



How does intellectual capital affect product innovation performance? Evidence from China and India

Journal:	<i>International Journal of Operations and Production Management</i>
Manuscript ID	IJOPM-10-2016-0612.R2
Manuscript Type:	Research Paper
Keywords:	intellectual capital, supplier knowledge integration, supply chain adaptability, product innovation performance, China, India

SCHOLARONE™
Manuscripts

How does intellectual capital affect product innovation performance? Evidence from China and India

Abstract

Purpose Intellectual capital reflects the sum of existing knowledge a manufacturer is able to leverage and plays a critical role in new product development. This study aims to empirically investigate the mechanisms through which intellectual capital enhances product innovation performance and how economic and institutional environments affect the mechanisms.

Design/methodology/approach Using a knowledge-based view and institutional theory, this study proposes a model on the relationships among intellectual capital, supplier knowledge integration, supply chain adaptability, and product innovation performance. The hypotheses are empirically tested using multiple group structural equation modelling and data collected from 300 Chinese and 200 Indian manufacturers.

Findings We find that intellectual capital improves product innovation performance both directly and indirectly through supplier knowledge integration. However, the effects are different in China and India. In particular, the direct effect of intellectual capital on product innovation performance is significantly higher in China than that in India, and intellectual capital improves product innovation performance indirectly through supplier knowledge integration only in India. We also find that supplier knowledge integration improves product innovation performance indirectly through supply chain adaptability in both China and India.

Originality/value Using a moderated mediation model, this study provides insights into the joint effects of intellectual capital, supplier knowledge integration, and supply

1
2
3 chain adaptability on product innovation performance. The findings enhance current
4 understandings of how supply chain management helps a manufacturer develop new
5 products using existing knowledge and the influences of economic and institutional
6 environments on knowledge and supply chain management.
7
8
9
10

11
12
13
14 **Keywords** intellectual capital, supplier knowledge integration, supply chain
15 adaptability, product innovation performance, China, India
16
17
18

19 20 21 **1. Introduction**

22
23 Intellectual capital refers to the knowledge stock embedded in a firm (Nahapiet
24 and Ghoshal, 1998; Subramaniam and Youndt, 2005). Empirical evidence exists that
25 intellectual capital positively affects innovation (Lee et al., 2011; Menor et al., 2007;
26 Subramaniam and Youndt, 2005) and firm performance (Hsu and Wang, 2012;
27 Youndt et al., 2004). Knowledge sourced from suppliers can stimulate creativity and
28 effectively address the interdependence among product, process, and supply chain
29 designs (Cousins et al., 2011; Petersen et al., 2003). Intellectual capital and supplier
30 knowledge integration thus enable a manufacturer to implement and exploit the
31 existing knowledge resided internally and externally in supply networks for product
32 innovation (Youndt et al., 2004; Hult et al., 2006). Although researchers argue that
33 existing knowledge enables a manufacturer to acquire and integrate external
34 knowledge (Cohen and Levinthal, 1990; Szulanski, 1996), the majority of empirical
35 studies take an internal perspective and focus on intellectual capital's direct effects on
36 performance outcomes (e.g., Lee et al., 2011; Subramaniam and Youndt, 2005). By
37 exploring the effect of intellectual capital on supplier knowledge integration and how
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 they jointly influence product innovation performance, this study enhances current
4
5 understandings on how existing knowledge contributes to new product development.
6

7
8 Although researchers argue that knowledge acquired from suppliers enhances
9
10 new product development (Cousins et al., 2011; Petersen et al., 2003; Un et al., 2010),
11
12 some empirical studies fail to support a direct and positive relationship between
13
14 learning from suppliers and product innovation performance (Tavani et al., 2013; Jean
15
16 et al., 2014). Integrating the knowledge sourced from suppliers, such as technical
17
18 know-how, changes in factor markets, and suggestions for process improvement, can
19
20 assist manufacturers in adapting supply chain designs and reconfiguring supply chain
21
22 resources to deal with unexpected and unpredicted changes and events (Braunscheidel
23
24 and Suresh, 2009; Lee, 2004). Supply chain adaptability helps manufacturers identify
25
26 shifts in environments which facilitates the manufacturers to develop new or adjust
27
28 existing products in a timely and cost-effective manner (Swafford et al., 2006; Blome
29
30 et al., 2013). Therefore, exploring how supplier knowledge integration and supply
31
32 chain adaptability jointly influence product innovation performance can provide
33
34 insights into the mixed findings about the roles of suppliers in new product
35
36 development (Wang et al., 2011; Gao et al., 2015; Jean et al., 2014) and the
37
38 mechanisms through which supply chain learning contributes to product innovation
39
40 performance.
41
42
43
44

