organisations such as chambers of commerce, research associations, technology services companies, consultants, universities or public research organisations or sponsored by local, regional or central governments” (OECD/Eurostat, 2005, p. 79). Internal firm capabilities are necessary to access and absorb knowledge from informal linkages, while formal cooperation

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3 activity is associated with the use of knowledge resulting from access to resources and  
4 innovative capabilities of partners (Freitas *et al.*, 2011).  
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6 Several previous studies have investigated the interaction among sources of knowledge  
7 used for innovation activities. One of the main discussions in these studies is whether  
8 complementary or substitution relationships exist between internal and external knowledge  
9 sourcing strategies in innovation activities. Some scholars argue that studies of such  
10 relationships remain unclear and inconclusive (Hagedoorn and Wang, 2012; Schmiedeberg,  
11 2008). On the one hand, some studies reveal a complementary relationship between internal  
12 R&D and external knowledge in knowledge sourcing activities (Cassiman and Veugelers,  
13 2002; Hagedoorn and Wang, 2012; Roper *et al.*, 2008; Schmiedeberg, 2008; Veugelers and  
14 Cassiman, 2005). On the other hand, other empirical studies identify a substitution relationship  
15 in these activities (Hess and Rothaermel, 2011; Laursen and Salter, 2006; Love and Roper,  
16 2001; Xu *et al.*, 2013). In this study, the term ‘complementarity’ is used interchangeably with  
17 ‘synergistic’, which means that the implementation of one strategy increases the marginal  
18 returns from another (Milgrom and Roberts, 1995).  
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23 Turning to the Indonesia context, there are a few insights related to synergistic or  
24 substitution strategies in innovation activities performed by Indonesian firms. In general, as in  
25 any other developing country, advanced knowledge of technology is accessed by importing  
26 from the advanced industrial countries, and the international technology transfer process  
27 mostly takes place in the private sector (Wie, 2005) because public support for R&D is minimal  
28 (Hill and Tandon, 2010). Wie (2005) identifies two major channels of international technology  
29 transfer to Indonesia: (1) a formal or market-mediated channel that includes FDI; technology  
30 licensing agreements; imports of capital goods; foreign education and training; turnkey plants;  
31 and technical consultancies, and (2) an informal or non-market mediated channel composed of  
32 technical assistance by foreign buyers and foreign vendors; copying or reverse engineering;  
33 information from trade journals; and technical information services provided by public  
34 agencies.  
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39 Apart from imported technology, the use of various sources of knowledge by Indonesian  
40 firms has also been studied. For example, Indonesian small furniture firms tend to generate  
41 knowledge through in-house learning by experimentation as well as from customers (Van  
42 Geenhuizen and Indarti, 2005). The cooperative activity was also found positively related to  
43 innovation in a cluster of Indonesian small food processors (Najib and Kiminami, 2011) and  
44 small scale roof tile firms (Sandee and Rietveld, 2001). Collaboration within Indonesian small  
45 firm clusters is also effective for sharing costs and risks (Sandee and Rietveld, 2001). As an  
46 example of Indonesian high-technology industry, the automotive industry develops innovation  
47 mainly from inside the organisation and competitors are the main source of external knowledge  
48 to support the creation of new products in a competitive market (Aminullah and Adnan, 2012).  
49 On the other hand, universities and public research institutions contribute little external  
50 knowledge to the Indonesian automotive industry (Aminullah and Adnan, 2012). Although  
51 literature that discusses the involvement of external actors as sources of knowledge in the  
52 innovation process is scarce, a synergistic relationship between internal and external  
53 knowledge may exist to some extent.  
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3 The complementary relationship also exists between internal and external knowledge  
4 sourcing activities in recent studies. In the context of a developing economy, Majidpour (2017)  
5 finds that the complementary relationship between Iranian firms' catch-up through indigenous  
6 R&D and overseas technology sources. Complementary relationships are also found between  
7 internal and external R&D in firms from high-technology industries in manufacturing firms  
8 across European countries (Paula and Da Silva, 2018). While, a complementary relationship  
9 also exists between Irish SMEs internal and external knowledge sourcing activities, especially  
10 between R&D and linkages with customers and public knowledge sources (Doran *et al.*, 2019).  
11 Based on this, a hypothesis is proposed:  
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16 *H1 In knowledge sourcing activities, a synergistic relationship exists between internal R&D*  
17 *and external sources of knowledge.*  
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## 20 2.2. Knowledge transformation activity

21 In the second link of the IVC, different sources of knowledge used in the innovation activities  
22 are transformed into different types of innovation (Hansen and Birkinshaw, 2007; Roper *et al.*,  
23 2008). This involves innovation or knowledge production in which the success of knowledge  
24 transforming activities relies on the firms' knowledge sources (Griliches, 1992; Love and  
25 Roper, 1999). Therefore, the main issue addressed in this stage is comparative impact of  
26 various sources of knowledge on different types of innovations (product, process,  
27 organisational, and marketing).  
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31 Innovation is a complex phenomenon and normally firms use several sources of  
32 information simultaneously (Freitas *et al.*, 2011). The link between various sources of  
33 knowledge and the adoption of different innovations has been investigated (Amara and Landry,  
34 2005; Srholec and Verspagen, 2012; Tödtling *et al.*, 2009). Previous scholars (Amara and  
35 Landry, 2005; Tödtling *et al.*, 2009) find that advanced innovations that are new to the market  
36 need a higher level of extended internal R&D, patent and more knowledge from universities,  
37 and research organisations to stimulate and support them. Meanwhile, less advanced  
38 innovations, such as business services (Tödtling *et al.*, 2009) and market innovations (Amara  
39 and Landry, 2005), require knowledge links with less research-based input.  
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43 A majority of previous IVC studies in advanced economies reveal that internal R&D  
44 activities are positively and significantly associated with innovation adoption (Doran and  
45 O'leary, 2011; Ganotakis and Love, 2012; Roper *et al.*, 2008; Roper and Arvanitis, 2012).  
46 Apart from the IVC studies, other studies in industrialised countries at the firm level show  
47 positive links among R&D, innovation and productivity (Griffith *et al.*, 2004, 2006; Mohnen  
48 *et al.*, 2006). Evidence from developing and newly industrialised countries also show a positive  
49 association between R&D, innovation and productivity, with examples including Argentina  
50 (Chudnovsky *et al.*, 2006), Malaysia (Hegde and Shapira, 2007), China (Jefferson *et al.*, 2006)  
51 and Taiwan (Aw *et al.*, 2011). Firms that have higher levels of investment in R&D are more  
52 likely to introduce technological innovation as was found in Brazil (Raffo *et al.*, 2008) and  
53 Chile (Alvarez *et al.*, 2010). Based on this, a second hypothesis is proposed:  
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59 *H2a Internal R&D positively influences innovation and innovation success.*  
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The use of informal knowledge as input for the innovation process comes mainly from external information sources gained without any formal arrangements (Garcia-Torres and Hollanders, 2009). The informal link between certain actors and types of innovation has been investigated in previous studies. Past subjects of investigation have included the role and involvement of *customers* in the innovation process (Franke and Schreier, 2002; von Hippel and Katz, 2002; Joshi and Sharma, 2004); *key suppliers* and their roles in product innovation development (Amara and Landry, 2005; Nieto and Santamaría, 2007; Smith and Tranfield, 2005); the role of *competitors* in knowledge transfer and innovation (Malmberg and Maskell, 2002); and fostering advanced technological innovation (Gnyawali and Park, 2011). Open-source information and knowledge from *scientific publications* prove beneficial for firms (Caloghirou *et al.*, 2004). Recent empirical evidence shows that different external sources of knowledge used by firms influence innovation adoption (Doran *et al.*, 2019; Simao and Franco, 2018).

In the case of Indonesian firms, studies of informal knowledge usage for innovation have been conducted and the results show that different sources of external knowledge contribute to diverse benefits for the firms. External actors apart from the market, for example, *foreign suppliers*, have very important roles in the development of technological capability and innovation in Indonesian firms (Wie, 2005). *Foreign buyers* also contribute technical and managerial assistance for many Indonesian SMEs (Wie, 2005). *Competitors* support the development of new products in the competitive market (Aminullah and Adnan, 2012). However, there is no single study in the Indonesia context that links diverse knowledge of innovation and adoption of different types of innovation with innovation success achieved by Indonesian manufacturing firms. In this study, informal knowledge derived from the IIS 2011 is grouped into *market*, including suppliers, customers, competitors, consultants and commercial labs; *science institutions*, including universities, polytechnic institutes, government R&D and non-profit R&D; *associations*, including industry associations, investors and entrepreneurs; and *open sources*, including events, scientific publications and the internet. Therefore, another hypothesis is proposed:

*H2b Different levels of informal knowledge influence innovation adoption differently.*

### 2.3. Knowledge exploitation activities

The final link in the IVC is knowledge exploitation that generates value for the firm. Starting with the work of Geroski, Machin, and Reenen (1993), previous scholars such as (Ganotakis and Love, 2012; Love *et al.*, 2011; Roper *et al.*, 2008) argue that, in the knowledge exploitation stage, firm performance is affected by innovation output as the result of codified knowledge gained through knowledge sourcing activities. They state that the innovation output needs to be determined prior to knowledge exploitation. Therefore, the main interest at this stage is how firms gain business productivity or profitability from the exploitation of adopted innovation. In this study, productivity (indicated by total sales/number of employees) is used to measure how innovation affects overall firms' performance. Prior IVC studies find that innovation output in the form of process innovation (Doran *et al.*, 2019), product and process innovation (Ganotakis and Love, 2012; Roper *et al.*, 2008) significantly and positively influence innovation performance as measured by sales and employment growth. Surprisingly, both a

negative impact (Roper *et al.*, 2008) and no relationship (Ganotakis and Love, 2012) of product innovation success on productivity have been found. Therefore, in this study, the involvement of wider innovation is expected to provide a different view compared to previous IVC studies. Hence, an additional hypothesis is proposed:

*H3 In knowledge exploitation activity, innovation and innovation success positively affects a firm's performance.*

### 3. DATA AND METHODS

#### 3.1. Data

The empirical analysis in this study is derived from the Indonesia Innovation Survey (IIS) 2011 that covers 2009-2010. In terms of firm size, the IIS 2011 surveyed only medium (20-99 employees) and large (more than 99 employees) Indonesian manufacturing firms. The surveyed firms are classified based on the International Standard Industrial Classification (ISIC) Rev. 3.1. Multi-stage random sampling was used to collect data from 1,500 firms and a total of 1,375 questions were successfully collected. Of the returned questionnaires, 1,179 were usable. Face to face interviews with R&D or production managers were conducted to collect the data. The IIS 2011 used the Oslo Manual (OECD/Eurostat, 2005) as the guideline for collecting and interpreting innovation data and adjustments were made to facilitate innovation activities in Indonesia that may differ from those in developed economies. For example, the innovation activity and internal sources of knowledge variables in the IIS 2011 have broader categories than the same variables in the UK CIS. Unfortunately, Indonesia has three waves of innovation survey only (2008, 2011, and 2014) and no continuity of the survey. As a result, there is no update data on the innovation survey. The number of samples in the last innovation survey (2014) nearly a half of the second wave of the survey (2011) and the sample covers business firms only. As a result, it may not represent Indonesian firms in general. Therefore, the 2011 innovation survey is used in this study.

#### 3.2. Methods

In the knowledge sourcing activity, the main issue that is addressed is the behaviour of Indonesian manufacturing firms in sourcing knowledge from various sources. More specifically, synergistic or substitution relationships among the three groups of knowledge are tested. Following Roper, Du, and Love (2008), a simple approach of single equation probit model is used to test Hypothesis 1 with the dependent variables being a series of sources of knowledge. This allows for a detailed analysis of the impact of 17 various knowledge sources.

In the knowledge transformation link, an innovation or knowledge production function is used to model the knowledge transformation activities (Geroski, 1990; Harris and Trainor, 1995). Logit regression is used to test Hypotheses 2 with the dependent variables being different types of innovation. Tobit regression is employed when the dependent variable is innovation success (the proportion of sales derived from product innovation new to the market) that has both upper and lower bounds (0 to 100%). In the knowledge exploitation stage, OLS regression is used to test Hypothesis 3, and the dependent variable is the firms' productivity, which is a measure of how innovation affects overall firm performance.



## 4. RESULTS

### 4.1. Descriptive statistics

Table 1 presents descriptive statistics for the IIS 2011. Following the 3<sup>rd</sup> Oslo Manual, the IIS 2011 defines innovation as “the implementation of a new or significantly improved product (good or services), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations” (OECD/Eurostat, 2005, p. 46). Based on the definition that covers a broad range of possible innovations, the IIS 2011 then defines an innovative firm as a firm that performed any product, process, organisational or marketing innovation from 2009 to 2010. According to Table 1, the mean of productivity (total sales/number of employees) is approximately IDR 1.3 trillion. The highest proportion is marketing innovation (42.8%), while the lowest is organisational innovation (31%). The mean of product innovations that are new to the market is lower than the same innovations that are new to the firm, and account for 28.8% versus 35.8% respectively. The mean of innovation success as the proportion of launched products new to the market accounted for 8.43%. The fact that marketing innovation outnumbered other innovation is typical in developing countries that tend to focus on the market rather than on the technology (Wamae, 2009).

Turning to knowledge sourcing activities, approximately 29% of firms report generating their own knowledge from internal R&D, while only 3.2% of firms source knowledge from external R&D. Firms report market as more important than other sources of knowledge, including suppliers, competitors and customers which represent 19.1%, 22.5% and 34.4%, respectively. These are followed by open sources (internet) and associations (entrepreneurs) that account for 11.3% and 14.6%, respectively. In contrast, less than 5% of firms source science-based knowledge from universities, polytechnic, government and non-profit R&D institutions.

The mean of firm size as indicated by the number of employees is nearly 175 people. Of surveyed firms, mature firms (more than 20 years) dominate in the IIS 2011 data. The proportion of national firms is significantly higher at 90%, compared to multi-nationals and joint ventures, at 6% and 4.2%, respectively. Most of the surveyed firms operate in their headquarters, not in the manufacturing plants (91% versus 9.2%). Labour education levels are low. More than 50% of employees have no high school degree, which indicates the low level of education of the firms’ human resources. In contrast, less than 5% of employees hold undergraduate degrees.