45
46 China and India have experienced high-speed economic growth, demonstrated
47
48 rising levels of innovation performance, and have diversified domestic markets with
49
50 large low income population (Altenburg et al., 2008; Bruche, 2009; Fan, 2011).
51
52 Manufacturers in China and India tend to develop new products that are affordable to
53
54 local customers (Breznitz and Murphree, 2011; Ernst et al., 2015). To benefit from
55
56 latecomer's advantage, they innovate by adapting and exploiting existing technologies
57
58
59
60

1
2
3 and products creatively (Parayil and D'Costa, 2009; Ernst et al., 2015; Radjou et al.,
4
5 2012). Intellectual capital and supplier knowledge integration enable a manufacturer
6
7 to apply existing knowledge innovatively which reduces new product development
8
9 costs and lead-times (Prahalad and Mashelkar, 2010; Radjou et al., 2012). In addition,
10
11 product innovations may be copied by competitors because of the lack of sufficient
12
13 market-supporting institutions and may become out of date quickly because of high
14
15 market uncertainties in China and India (Parayil and D'Costa, 2009; Fan, 2011). The
16
17 speed for commercialization, which is dependent on a manufacturer's capability to
18
19 adapt and adjust supply chains quickly, is critical for a manufacturer to profit from
20
21 product innovation (Blome et al., 2013). Hence, China and India provide interesting
22
23 contexts to investigate the combined effects of intellectual capital, supplier knowledge
24
25 integration, and supply chain adaptability on product innovation performance.
26
27 Moreover, the economic development paths and institutional environments are
28
29 different in China and India (Parayil and D'Costa, 2009; Saran and Guo, 2005), which
30
31 may affect a manufacturer's supply chain management and new product development
32
33 decisions (Marquis and Tilcsik, 2013; Simsek et al., 2015). Conducting the survey in
34
35 the two countries and comparing the results can not only improve the generalizability
36
37 of the findings but also provide insights into the impacts of economic and institutional
38
39 environments on how intellectual capital affects product innovation performance. By
40
41 combining a knowledge-based view (KBV) of the firm and institutional theory, this
42
43 study links a manufacturer's existing knowledge with supply chain management and
44
45 external environments. The findings enhance current understandings on the complex
46
47 relationships among intellectual capital, supply chain learning and adaptability,
48
49 product innovation, and environmental conditions, and how to develop new products
50
51 by exploiting existing knowledge and collaborating with suppliers.
52
53
54
55
56
57
58
59
60

1
2
3 The objective of this study is to empirically investigate how intellectual capital
4 influences product innovation performance. This study addresses two research
5 questions. First, how do intellectual capital, supplier knowledge integration, and
6 supply chain adaptability jointly influence product innovation performance? Second,
7 how do economic and institutional environments affect such influences?
8
9
10
11
12

13 14 15 16 **2. Theoretical Background and Research Hypotheses**

17 18 *2.1 Knowledge-Based View*

19
20 KBV considers knowledge as an important strategic resource of a manufacturer
21 (Kogut and Zander, 1992; Grant, 1996; Szulanski, 2000). Scholars further argue that a
22 manufacturer's knowledge comes not only from within its boundary but also from a
23 wider network of supply chain relationships (Hult et al., 2006; Zhang et al., 2015).
24 This study focuses on intellectual capital and supplier knowledge integration because
25 they represent the internal and external sources of knowledge a manufacturer can
26 leverage.
27
28
29
30
31
32
33
34
35

36 Intellectual capital reflects the intangible assets held by individuals, stored within
37 organizational processes and structures, and resided in social relationships (Youndt et
38 al., 2004). Intellectual capital can be conceptualized as three complementary
39 dimensions: human (i.e., employees' knowledge and skills), structural (i.e., operating
40 procedures and systems), and social capital (i.e., social relationships and interactions
41 among employees) (Lee et al., 2011; Youndt et al., 2004). Empirical evidence exists
42 that the three components are complementary and their interactions are positively
43 associated with performance outcomes (Subramaniam and Youndt, 2005; Youndt et
44 al., 2004). Hence, we conceptualize intellectual capital as a second-order construct to
45 capture the combined effects of human, structural, and social capital (Hsu and
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Sabherwal, 2012; Menor et al., 2007). Supplier knowledge integration refers to a
4
5 manufacturer's ability to acquire knowledge from suppliers and apply the knowledge
6
7 into operations (Hult et al., 2004; Song et al., 2005). The information and know-how
8
9 obtained from suppliers can enlarge a manufacturer's knowledge base and enable the
10
11 manufacturer to develop new applications for existing knowledge and to create new
12
13 product designs (Zhang et al., 2015).
14
15