Table 1 Descriptive statistics

VARIABLES	Obs.	Mean	SD	Min.	Max.
<b><i>Firm performance</i></b>					
Productivity (total sales/number of employee) (IDR)	1179	1312.096	8399.761	.088	125000
<b><i>Innovation performance</i></b>					
Innovation success (% sales of product innovation new to the market)	1179	8.43	16.99	0	100
<b><i>Innovation output</i></b>					
Product innovation (0/1)	1179	.377	.485	0	1
Product innovation new to the market (0/1)	1179	.288	.453	0	1

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Product innovation new to the firms (0/1)	1179	.358	.480	0	1
Process innovation (0/1)	1179	.322	.468	0	1
Organisational innovation (0/1)	1179	.310	.463	0	1
Marketing innovation (0/1)	1179	.428	.495	0	1
<b>R&amp;D Activities</b>					
Internal R&D (0/1)	1179	.292	.455	0	1
External R&D (0/1)	1179	.032	.177	0	1
<b>Market agents (highly important)</b>					
Suppliers (0/1)	1179	.191	.393	0	1
Customers (0/1)	1188	.344	.475	0	1
Competitors (0/1)	1179	.225	.418	0	1
Consultant (0/1)	1179	.041	.198	0	1
Commercial labs (0/1)	1179	.042	.200	0	1
<b>Science institutions (highly important)</b>					
University (0/1)	1179	.031	.174	0	1
Polytechnic (0/1)	1179	.027	.163	0	1
Government R&D institutions (0/1)	1179	.041	.198	0	1
Non-profit R&D institutions (0/1)	1179	.036	.185	0	1
<b>Associations (highly important)</b>					
Investors (0/1)	1179	.091	.287	0	1
Industry Association (0/1)	1179	.065	.247	0	1
Entrepreneurs (0/1)	1179	.146	.353	0	1
<b>Open sources (highly important)</b>					
Events (0/1)	1188	.109	.312	0	1
Science Publication (0/1)	1188	.067	.251	0	1
Internet (0/1)	1179	.113	.316	0	1
<b>Firms Resources</b>					
Size (number of employee)	1179	174.608	1318.078	20	32977
Firms' age (years)	1179	21.077	12.704	0	84
Export (%)	1179	9.726	25.106	0	100
Ownership National (0/1)	1179	0.899	0.301	0	1
Ownership Multi-National (0/1)	1179	0.059	0.235	0	1
Ownership Joint Venture (0/1)	1179	0.042	0.202	0	1
Operation Plant (0/1)	1179	0.092	0.289	0	1
Operation Head Quarter (0/1)	1179	0.908	0.289	0	1
Education Under High school (%)	1179	56.247	36.423	0	100
Education High School (%)	1179	36.430	31.492	0	100
Education Diploma (%)	1179	3.246	6.779	0	55
Education Undergraduate (%)	1179	4.077	8.623	0	90
Employees' proportion in R&D dept (%)	1179	2.986	6.717	0	57
Low technology (0/1)	1179	.735	.442	0	1
Medium-low technology (0/1)	1179	.174	.379	0	1
Medium-high technology (0/1)	1179	.082	.275	0	1
High technology (0/1)	1179	.009	.096	0	1

#### 4.2. Knowledge sourcing activity

The empirical analysis in the first stage of IVC follows the approach of Roper *et al.*, (2008) and it allows for a detailed analysis of the interdependence of various knowledge sources. The following equation is estimated using a series of probit models.

$$KS_{ji} = KS_{ki}\beta_0 + X_{li}\beta_l + \varepsilon_{li} \quad \text{if } y_{0i} = 1$$

where  $KS_{ji}$  represents firm  $i$ 's knowledge sourcing activity  $j$  during the reference period.  $KS_{ki}$  represents firm  $i$ 's knowledge sourcing activity  $k$  where  $j \neq k$ ,  $X_{li}$  is a vector of explanatory variables,  $\beta_l$  is the associated coefficient vector, and  $\varepsilon_{li}$  is the error term. When sourcing knowledge H1 suggests that a complementary/synergistic relationship exists between internal R&D and external knowledge sourcing activities. Therefore, if  $\beta_0 > 0$  this implies that firms which engage in one type of knowledge sourcing (e.g., R&D) are more likely to engage in other types of knowledge sourcing (e.g., customers, suppliers, and competitors). This provides a direct test of H1.

Table 2 indicates a synergistic relationship between internal and external R&D and this is in line with previous findings (Cassiman and Veugelers, 2002, 2006; Ganotakis and Love, 2012; Schmiedeberg, 2008). Firms are more likely to perform external R&D if they also generate their own knowledge from internal R&D. The same relationship also exists between IN\_RD and external agents from market (customers, competitors, and commercial labs) and from associations, such as industry associations and entrepreneurs. However, the firms interact less with external networks from science institutions and open sources. Firms also interact less with external actors if they already perform external R&D. Based on this finding, the first hypothesis is supported.

Turning to informal knowledge (see Table 2), it can be observed that firms that source knowledge from market tend to interact with other market networks, associations and open sources. However, these firms interact less with scientific institutions, with the exception that firms sourcing knowledge from commercial labs tend to interact with universities and government R&D. Firms that source knowledge from suppliers and competitors are more likely to source from associations. In addition, firms tend to source knowledge from open sources if they already source from customers. To sum up, in the market groups, synergistic relationships tend to exist among market; between market and associations; and between market and open sources networks.

In relation to scientific institutions, a synergistic relationship can also be identified among the institutions and between the institutions and associations. However, there are few negative and significant associations, and these are shown only between polytechnic and investors and between universities and science publication. This may indicate that firms that already source knowledge from polytechnic tend not to interact with investors, while firms that source knowledge from universities tend to cite knowledge from science publication. Lastly, firms that source knowledge from associations and open sources networks are more likely to interact with all external knowledge networks proportionally.

Turning to control variables, exporters tend to rely on knowledge that is sourced from suppliers and entrepreneurs. Both national and multi-national firms are similar in that they have positive and significant associations with entrepreneurs. In contrast, both national and multi-

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3 national firms have negative and significant associations with investors and the internet. It is  
4 striking that high technology firms do not have positive associations with R&D activities. A  
5 speculative reason for this phenomenon is that these firms tend to import advanced technology  
6 from advanced countries as shown in Wie (2005) study. However, it is important to note that  
7 all the coefficient values among firm resources and a wide range of sources of knowledge tend  
8 to show weak relationships.  
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Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge)