16 KBV argues that manufacturers can develop capabilities and gain superior
17
18 performance by acquiring and implementing knowledge (Grant, 1996; Hult et al.,
19
20 2004). This study focuses on supply chain adaptability and product innovation
21
22 performance. Supply chain adaptability refers to a manufacturer's ability to quickly
23
24 and efficiently adapt product and supply chain designs in response to market changes
25
26 (Engelhardt-Nowitzki, 2012; Swafford et al., 2006). An adaptable supply chain
27
28 enables manufacturers to gain competitive advantages by quickly adapting existing
29
30 products and technologies (e.g., implementing engineering changes), identifying new
31
32 resources (e.g., acquiring raw materials for new products), and solving problems (e.g.,
33
34 in commercialisation and launch) (Blome et al., 2013; Lee, 2004). Product innovation
35
36 performance refers to how well a manufacturer develops new products (Chandy and
37
38 Tellis, 1998). Customer preferences change very quickly in China and India due to
39
40 globalisation and fast economic growth (Fan, 2011). Manufacturers need to develop
41
42 more new products with fewer resources for more people, and make adaptations,
43
44 refinements, and improvements to existing products quickly (Prahalad and Mashelkar,
45
46 2010; Breznitz and Murphree, 2011; Radjou et al., 2012). Hence, the number of new
47
48 products developed and the speed and frequency of new product introduction are
49
50 critical for the success of product innovation (Parayil and D'Costa, 2009).
51
52
53
54
55
56
57
58
59
60

1
2
3 KBV also indicates that a manufacturer's capability to integrate and utilise
4 external knowledge is largely influenced by its prior knowledge base (Cohen and
5 Levinthal, 1990; Szulanski, 1996). Hence, we argue that intellectual capital helps a
6
7 manufacturer integrate knowledge from suppliers which then improves product
8
9 innovation performance (Cousins et al., 2011; Szulanski, 2000). In this way, this
10
11 study proposes that intellectual capital can improve product innovation performance
12
13 both directly and indirectly through supplier knowledge integration. In addition, a
14
15 manufacturer can acquire different kinds of knowledge from suppliers, such as
16
17 inventory levels, production planning, new applications of raw materials or
18
19 components, process improvement suggestions, and new product ideas (Kogut and
20
21 Zander, 1992; Zhang et al., 2015). Some of the knowledge can be applied in new
22
23 product development and hence supplier knowledge integration can improve product
24
25 innovation performance directly. Others allows the manufacturer to adapt supply
26
27 chain processes according to new product designs (Braunscheidel and Suresh, 2009;
28
29 Atuahene-Gima, 2005). Therefore, we argue that supplier knowledge integration also
30
31 improves product innovation performance indirectly through supply chain adaptability.
32
33

34 35 36 37 38 39 *2.2 Institutional Theory*

40
41 Institutional theory argues that manufacturers' practices and strategies are
42
43 substantially influenced and shaped by the broader social institutional settings in
44
45 which they operate (DiMaggio and Powell, 1983; Marquis and Tilcsik, 2013; Peng et
46
47 al., 2008). Institutions set legitimate requirements on manufacturers which lead to
48
49 isomorphism among them (DiMaggio and Powell, 1983). Manufacturers' strategic
50
51 choices are made within environmental conditions and constraints (Peng et al., 2008).
52
53 Hence, the institutional theory indicates that manufacturers' behaviour and decisions,
54
55 including product innovation and supply chain management practices, are influenced
56
57
58
59
60

1
2
3 by the prominent features of a country's economic and institutional environments
4 (Marquis and Tilcsik, 2013; Simsek et al., 2015). Scholars further argue that the
5 evolution of a country's economic and institutional environments affects
6 manufacturers' operations (Boeker, 1989). Manufacturers preserve previously
7 adopted structures and capabilities which persist in the long run due to inertia or
8 institutionalisation (Marquis and Tilcsik, 2013; Simsek et al., 2015). They tend to
9 follow the strategies or practices that are rewarded or encouraged by environmental
10 conditions to ensure survival and growth (Boeker, 1989; Peng et al., 2008). China and
11 India have different political and legal institutions and patterns of economic
12 development (Parayil and D'Costa, 2009; Saran and Guo, 2005). Therefore, we
13 propose that the mechanisms through which intellectual capital influences product
14 innovation performance are different in China and India. The conceptual model and
15 all proposed hypotheses are provided in Figure 1.
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31

32 -----
33 Figure 1 about here
34 -----
35

36 2.3 Research Hypotheses

37
38 Intellectual capital enables manufacturers to find new applications for existing
39 technologies and to synthesise existing capabilities in a fresh way, both of which are
40 critical for designing affordable products (Ernst et al., 2015; Radjou et al., 2012). In
41 particular, employees' knowledge and skills allow manufacturers to quickly reverse
42 engineer and adapt existing products and technologies based on local customers'
43 preferences (Prahalad and Mashelkar, 2010). Operating procedures and systems can
44 keep the knowledge created by employees and hence manufacturers can use the
45 knowledge even when the employees leave the manufacturers (Lee et al., 2011). They
46 can also standardise the development of new products, and reduce the variety in and
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 improve the efficiency of product innovation (Ernst et al., 2015). Technical manuals
4 and databases help employees reuse existing modules and components in product
5 innovation to satisfy price-sensitive customers (Radjou et al., 2012). Social
6 relationships facilitate collaboration and cooperation among employees (Nahapiet and
7 Ghoshal, 1998). They are critical for the employees to access each other's private and
8 personal knowledge (Szulanski, 1996). Interactions between employees also allow
9 manufacturers to implement cross-functional teams on new product development,
10 solve conflict among different departments, and make joint decisions on the price,
11 quality, and functionality of new products which are important for adapting products
12 quickly (Szulanski, 2000; Zhang et al., 2014). Hence, manufacturers with higher
13 levels of intellectual capital are more capable of responding to varying and
14 unpredictable market environments by introducing new products quickly and
15 frequently (Atuahene-Gima, 2005). Therefore, we propose the following hypothesis.

16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32 *H1: Intellectual capital directly improves product innovation performance.*

33
34 Intellectual capital retains a manufacturer's past experiences on supplier
35 collaboration within employees' knowledge and organisational procedures (Lee et al.,
36 2011). Manufacturers thus can rely on intellectual capital to identify suppliers'
37 valuable knowledge and integrate such knowledge (Szulanski, 1996; Menor et al.,
38 2007). Product innovation requires manufacturers to develop fresh insights into
39 supply chain operations, technology trends, and local markets (Radjou et al., 2012).
40 Such knowledge can be sourced from suppliers (Gao et al., 2015; Zhang et al., 2015).
41 For example, suppliers can provide knowledge on new applications of existing
42 materials, information about the components and modules used in competitors'
43 products, and new product ideas (Zhang et al., 2015; Zhang et al., 2014). The
44 knowledge enables a manufacturer to imitate competitors' products and to adapt
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 existing products by designing new components or reconfiguring modules
4
5 innovatively, thereby increasing the speed and frequency of new product introduction
6
7 (Chandy and Tellis, 1998; Jean et al., 2014). In addition, supplier knowledge
8
9 integration supplements internal research and development (R&D) efforts and enables
10
11 a manufacturer to exploit suppliers' knowledge for new product development
12
13 (Cousins et al., 2011). The manufacturer can thus develop more products with fewer
14
15 R&D investments (Radjou et al., 2012). Integrating knowledge acquired from
16
17 suppliers also enhances a manufacturer's ability to generate new ideas on how to
18
19 extend functionality or improve specifications when customising and localising
20
21 products, and assists the manufacturer in developing products concurrently with
22
23 suppliers (Un et al., 2010; Wang et al., 2011). Moreover, incorporating suppliers' new
24
25 ideas and designs when adapting products helps a manufacturer enhance product
26
27 quality and manufacturability and make better decisions on product features (Jean et
28
29 al., 2014; Tavani et al., 2013), improving product innovation performance. Therefore,
30
31 we propose the following hypothesis.
32
33
34

35
36 *H2: Intellectual capital improves product innovation performance indirectly through*
37
38 *supplier knowledge integration.*
39

40
41 Knowledge acquired from suppliers, such as inventory levels and production
42
43 planning, can improve a manufacturer's procurement and manufacturing processes
44
45 (Tavani et al., 2013), and help the manufacturer reduce delivery lead-times and
46
47 improve supply chain responsiveness and flexibility (Un et al., 2010). In addition,
48
49 supplier knowledge integration allows manufacturers to capture the latest information
50
51 and to develop a better understanding about their supply chains (Nahapiet and
52
53 Ghoshal, 1998; Petersen et al., 2003) which help the manufacturers rapidly adapt to
54
55 changing environments (Lee, 2004). Hence, knowledge acquired from suppliers can
56
57
58
59
60

1
2
3 be implemented to adjust and adapt supply chain processes with reduced reaction
4 times, enhancing supply chain adaptability (Braunscheidel and Suresh, 2009; Tavani
5 et al., 2013).
6
7
8