INDEPENDENT VARIABLES	Model 1 IN RD	Model 2 EXT RD	Model 3 SUPPLIER	Model 4 CUSTOM	Model 5 COMPET	Model 6 CONSUL	Model 7 COMMLAB	Model 8 UNIVERSITY	Model 9 POLTECH
INTERNAL_RD	-	<b>.088**(.017)</b>	-0.021 (.029)	<b>.059**(.026)</b>	<b>.045**(.023)</b>	.018 (.011)	<b>.023**(.011)</b>	<b>.019**(.009)</b>	.006 (.008)
EXTERNAL_RD <sup>1</sup>	<b>.568***(.098)</b>	-	.012 (.065)	-0.032 (.060)	.021 (.051)	-0.002 (.021)	.019 (.020)	-0.003 (.016)	.010 (.013)
<i>Market</i>									
SUPPLIERS	-0.023 (.030)	.006 (.013)	-	.031 (.028)	-0.005 (.026)	-0.008 (.014)	<b>.025**(.012)</b>	-0.003 (.011)	.005 (.009)
CUSTOMERS	<b>.077***(.028)</b>	-0.006 (.012)	.041 (.029)	-	<b>.287***(.018)</b>	<b>-.023*(.014)</b>	.000 (.013)	.006 (.010)	-0.003 (.009)
COMPETITORS	.044 (.030)	.005 (.011)	-0.004 (.032)	<b>.329***(.022)</b>	-	<b>.031***(.012)</b>	.016 (.012)	-0.003 (.010)	.006 (.008)
CONSULTANT	.081 (.063)	-0.003 (.019)	-0.043 (.066)	<b>-.158**(.063)</b>	<b>.109**(.047)</b>	-	<b>.072***(.016)</b>	.008 (.014)	.008 (.012)
COMMLAB	.085 (.063)	.031 (.019)	<b>.121*(.062)</b>	-0.017(.066)	.050 (.051)	<b>.069***(.016)</b>	-	<b>.042***(.013)</b>	-0.005 (.012)
<i>Science</i>									
UNIVERSITIES	<b>.176**(.076)</b>	-0.027 (.026)	.0004 (.077)	.023 (.077)	-0.075 (.063)	.020 (.020)	<b>.065***(.019)</b>	-	<b>.042***(.011)</b>
POLYTECHNIC	-0.036 (.083)	.015 (.025)	.046 (.084)	-0.134 (.085)	.018 (.062)	-0.003 (.023)	-0.016 (.024)	<b>.047***(.015)</b>	-
GOV_RD	-0.013 (.071)	<b>-.051*(.029)</b>	-0.014 (.078)	-0.038 (.073)	-0.025 (.057)	.001 (.021)	<b>.036*(.021)</b>	<b>.024*(.013)</b>	<b>.037***(.011)</b>
NON_PROFITRD	-0.012 (.072)	<b>.048**(.023)</b>	-0.034 (.077)	<b>.224***(.078)</b>	-0.037 (.055)	.030 (.020)	.021 (.020)	.012 (.013)	<b>.019*(.010)</b>
<i>Associations</i>									
INVESTORS	.033 (.045)	<b>.024*(.014)</b>	.017 (.045)	.045 (.045)	.031 (.035)	.013 (.014)	-0.001 (.015)	<b>.019*(.011)</b>	-0.015 (.011)
IND_ASSOC.	.051 (.050)	-0.011 (.017)	-0.043 (.053)	.031 (.054)	.007 (.041)	<b>.030**(.015)</b>	.004 (.016)	<b>.025**(.011)</b>	.006 (.010)
ENTREPRENEURS	<b>.176***(.037)</b>	-0.006 (.013)	-0.021 (.040)	<b>.125***(.036)</b>	<b>.064**(.030)</b>	.003 (.014)	.012 (.014)	-0.010 (.012)	.010 (.009)
<i>Open sources</i>									
EVENTS	-0.003 (.043)	.004 (.015)	.041 (.043)	<b>.177***(.044)</b>	<b>.064**(.033)</b>	.001 (.015)	-0.005 (.015)	.009 (.011)	-0.002 (.009)
SCIENCE_PUB	-0.026 (.053)	.0003 (.017)	-0.060 (.053)	<b>.215***(.061)</b>	.039 (.039)	.018 (.016)	<b>.033**(.015)</b>	-0.014 (.013)	<b>.029***(.010)</b>
INTERNET	<b>.229***(.037)</b>	.011 (.012)	.050 (.040)	<b>.177***(.037)</b>	-0.048 (.031)	<b>.029**(.013)</b>	-0.022 (.015)	-0.004 (.011)	.009 (.008)
<i>Firm resources</i>									
SIZE	-0.0002(.0003)	-0.0003(.0003)	.0002(.0001)	-0.0001(.0001)	-0.0003(.0003)	-0.0003(.0004)	-0.0003(.0002)	-0.0001(.0002)	-0.0002(.0003)
AGE	-0.00006(.001)	-0.0003(.0004)	.001(.001)	.001(.001)	.0001(.001)	.0003(.0004)	-0.001(.0005)	-0.001(.0004)	.0002(.0003)
EXPORT	-0.0003(.0005)	.00002(.0002)	<b>.001**(.0004)</b>	.0004(.0004)	-0.0001(.0004)	.0002(.0002)	.0002(.0002)	-0.0003(.0002)	.00003(.0001)

<sup>1</sup> External R&D in this study is grouped in R&D activities along with internal R&D, however, based on the degree of externalisation, external R&D, informal and open networks, and cooperation activities 'are external to the enterprise to various degrees, depending on their ownership and the contractual structures of the relationship between our enterprise and the other party or parties to the transfer' (Frenz and Ietto-Gillies, 2009, p. 1126).

OWN_NATIONAL	.098(.064)	.007(.030)	.034(.059)	-.029(.057)	-.003(.051)	.013(.030)	.042(.033)	-.002(.021)	.014(.024)
OWN_MULTI	.123(.077)	-.0002(.037)	.102(.072)	-.005(.071)	-.067(.068)	.017(.036)	-	.014(.024)	.004(.029)
OWN_JOIN	-	-	-	-	-	-	-	-	-
OPS_PLANT	-.002(.043)	-.020(.022)	.016(.041)	-.031(.040)	-.013(.038)	-.001(.019)	-.027(.027)	.009(.013)	.012(.011)
OPS_HEAD	-	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.071(.029)	.012(.016)	.032(.031)	.027(.029)	-.032(.027)	.025(.016)	.007(.014)	<b>-.024***(.008)</b>	.010(.012)
MEDHIGH_TECH	.004(.044)	<b>-.025**(.010)</b>	.005(.042)	.036(.041)	-.036(.037)	-.006(.017)	.014(.023)	-.001(.015)	.008(.016)
HIGH_TECH	-.049(.109)	-	-.045(.095)	.188(.137)	-.095(.082)	-	-	.002(.037)	-
EDU_UNDERHS	-.0003(.001)	-.001(.001)	-.0004(.001)	-.0005(.001)	-.001(.001)	-.001(.001)	.001(.001)	-.0002(.0005)	.001(.001)
EDU_HIGHSCHOOL	-.0004(.002)	-.001(.001)	.001(.001)	-.0002(.001)	-.001(.001)	-.001(.001)	.001(.001)	-.0003(.001)	.0005(.001)
EDU_DIPLOMA	-.001(.003)	-.0004(.001)	.001(.003)	.001(.003)	.000(.002)	.000(.001)	.001(.001)	-.0002(.001)	.0004(.001)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-	-
RD_STAFF	.0001(.002)	<b>-.002*(.001)</b>	<b>.006***(.002)</b>	-.002(.002)	.000(.002)	.000(.001)	.000(.001)	-.0002(.001)	.000(.001)
Observation	1,179	1,168	1,179	1,179	1,179	1,168	1,119	1,179	1,168
LR chi2(29)	297.2	98.16	53.52	498.23	352.76	136.41	154.75	154.13	162.17
Prob > chi2	.000	.000	.0037	.000	.000	.000	.000	.000	.000
Pseudo R2	.209	.293	.047	.327	.281	.341	.385	.469	.553
Log likelihood	-563.198	-118.462	-547.930	-511.940	-451.881	-132.001	-123.827	-87.424	-65.588
Mean VIF	2.76	2.77	2.78	2.74	2.75	2.76	2.76	2.75	2.75

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.

Table 2. Knowledge sourcing activity - (IV: R&amp;D and informal knowledge) (continued)

INDEPENDENT VARIABLES	Model 10 GOV_RD	Model 11 NPROFIT_RD	Model 12 INVESTOR	Model 13 TRADE_ASSOC	Model 14 ENTREPRENEUR	Model 15 EVENTS	Model 16 SCIENCE_PUB	Model 17 INTERNET
INTERNAL_RD	.004 (.009)	.001 (.010)	.025 (.015)	<b>.030**(.013)</b>	<b>.087***(.016)</b>	.010 (.016)	.003 (.013)	<b>.112***(.016)</b>
EXTERNAL_RD	-.022 (.018)	<b>.030*(.017)</b>	<b>.048*(.028)</b>	-.011 (.025)	-.020 (.035)	.014 (.031)	.010 (.025)	.030 (.032)
<b>Market</b>								
SUPPLIERS	-.001 (.011)	-.007 (.012)	.004 (.017)	-.009 (.015)	-.014 (.020)	.017 (.018)	-.020 (.015)	.025 (.020)
CUSTOMERS	.002 (.010)	<b>.041***(.013)</b>	<b>.037**(.017)</b>	.013 (.015)	<b>.084***(.018)</b>	<b>.078***(.018)</b>	<b>.071***(.016)</b>	<b>.087***(.018)</b>
COMPETITORS	-.003 (.009)	-.010 (.010)	.016 (.016)	<b>.024*(.014)</b>	<b>.047***(.017)</b>	<b>.039**(.016)</b>	.019 (.013)	-.009 (.018)
CONSULTANT	-.000004 (.015)	.008 (.017)	.012 (.028)	<b>.042**(.021)</b>	.020 (.035)	-.003 (.031)	.019 (.022)	<b>.080**(.033)</b>
COMMLAB	<b>.023*(.014)</b>	.010 (.015)	-.009 (.028)	-.012 (.023)	.045 (.033)	-.005 (.030)	<b>.048**(.021)</b>	-.039 (.037)
<b>Science institutions</b>								
UNIVERSITIES	<b>.023*(.013)</b>	.013 (.015)	<b>.065**(.032)</b>	<b>.045*(.024)</b>	-.030 (.042)	.029 (.035)	<b>-.045*(.027)</b>	-.019 (.040)
POLYTECHNIC	<b>.050***(.015)</b>	.019 (.016)	<b>-.105**(.042)</b>	.001 (.027)	<b>.079*(.044)</b>	-.031 (.036)	<b>.081***(.024)</b>	.044 (.041)
GOV_RD	-	<b>.071***(.015)</b>	<b>.130***(.030)</b>	.032 (.022)	-.036 (.038)	.046 (.031)	.000 (.024)	.055 (.038)
NON_PROFITRD	<b>.061***(.012)</b>	-	.009 (.024)	<b>.036**(.017)</b>	-.029 (.028)	-.005 (.022)	.015 (.017)	-.028 (.029)
<b>Associations</b>								
INVESTORS	<b>.043***(.011)</b>	-.001 (.013)	-	<b>.046***(.015)</b>	<b>.164***(.021)</b>	<b>.058**(.023)</b>	.024 (.017)	.013 (.023)
IND_ASSOC.	.013 (.010)	<b>.022*(.012)</b>	<b>.058***(.021)</b>	-	<b>.085***(.020)</b>	<b>.077***(.018)</b>	-.017 (.016)	<b>.072***(.020)</b>
ENTREPRENEURS	-.010 (.011)	-.001 (.012)	<b>.123***(.017)</b>	.018 (.015)	-	.009 (.030)	.029 (.021)	-.062 (.040)
<b>Open sources</b>								
EVENTS	.016 (.010)	.002 (.012)	-.018 (.031)	.026 (.022)	-.010 (.039)	-	<b>.096***(.013)</b>	.033 (.023)
SCIENCE_PUB	-.0001 (.011)	<b>.026**(.012)</b>	-.019 (.021)	<b>.036**(.015)</b>	<b>.099***(.022)</b>	<b>.145***(.019)</b>	-	<b>.057**(.025)</b>
INTERNET	<b>.019*(.010)</b>	-.015 (.013)	.008 (.018)	<b>.034**(.014)</b>	.039 (.027)	.030 (.019)	-.007 (.016)	-
<b>Firm resources</b>								
SIZE	.00001(.00003)	-.00001(.00003)	.00002(.00001)	-.00001(.00002)	-.00004(.00003)	.00002(.00001)	-.00002(.00001)	.00003(.00001)
AGE	-.0004 (.0004)	.0001 (.0004)	.0002(.001)	-.001(.0005)	.001(.001)	-.001(.001)	-.0002(.0005)	-.0004 (.001)
EXPORT	-.00003 (.0002)	-.0002 (.0002)	-.00001(.0003)	.0002(.0002)	<b>.001**(.0003)</b>	-.0003(.0003)	-.0002(.0002)	-.00001(.0003)
OWN_NATIONAL	.022(.025)	-.01 (.020)	<b>-.061**(.031)</b>	.033(.035)	<b>.105**(.048)</b>	-.047(.033)	.008(.029)	<b>-.067*(.035)</b>
OWN_MULTI	.003(.030)	.007(.025)	<b>-.078**(.042)</b>	<b>.069*(.039)</b>	<b>.105*(.056)</b>	-.030(.043)	-.009(.039)	-.054(.045)
OWN_JOIN	-	-	-	-	-	-	-	-

OPS_PLANT	-.016(.020)	.002(.017)	-.030(.027)	-.021(.024)	.042(.027)	-.008(.027)	.005(.021)	.005(.028)
OPS_HEAD	-	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-	-
MEDLOW_TECH	-.006(.011)	<b>.0100(.010)**</b>	-.005(.018)	.002(.016)	.023(.023)	-.026(.019)	-.011(.016)	.014(.022)
MEDHIGH_TECH	.001(.015)	-	.018 (.029)	<b>.048(.028)*</b>	-.0003(.029)	-.027	.027(.025)	.027(.031)
HIGH_TECH	.0111(.103)	-.005(.034)	-.055 (.037)	.049(.076)	.015(.072)	.082 (.090)	-	-.038(.061)
EDU_UNDERHS	-.0004(.0004)	.001(.001)	-.001(.001)	.001(.001)	-.0001(.001)	.002(.001)	-.001(.001)	.000(.001)
EDU_HIGHSCHOOL	-.0004(.0005)	.001(.001)	-.001(.001)	.002(.001)	.0003 (.001)	.002 (.001)	<b>-.001*(.001)</b>	.000(.001)
EDU_DIPLOMA	-.0003(.001)	.002(.001)	-.0001(.002)	.001(.002)	-.002 (.002)	.002 (.002)	-.001 (.001)	.000(.002)
EDU_UNDERGRAD	-	-	-	-	-	-	-	-
RD_STAFF	-.0004(.001)	.001(.001)	.001(.001)	.001(.001)	-.0004(.001)	.00 (.001)	.0002 (.001)	-.002(.001)
Observation	1179	1082	1179	1179	1179	1179	1168	1179
LR chi2(29)	226.89	172.32	249.06	210.13	405.55	326.27	251.48	252.34
Prob > chi2	.000	.000	.000	.000	.000	.000	.000	.000
Pseudo R2	.565	.485	.347	.369	.414	.399	.431	.304
Log likelihood	-87.225	-91.467	-234.216	-179.467	-287.107	-246.055	-165.938	-289.245
Mean VIF	1.34	2.75	2.75	2.76	2.75	2.75	2.75	2.76

Notes: Significant levels \* $p \leq 10$ , \*\* $p \leq 05$ , \*\*\* $p \leq 001$ . All figures in the tables are marginal effects generated from probit models.