9
10 An adaptive supply chain is able to leverage supply chain resources to adjust
11 operations swiftly and nimbly and to profit from rapidly changing environments
12 (Blome et al., 2013). This capability enables manufacturers to innovate by localising
13 and customising existing products and technologies (Ernst et al., 2015). Supply chain
14 adaptability also enables a manufacturer to adjust supply chain processes quickly
15 according to new product designs which can speed up the commercialisation of
16 product innovations (Braunscheidel and Suresh, 2009; Engelhardt-Nowitzki, 2012).
17
18 An adaptable supply chain can deal with the negative effects of late engineering or
19 specification changes by enabling a manufacturer to launch products into markets as
20 basic platforms and then to improve designs based on user feedback (Swafford et al.,
21 2006). Hence, supply chain adaptability enables a manufacturer to introduce more
22 new products quickly. Therefore, we propose the following hypothesis.
23
24
25
26
27
28
29
30
31
32
33
34
35

36 *H3: Supplier knowledge integration improves product innovation performance*
37 *indirectly through supply chain adaptability.*
38
39
40

41 China and India liberalised their markets in 1978 and 1991 respectively. Since
42 then, both countries have experienced rapid economic growth (Bruche, 2009).
43 However, they have followed different growth paths (Fan, 2011; Parayil and D'Costa,
44 2009). Compared to India, China reformed its economic systems much earlier. China
45 also developed at a faster pace and received larger inflows of foreign direct
46 investment (Table 1). In addition, exports of goods and services and high-technology
47 exports play more important roles in Chinese economic development (Table 1). The
48 Chinese government has practiced the “swap market for technology” strategy that
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 encouraged Chinese manufacturers to form joint-ventures with Western firms seeking
4 access to China's large and growing markets, enabling Chinese manufacturers to learn
5 advanced technologies, production techniques, and management skills (Altenburg et
6 al., 2008; Breznitz and Murphree, 2011). As an important part of global production
7 network and with the help of intensive capital investment, Chinese manufacturers can
8 and must build extensive intellectual capital to catch up with domestic and foreign
9 customers' changing and novel demands. Moreover, the Chinese government has
10 provided supportive policies to motivate Chinese manufacturers to implement the
11 "self-dependent innovation" strategy that emphasised endogenous innovation using
12 internal resources and capabilities (Parayil and D'Costa, 2009). Manufacturers that
13 answer such institutional arrangements are rewarded by the government. Thus,
14 Chinese manufacturers are encouraged by the environment to rely on internal
15 knowledge and resources, such as intellectual capital, to develop new products. In
16 contrast, India has followed an import substitution policy and relied on domestic
17 resource mobilisation with much lower foreign capital participation (Fan, 2011).
18 Hence, Indian manufacturers may accumulate fewer technological capabilities and
19 successful new product development experiences by exporting and supplying Western
20 customers and thus may depend less on intellectual capital for product innovation
21 compared to Chinese manufacturers. We argue that the differences in economic
22 growth paths and institutional environments in China and India moderate the direct
23 effect of intellectual capital on product innovation performance.
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

49
50 -----
51 Table 1 about here
52 -----
53

54 Although both China and India are experiencing transition to market economies
55 (Altenburg et al., 2008; Fan, 2011), they have different legal and political
56
57
58
59
60

1
2
3 environments (Rajagopalan and Zhang, 2008; Saran and Guo, 2005). India maintains
4 a legal system inherited from the colonial era. Various legislations first introduced by
5 the British are still in effect and laws also incorporate important US court decisions.
6
7 For example, the Indian Contract Act was passed by British India and is based on the
8 principles of British Common Law. India also adopts the Westminster style of
9 democracy with a multi-party system. The legislature, the executive, and the judiciary
10 are independent of each other. Laws in China are influenced by traditional Chinese
11 approaches and philosophies (Saran and Guo, 2005). Moreover, the Communist Party
12 of China is the sole governing party and has ultimate authority throughout the
13 economic system. Officials can undermine the rule of law and the execution of law is
14 largely subject to local authorities' discretion (Zhou and Poppo, 2010). Inadequacy
15 and enforcement inefficiency characterise China's legal environment and
16 manufacturers may suffer from unlawful or unfair competitive behaviour, such as
17 contract violation, copyright piracy, and counterfeiting, when involving suppliers
18 directly in product innovation (Wang et al., 2011). Hence, legal institutions cannot
19 provide sufficient protection for Chinese manufacturers' business interests during
20 collaborative innovation with suppliers. In comparison to China, India's legal
21 framework is relatively more developed and more effective. Indian manufacturers can
22 follow formal legal processes and depend on contracts for settling disputes, resolving
23 conflict, and gaining protection when developing new products collaboratively with
24 suppliers. We argue that the differences in institutional environments in China and
25 India moderate the roles played by suppliers in product innovation and hence the
26 indirect effect of intellectual capital on product innovation performance. Therefore,
27 we propose the following hypothesis.
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 *H4: The mechanisms through which intellectual capital influences product innovation*
4 *performance are different in China and India.*
5
6
7
8
9