#### 4.3. Knowledge transformation activity

The main interest in this section is how various sources of knowledge contribute to innovation. Table 3 shows that internal R&D has positive and significant effects on any type of innovation and innovation success. By contrast, external R&D has no significant impacts on innovation and innovation success. Evidence that internal R&D is the only source of knowledge that positively and significantly affects all types of innovation and innovation success may suggest that internal R&D plays a more important role than the rest of the sources of knowledge. Therefore, based on this finding, Hypothesis 2a is supported.

Turning to informal knowledge, different sources of informal knowledge used in the innovation transformation activity have different impacts on types of innovation and innovation success. Among market networks, knowledge transformed from *customers* positively and significantly affects product innovation, product innovation new to the firm, marketing innovation and innovation success. While knowledge transformed from *competitors* positively and significantly affects product innovation new to the market, process innovation and marketing innovation. Surprisingly, knowledge from science institutions only influences process innovation and this finding differs compared from most previous studies that show a positive influence of science institutions on radical innovation. The knowledge that is generated from the association (industry association and entrepreneurs) is more likely to influence innovation and innovation success in significant and negative ways. Open sources (events) contribute positively to product innovation, product innovation that new to the market, product innovation that new to the firms and innovation success.

In relation to firm resources, most variables have weak and negative effects on diverse types of innovation and innovation success. Only firms age and multi-national ownership influence innovation insignificant and negative directions. Firm age has a weak negative and significant association with marketing innovation. The same direction was found for the influence of multi-national firm status on organisation innovation.

Table 3. Knowledge transformation activity

INDEPENDENT VARIABLES	Model 1 Product Innov.	Model 2 Prod. Innov. New to market <sup>1</sup>	Model 3 Prod. Innov. New to firms <sup>2</sup>	Model 4 Process Innov.	Model 5 Organisational Innov.	Model 6 Marketing Innov.	Model 7 Innovation Success <sup>3</sup>
INTERNAL_RD	<b>.133***(.022)</b>	<b>.069***(.023)</b>	<b>.126***(.022)</b>	<b>.188***(.019)</b>	<b>.231***(.018)</b>	<b>.162***(.022)</b>	<b>8.342** (3.295)</b>
EXTERNAL_RD	.039(.065)	.077(.057)	.080(.067)	.093(.074)	.096(.074)	-.091(.069)	6.853(7.118)
<i>Market</i>							
SUPPLIERS	-.027(.027)	-.026(.027)	-.021(.027)	-.004(.027)	-.007(.026)	.017(.027)	-5.139(3.724)
CUSTOMERS	<b>.062**(.025)</b>	.039(.025)	<b>.053**(.025)</b>	-.027(.025)	-.036(.025)	<b>.099***(.025)</b>	<b>6.122*(3.470)</b>
COMPETITORS	-.003(.025)	<b>.046*(.024)</b>	.004(.025)	<b>.042*(.024)</b>	.001(.025)	<b>.053**(.026)</b>	3.970(3.364)
CONSULTANTS	.001(.051)	-.012(.048)	.009(.052)	-.075(.049)	-.002(.052)	.003(.053)	-5.513(6.529)
COMMLAB	.043(.053)	.013(.049)	.067(.054)	.060(.050)	-.004(.049)	.022(.054)	3.486(6.499)
<i>Science</i>							
UNIVERSITIES	.030(.063)	.059(.058)	.061(.065)	<b>-.123**(.059)</b>	-.041(.061)	.036(.068)	6.438(7.874)
POLYTECHNIC	.053(.073)	.033(.068)	.001(.071)	<b>-.132*(.068)</b>	.055(.066)	-.006(.070)	6.574(8.503)
GOVERNMENT_RD	-.098(.060)	-.030(.059)	-.073(.061)	<b>.109*(.064)</b>	-.028(.060)	-.050(.064)	-1.260(7.652)
NON_PROFIT_RD	-.022(.022)	.026(.053)	-.032(.056)	<b>.149***(.057)</b>	-.045(.058)	.057(.061)	6.800(7.084)
<i>Associations</i>							
INVESTORS	.057(.057)	.036(.034)	<b>.068*(.036)</b>	<b>.058*(.035)</b>	.056(.035)	-.048(.036)	0.776(4.696)
IND_ASSOC.	-.056(.041)	<b>-.095**(.039)</b>	<b>-.087**(.041)</b>	-.036(.040)	.058(.043)	-.017(.044)	-8.185(5.473)
ENTREPRENEURS	<b>-.059*(.031)</b>	-.043(.031)	-.051(.031)	-.017(.030)	.013(.031)	-.049(.032)	<b>-6.954*(4.188)</b>
<i>Open resources</i>							
EVENTS	<b>.189***(.038)</b>	<b>.164***(.033)</b>	<b>.174***(.037)</b>	.028(.033)	.044(.035)	.026(.036)	<b>16.800*** (4.387)</b>
SCIENCE_PUB.	-.033(.044)	-.047(.041)	-.010(.044)	-.022(.040)	-.040(.043)	-.012(.045)	-5.755(5.279)
INTERNET	-.039(.032)	-.029(.031)	-.040(.032)	-.024(.031)	.023(.032)	-.031(.034)	-2.148(4.210)
<i>Firm resources</i>							
SIZE	-.00002(.000)	-.00003(.000)	-.00001(.000)	.00004(.000)	-.00002(.000)	-.00001(.000)	-.001(0.004)
AGE	.00(.001)	.0001(.001)	.0002(.001)	-.001(.001)	.0003(.001)	<b>-.001*(.001)</b>	.009(0.114)

EXPORT	.0004(.000)	.001(.000)	.001(.000)	.00004(.000)	-.001(.000)	.00002(.000)	.056(0.054)
OWN_NATIONAL	.038(.062)	.001(.060)	.049(.062)	.037(.060)	-.064(.055)	.049(.059)	1.596(7.825)
OWN_MULTI	.006(.073)	-.049(.074)	.006(.073)	.007(.073)	<b>-.130*(.070)</b>	.011(.072)	-4.198(9.789)
OWN_JOIN	-	-	-	-	-	-	-
OPS_PLANT	.027(.039)	.010(.040)	.051(.040)	.004(.039)	-.014(.039)	.031(.039)	.601(5.286)
OPS_HEAD	-	-	-	-	-	-	-
LOW_TECH	-	-	-	-	-	-	-
MED_LOW TECH	<b>.051(.029)*</b>	.036(.030)	<b>.058(.029)**</b>	-.009(.029)	.012(.030)	-.010(.029)	4.267(3.988)
MED_HIGH TECH	.036(.038)	<b>.063(.038)*</b>	.041(.038)	.014(.038)	-.046(.037)	.049(.037)	5.827(5.206)
HIGH_TECH	.106(.110)	.171(.118)	.130(.108)	<b>-.175(.095)*</b>	.039(.109)	.010(.122)	13.248(14.064)
EDU_UNDERHS	-.001(.001)	-.001(.001)	-.002(.001)	-.0001(.001)	-.0004(.001)	-.0002(.001)	-.235(.172)
EDU_HIGHSCHOOL	-.001(.001)	-.002(.001)	-.002(.001)	-.0003(.001)	-.0003(.001)	-.002(.001)	-.201(.182)
EDU_DIPLOMA	-.003(.003)	-.002(.002)	-.004(.002)	-.003(.002)	-.002(.003)	-.002(.003)	-.225(.330)
EDU_UNDERGRAD	-	-	-	-	-	-	-
RD_STAFF	-.001(.002)	.0003(.002)	-.002(.002)	-.001(.002)	-.001(.002)	.0001(.002)	.188(.226)
Number of obs	1179	1179	1179	1179	1165	1170	1179
LR chi2(57)	685.65	546.38	652.18	641.39	572.46	720.65	517.02
Prob > chi2	.000	.000	.000	.000	.000	.000	.000
Pseudo R2	.439	.3862	.4241	.4327	.401	.4519	.1192
Log likelihood	-438.107	-434.124	-442.875	-420.422	-427.534	-437.063	-1909.790
Mean VIF	3.50	3.50	3.50	3.50	3.50	3.50	3.50