10 **3. Methodology**

11 *3.1 Questionnaire Design*

12
13
14 Based on the relevant literature, a survey instrument was designed to measure a
15 manufacturer's intellectual capital, supplier knowledge integration, supply chain
16 adaptability, and product innovation performance. In addition, the questionnaire
17 included the demographic profile of the manufacturer (e.g., industry, age, size, R&D
18 investment, and training budget). A multiple-item, 7-point Likert-type scale (1 =
19 "strongly disagree"; 7 = "strongly agree") was employed for all constructs. The
20 questionnaire was developed in English. We organised a panel of academics to review
21 the English version of the questionnaire and to translate it into Chinese. The Chinese
22 version was then translated back into English and checked against the original to
23 verify the reliability of the survey instrument. The English and Chinese versions were
24 used in India and China for data collection respectively. The scales, which consist of
25 21 measurement items, are listed in the appendix.
26
27
28
29
30
31
32
33
34
35
36
37
38
39

40 Intellectual capital was measured by three first-order constructs adapted from
41 Subramaniam and Youndt (2005). In particular, three items regarding employees'
42 skills and expertise were used to measure human capital; structural capital was
43 operationalized as a firm's manuals, procedures, rules, databases, and systems using
44 three items; and social capital was measured by the interactions and relationships
45 among employees using another three items (Subramaniam and Youndt, 2005).
46 Supplier knowledge integration was operationalized as acquiring and applying
47 knowledge from suppliers using four items that were adapted from Hult et al. (2004)
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 and Song et al. (2005). Supply chain adaptability was gauged by four items examining
4 the capabilities for problem solving and changing product and supply chain designs
5 quickly. They were adapted from Swafford et al. (2006) and Blome et al. (2013).
6
7 Product innovation performance was measured by four items gauging the number,
8 speed, and frequency of new product introduction (Atuahene-Gima, 2005; Chandy
9 and Tellis, 1998).

10
11 We included R&D investment as a control variable in the analysis as
12 manufacturers who have invested more in R&D tend to have better product
13 innovation performance (Un et al., 2010). It was measured by the percentage of
14 annual sales invested in R&D. We also controlled for firm size and age which were
15 measured by the number of employees and years of operation respectively. Larger
16 manufacturers may have higher capabilities and more resources for product
17 innovation, and elder manufacturers may have accumulated more expertise and
18 experiences for new product development (Un et al., 2010). Moreover, we controlled
19 for training budget as task-related training can upgrade employees' skills which may
20 improve product innovation performance. This was measured by the percentage of
21 annual sales spent on training.

22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

3.2 Data Collection

We interviewed 15 manufacturers in China to pilot test the questionnaire. We then decided to use one key informant per manufacturer who is knowledgeable about supply chain management and product innovation and is familiar with knowledge management practices. Such key informants can be general managers or directors, senior R&D managers, operations/manufacturing managers, and supply chain managers.

1
2
3 In China, manufacturers were selected from three special economic zones (i.e.,
4 Pearl River Delta, Yangtze River Delta, and Circum-Bohai Economic Zone). We
5 randomly selected 2379 manufacturers from the target industries (Table 2) in the three
6 regions using the directory provided by the National Bureau of Statistics of the
7 People's Republic of China. A professional market research firm was hired to conduct
8 the data collection. The firm contacted the target manufacturers by telephone to
9 identify and verify the informant who was able to answer the survey questions and to
10 solicit his/her participation in the survey. Of the selected sample, 2061 could not be
11 contacted due to incorrect contact information or they did not wish to participate in
12 the survey. The market research firm sent representatives to visit the respondents from
13 the remaining 318 manufacturers on site. Finally, 300 completed questionnaires were
14 returned for a response rate of 12.6% (300/2379).
15
16
17
18
19
20
21
22
23
24
25
26
27
28

29 In India, manufacturers were randomly selected from important industrial cities,
30 including Delhi, Mumbai, Bangalore, Chennai, Kolkata, Chandigarh, and Ahmadabad
31 and from the same industries as those in China. The manufacturers were selected from
32 the *IndiaMART* business directory, the most comprehensive business directory of
33 companies in India. A professional market research firm was also hired for data
34 collection. Using a similar approach, the firm contacted target manufacturers by
35 telephone to identify and verify the appropriate informants, resulting in a sample of
36 550 manufacturers who agreed to participate in this study. The firm sent
37 representatives to collect data through face-to-face interviews with the appropriate
38 respondents and finally collected 200 valid responses. The response rate is 36.4%
39 (200/550). The demographic statistics of the sample manufacturers are shown in Table
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54 2.

55
56
57 -----
58 Table 2 about here
59
60

We conducted four statistical tests using SPSS 21.0 and AMOS 21.0 to assess common method bias. First, we performed Harman's single factor test using unrotated exploratory factor analysis (Podsakoff et al., 2003). The largest percentage of variances explained is 26.1% in the Indian sample and 19.3% in the Chinese sample, indicating that the magnitude of common method bias is not significant. Second, we constructed a confirmatory factor analysis (CFA) model in which the common method was treated as a single factor loading on all items (Podsakoff et al., 2003). The fit indices are $\chi^2 (189)=1514.58$, $\chi^2/df=8.01$, Comparative Fit Index (CFI)=0.56, Tucker Lewis Index (TLI)=0.52, Root Mean Square Error of Approximation (RMSEA)=0.15 in the Chinese sample, and $\chi^2 (189)=702.71$, $\chi^2/df = 3.72$, CFI=0.74, TLI=0.71, RMSEA=0.12 in the Indian sample, which are unacceptable (Hu and Bentler, 1999). Third, we constructed a conventional CFA model with each construct loading on its own items. Next, we added a common factor loading on all items to this CFA model. The purpose of this method is to estimate the amount of variance from each item that can be attributed to the common method (Podsakoff et al., 2003). The results show that the average variance explained by the common method is only 3.3% in the Chinese sample and 9.6% in the Indian sample, indicating that the common method bias is minimal. Finally, we introduced a marker variable, environmental uncertainty (EU), to gauge and partial out the effect of common method (Lindell and Whitney, 2001). The smallest positive correlation between EU and other constructs is 0.02 (insignificant) and 0.12 (insignificant) in the Chinese and Indian samples respectively. Using Lindell and Whitney's (2001) estimation method, we calculated the corrected correlations and t values for all pairs of correlations between constructs in this study. The results indicate that all corrected correlations do not change much

1
2
3 and remain significant in both Chinese and Indian samples. Therefore, we drew the
4
5 conclusion that common method bias is not a serious problem in this study.
6

7 8 3.3 Psychometric Test

9
10 We employed Cronbach's alpha and composite reliability for assessing construct
11
12 reliability. The Cronbach's alpha values range from 0.72 to 0.87 and the composite
13
14 reliabilities range from 0.84 to 0.91 (appendix) which are all above the recommended
15
16 threshold value of 0.70, suggesting that all constructs are reliable in both Chinese and
17
18 Indian samples.
19

20
21 We used average variance extracted (AVE) and CFA to assess the convergent
22
23 and discriminant validity. All of the AVE values range from 0.63 to 0.72, which are
24
25 above the recommended value of 0.50 (appendix), thereby demonstrating adequate
26
27 convergent validity in both samples (Fornell and Larcker, 1981). We built a second-
28
29 order CFA model to further assess the convergent validity. In the model, the items for
30
31 intellectual capital were linked first to the three first-order constructs (i.e., social,
32
33 structural, and human capital), which then loaded onto the second-order construct, and
34
35 the items for supplier knowledge integration, supply chain adaptability, and product
36
37 innovation performance were directly linked to corresponding constructs. The
38
39 covariance among the constructs was freely estimated. The model fit indices are
40
41 $\chi^2(180)=318.49$, $\chi^2/df=1.86$, CFI=0.95, TLI=0.95, RMSEA=0.05 in the Chinese
42
43 sample, and $\chi^2(180)=310.99$, $\chi^2/df=1.73$, CFI=0.93, TLI=0.92, RMSEA=0.06 in the
44
45 Indian sample, which are better than the threshold values recommended by Hu and
46
47 Bentler (1999). In addition, all factor loadings are greater than 0.50 (appendix), with
48
49 all t values greater than 2.0. The results indicate that convergent validity is ensured in
50
51 both Chinese and Indian samples.
52
53
54
55
56
57
58
59
60

Discriminant validity was assessed by comparing the square roots of the AVE of each construct with the correlations between the focal and other constructs. A square root higher than the correlation with other constructs suggests discriminant validity (Fornell and Larcker, 1981). Table 3 shows the means and standard deviations of the constructs and their correlations. Comparisons of the correlations and square roots of the AVEs on the diagonal indicate adequate discriminant validity for all constructs in both Chinese and Indian samples. We also assessed discriminant validity by building a constrained CFA model for every possible pair of latent constructs in which the correlations between the paired constructs were fixed to 1.0. This was compared with the original unconstrained model, in which the correlations among constructs were freely estimated. A significant difference in the chi-square statistics between the constrained and unconstrained models indicates high discriminant validity (Fornell and Larcker, 1981). This method was used in both Chinese and Indian samples, and all differences are significant at the 0.001 level, indicating that discriminant validity is ensured.