#### 4.4. Knowledge exploitation activity

Table 4 displays the statistical output of OLS regression for knowledge exploitation activity. Because data on sales and employee growth are not available in the IIS 2011, this study uses productivity as the only indicator of firm performance, as presented in Table 4. In the first model, product innovation is excluded. Strikingly, product innovation to new the market and new to the firms, as well as innovation success, have no significant effect on firms' performance that is proxied by productivity. When both product innovation and innovation success are excluded (model 2), there is no significant influence of either product innovation to new the market or new to the firms on productivity. In the third model, in which product innovation to new the market and new to the firms are excluded, there is no significant effect of product innovation and innovation success on productivity. Another surprising finding is that, in contrast, non-product innovations including process innovation, organisational innovation and marketing innovation, significantly affect productivity in all models. Positive associations were found between both process innovation and organisational innovation and productivity, while a negative association was found between marketing innovation and productivity. The evidence that innovation success has a negative and insignificant impact on productivity is in line with previous studies (Ganotakis and Love, 2012; Roper *et al.*, 2008; Roper and Arvanitis, 2012). Based on these findings, Hypothesis 3 partially is supported.

Firm resources negatively and significantly affect productivity, but only in low-technology firms. Variables such as size, age, export and the lowest level of education have negative associations with productivity. In contrast, in high-tech firms, having employees with high school and undergraduate degrees is positively associated with productivity.

Table 4. Knowledge exploitation activity

INDEPENDENT VARIABLES	Model 1 PRODUCTIVITY	Model 2 PRODUCTIVITY	Model 3 PRODUCTIVITY
Product Innovation	-	-	268.160(716.413)
Prod. Innov. New to Market	668.224(1122.881)	-289.371(832.420)	-
Prod. Innov. New to Firms	-45.167(820.431)	48.857(817.301)	-
Process Innovation	<b>1964.657***(631.219)</b>	<b>1985.895***(631.165)</b>	<b>1985.412***(629.213)</b>
Organisational Innovation	<b>2511.089***(631.492)</b>	<b>2578.718***(629.410)</b>	<b>2518.678***(632.025)</b>
Marketing Innovation	-	-	-
Innovation Success	-29.379(23.128)	-	-21.282(18.660)
<b><i>Firm resources</i></b>			
Size	-0.074(.184)	-0.077(.184)	-0.075(.184)
Age	-22.201(19.116)	-22.262(19.121)	-22.451(19.115)
Export	-7.785(9.670)	-7.583(9.672)	-7.678(9.661)
OWN_NATIONAL	362.853(1241.632)	371.125(1241.944)	351.187(1241.068)
OWN_MULTI	1109.779(1566.056)	1101.907(1566.458)	1076.938(1565.01)
OWN_JOIN	-	-	-
OPERATION_PLANT	-1003.043(879.703)	-986.841(879.843)	-997.590(879.377)
OPERATION_HEAD	-	-	-
LOW_TECH	-	-	-

MEDLOW_TECH	580.331(649.173)	580.257(649.345)	577.387(648.739)
MEDHIGH_TECH	<b>2005**(912.806)</b>	<b>2044.913**(912.506)</b>	<b>2025.741**(911.861)</b>
HIGH_TECH	2421.285(2542.052)	2457.057(2542.568)	2477.757(2539.589)
EDU_UNDERHS	-48.366(31.223)	-47.312(31.220)	-48.391(31.215)
EDU_HIGHSCHOOL	-43.934(33.014)	-43.345(33.020)	-44.058(33.000)
EDU_DIPLOMA	-44.996(58.843)	-44.698(58.858)	-45.006(58.821)
EDU_UNDERGRAD	-	-	-
RD_STAFF	11.331(37.141)	10.115(37.138)	11.454(37.121)
Obs.	1179	1179	1179
F ( )	2.92	3.00	3.07
Prob > F	.000	.000	.000
R <sup>2</sup>	.046	.044	.046
Adj. R <sup>2</sup>	.030	.030	.031
Root MSE	8272.30	8274.50	8270.00

## 5. DISCUSSION AND CONCLUSIONS

Key findings of this study are as follows. First, in the first link of the IVC, this study finds the existence of strong synergistic relationships between internal R&D and external sources of knowledge as well as among external sources of knowledge. This may indicate a similar pattern of knowledge sourcing activity to that in developed countries, namely the implementation of “open innovation strategy”. The role of external networks tends to be less important when the firms already source knowledge for innovation from external R&D activities. External actors from market groups (i.e. customers and competitors) have important roles as knowledge providers if the firm also generates knowledge from internal R&D. In contrast, the firms’ interactions with scientific institutions tend to be of lesser importance. The firms that source knowledge from market network interact less with scientific institutions, but they do interact with their own networks, associations and open sources. A synergistic relationship can also be found among science institutions. In relation to formal cooperation, firms tend to restrict cooperation with firms within the same group and with suppliers when they perform internal or external R&D activities. This finding supports the recent studies on the complementary relationship between internal and external knowledge sourcing activities (Bogers and Lhuillery, 2018; Doran *et al.*, 2019; Majidpour, 2017; Paula and Da Silva, 2018).

Second, in the second link of the IVC, internal R&D plays important roles and has strong positive impacts on all types of innovation and innovation success. External knowledge that shows similar patterns in shaping innovations mainly comes from informal knowledge from customers and competitors. Knowledge generated from scientific institutions makes no significant contribution to innovation and innovation success. Positive impacts on process innovation come only from government and non-profit R&D, while university and polytechnic sources contribute negatively to process innovation. This contradicts previous studies stating that novel and highly advanced innovation requires greater levels of R&D, patents or

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3 knowledge from science institutions such as universities and research centres (Amara and  
4 Landry, 2005; Tödting *et al.*, 2009).

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6 Third, the final link of the IVC relates to the impact of innovation on productivity  
7 provides surprising results. In general, product innovations new to the market and new to the  
8 firm as well as innovation success have no significant impact on productivity. The fact that  
9 innovation success is negatively associated with productivity may prompt questions related to  
10 the quality of innovative products that may be not able to disrupt the market and this may  
11 severely impact the firms' sales and further impact productivity.  
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14 The finding that neither product innovations new to the market and new to the firm nor  
15 innovation success lead to productivity, perhaps due to the firms' efforts to detect and  
16 overcome any weak links in the IVC to boost productivity. First, sourcing activity that relies  
17 on the synergy between internal R&D and external networks, mainly from market,  
18 automatically influences the minimum usage of other sources of knowledge such as scientific  
19 institutions that may provide additional added value for firms. In this sense, a diverse open  
20 innovation strategy may need to be implemented with the hope that the use of more diverse  
21 and better-quality sources of knowledge able to overcome the weak links in knowledge  
22 sourcing activities. Second, the low quality of firms' human resources may contribute to the  
23 success of knowledge sourcing, transformation and exploitation as indicated by no positive  
24 contributions to the three links of IVC. Third, diverse of innovation barriers that hamper  
25 Indonesian manufacturing firms may affect the success of the IVC activities. Lastly,  
26 environments external to the firms, or a weak conditional framework for innovation in  
27 Indonesia, may contribute indirectly to the success of the IVC activities.  
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### 34 5.1. Limitation of the study

35 This study is not without limitations. First, issues related to firms' sectors have not been  
36 discussed in this study and as a result, sectors' effects on the three links of IVC cannot be  
37 detected. The variation among firm sectors is only derived from the classification of technology  
38 intensity. Second, this study is a cross-sectional in nature i.e. the study only portrays IVC based  
39 on IIS 2011 data, as a result, dynamic of Indonesian manufacturing firms' IVC is missing.  
40 Hence, future studies may address this limitation by conducting a longitudinal study. Lastly,  
41 specific issues related to each stage of the IVC importantly should be explored. In the  
42 knowledge sourcing activity stage, the issue related to formal cooperation with various external  
43 partners has not been addressed, hence it is recommended to test it in the future studies. In  
44 addition, factors that may hinder the success of the IVC i.e. innovation barriers are not yet  
45 investigated. Since it is limited insight into the linking innovation barriers into the IVC activity.  
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### 51 5.2. Innovation policy implication and theoretical contribution

52 Based on the findings from the first and second links of the IVC, relevant innovation policies  
53 may be proposed. The fact that Indonesia faces problems related to scientific institutions such  
54 as "low public and private investment in R&D", "a low-ranking higher education and training  
55 system" and "a small number of researchers and scientists for a country of its size" (OECD,  
56 2013, p. 175), may present a problem for synergistic relationships between scientific  
57 institutions and other external agents. Further impact is clearly seen in the second link of the  
58 IVC in which the knowledge used from scientific institutions, both informally and formally,  
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3 negatively impacts innovations. Therefore, government policy, for instance, promoting a triple  
4 helix strategy that involves university-industry-government interaction and partnership, may  
5 help address these challenges to improve knowledge transfer by integrating the three types of  
6 institutions. As argued by Tambunan (2005), triple helix implementation in Indonesia has been  
7 relatively slow. The Indonesian government initiated the development of incubators and  
8 science parks in 1990 with UNDP's support, but the development of these incubators has been  
9 very slow (Simamora, 2009). Public scientific institutions such as technoparks may be used by  
10 Indonesian firms to generate knowledge from R&D activities when they lack sufficient internal  
11 funds. In relation to the synergistic relationship between internal R&D and a wide range of  
12 external sources of knowledge, this study also suggests that rather than engaging exclusively  
13 in either R&D or external linkages, firms may adopt a hybrid strategy of leveraging knowledge  
14 from both sources of knowledge in the innovation process. It is believed that the proposed  
15 policies implication also relevant for firms in developing economies since Firms in emerging  
16 economies tend to experience substantial institutional, resources and capability barriers that  
17 affect successful innovation (Fu *et al.*, 2014).  
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23 Findings from this study are expected to enrich the literature of innovation studies,  
24 especially innovation process framework in the context of developing countries, in several  
25 ways. First, the fact that non-technological innovation (i.e. marketing innovation) is the highest  
26 proportion of innovation produced by Indonesian manufacturing firms support and confirm  
27 previous studies that reveal most firms in developing countries: tend to focus on market rather  
28 than technological innovation (Wamae, 2009), beyond the traditional focus on R&D (Srholec,  
29 2011), and attempt to reach the technological frontier instead of achieving inventions that are  
30 new to the market (Hou and Mohnen, 2013). Second, the highest proportion of knowledge  
31 sourced by Indonesian manufacturing firms mainly from an informal source of knowledge e.g.  
32 customers and competitors. This also confirms previous innovation studies in Indonesia that  
33 reveal innovation in Indonesian manufacturing sectors generally as the results of learning  
34 through "informal experiences" not through "a formal scientific activity or R&D" (Aminullah,  
35 2012; Aminullah *et al.*, 2014). Third, this study also confirms the existence of complementary  
36 or synergy relationships between internal and external knowledge sourcing activities that have  
37 been tested as part of the innovation process framework in most studies conducted in developed  
38 economies.  
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44 In conclusion, this study investigates and models the IVC that encompasses knowledge  
45 sourcing, transformation and exploitation activities of Indonesia manufacturing firms using  
46 data from the IIS 2011. The literature on the IVC framework has been widely used to analyse  
47 inter-relationships among firm interaction, innovation, business growth and productivity in  
48 developed countries, however, based on the reviewed literature there is no empirical evidence  
49 to the IVC in the context of Indonesia. From a theoretical point of view, this study contributes  
50 some important insights on innovation process framework development by uncovered the  
51 nature of interrelationships within each stage and between linkages of the IVC performed by  
52 Indonesian firms.  
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**06**

**Bukti konfirmasi penerimaan artikel/fully  
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1 message

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22 December 2020 at 01:33

Reply-To: profsanjaysingh16@gmail.com

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21-Dec-2020

Dear Hartono, Arif; Singapurwoko, Arif

It is a pleasure to accept your manuscript JABS-05-2020-0209.R2, entitled "From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms" in its current form for publication in Journal of Asia Business Studies. Please note, no further changes can be made to your manuscript.

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Thank you for your contribution. On behalf of the Editors of Journal of Asia Business Studies, we look forward to your continued contributions to the Journal.

Yours sincerely,  
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**07**

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Forms Completion submitted (21-Dec-2020) - <a href="#">view</a>	AE: Arora, Punit EIC: Singh, Sanjay  <ul style="list-style-type: none"> <li>Accept (21-Dec-2020)</li> </ul> Archiving completed on 23-Jan-2021 <a href="#">view decision letter</a> <a href="#">Contact Journal</a>	JABS-05-2020-0209.R2	From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms  Files Archived	10-Dec-2020	21-Dec-2020
a revision has been submitted (JABS-05-2020-0209.R2)	AE: Arora, Punit EIC: Singh, Sanjay  <ul style="list-style-type: none"> <li>Minor Revision (11-Nov-2020)</li> <li>a revision has been submitted</li> </ul> Archiving completed on 23-Jan-2021 <a href="#">view decision letter</a> <a href="#">Contact Journal</a>	JABS-05-2020-0209.R1	From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms  Files Archived	26-Sep-2020	11-Nov-2020
a revision has been submitted (JABS-05-2020-0209.R1)	AE: Arora, Punit EIC: Singh, Sanjay  <ul style="list-style-type: none"> <li>Major Revision (29-Jul-2020)</li> <li>a revision has been submitted</li> </ul> Archiving completed on 23-Jan-2021 <a href="#">view decision letter</a> <a href="#">Contact Journal</a>	JABS-05-2020-0209	From Knowledge Sourcing to Firms' Productivity: Investigating Innovation Value Chain of Indonesian Manufacturing Firms  Files Archived	28-May-2020	29-Jul-2020





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Revision option expired on 09-Jan-2020	AE: Jiang, Ruihua Joy EIC: Kumar, Vikas <ul style="list-style-type: none"> <li>● Major Revision (11-Sep-2019)</li> <li>● Revision option expired on 09-Jan-2020</li> </ul> <i>Archiving completed on 18-Jul-2020</i> <a href="#">view decision letter</a> <a href="#">✉ Contact Journal</a>	JABS-05-2019-0137	Linking innovation barriers, firms' openness and innovation performance: Evidence from Indonesian firms <i>Files Archived</i> 📁	04-May-2019	11-Sep-2019

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