Table 3 about here

3.4 Measurement Equivalence

To ensure cross-country comparability, an empirical assessment of the measurement equivalence of the constructs between the two countries was conducted. Measurement equivalence evaluates the ability of a scale to yield an accurate measurement of some contextual issues across different settings (Cheung and Rensvold, 1999). As a methodological norm in cross-country survey study, measurement equivalence guarantees that the cross-country differences are not due to the differences in measurement scales (Rungtusanatham et al., 2008).

1
2
3 The measurement equivalence between Chinese and Indian samples was assessed
4 with the method recommended by Rungtusanatham et al. (2008) using multiple-group
5 CFA. First, a stacked model was built to assess configural equivalence which refers to
6 the extent to which Chinese and Indian samples share the same factor structure. The
7 configural model fits well between the two samples ($\chi^2(360)=629.59$, $\chi^2/df=1.75$,
8 CFI=0.95, TLI=0.95, RMSEA=0.039) and all factor loadings and variances are
9 statistically significant. These results establish configural equivalence between the
10 two samples (Rungtusanatham et al., 2008). Second, metric equivalence was assessed
11 with a nested CFA model which determines the extent to which individual factor
12 loadings are identical across the two samples. In this model, the factor loadings were
13 constrained to be equal across the two samples and other parameters were freely
14 estimated. The insignificant change ($\Delta\chi^2(17) =24.74$, $p>0.1$) between the
15 unconstrained and the constrained models shows the evidence of the metric
16 equivalence. Third, starting with the second model, another nested model was built to
17 assess the measurement error variance invariance (MEVI) which refers to the extent
18 to which measurement error variances for individual items are identical across the two
19 samples. In this model, the measurement error variances were further constrained to
20 be equal across the two samples and other parameters were freely estimated. The
21 significant change ($\Delta\chi^2(51)=329.16$, $p<0.01$) shows that the full MEVI cannot be
22 established. Thus, a series of CFA models were built to assess partial MEVI. The
23 results show that partial MEVI can be established across the two samples. As
24 suggested by Rungtusanatham et al. (2008), partial MEVI is enough for further
25 comparative analyses across two countries.
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55

56 **4. Analysis and Results**

57
58
59
60

The hypotheses are tested using structural equation modelling (SEM) with the maximum likelihood estimation method. The proposed model for each country (i.e., China and India) is stacked and tested using AMOS 21.0. The results are presented in Figure 2. The model fit indices are $\chi^2(518)=950.54$, $\chi^2/df=1.84$, CFI=0.92, TLI=0.91, RMSEA=0.041, which are acceptable (Hu and Bentler, 1999). We find that in China, intellectual capital significantly enhances supplier knowledge integration ($b=0.57$, $p<0.01$) and product innovation performance ($b=0.39$, $p<0.01$). Supplier knowledge integration increases supply chain adaptability ($b=0.56$, $p<0.01$) which positively influences product innovation performance ($b=0.29$, $p<0.01$). However, the direct effect of supplier knowledge integration on product innovation performance is not significant. In India, product innovation performance is positively influenced by intellectual capital ($b=0.32$, $p<0.01$), supplier knowledge integration ($b=0.25$, $p<0.05$), and supply chain adaptability ($b=0.36$, $p<0.01$). Intellectual capital also increases supplier knowledge integration ($b=0.71$, $p<0.01$) and supplier knowledge integration enhances supply chain adaptability ($b=0.53$, $p<0.01$). The results show that the direct effect of intellectual capital on product innovation performance is significant and positive in both countries. Thus, H1 is supported. Moreover, the effects of the four control variables on product innovation performance are not significant in both countries.

Figure 2 about here

As recommended by Malhotra et al. (2014), bootstrapping method is used to test the mediation effects in both Chinese and Indian samples. Accordingly, bias-corrected bootstrapping with 5000 samples is conducted in each sample. The indirect effect of intellectual capital on product innovation performance through supplier knowledge integration is insignificant in China but significant in India ($b=0.32$, $p<0.05$).

Therefore, H2 is partially supported. The indirect effect of supplier knowledge integration on product innovation performance through supply chain adaptability is significant in both China ($b=0.16$, $p<0.01$) and India ($b=0.19$, $p<0.01$). Therefore, H3 is supported.

A multiple group (i.e., China vs India) SEM analysis is further conducted to compare the relationships among intellectual capital, supplier knowledge integration, supply chain capability, and product innovation performance. As the control variables do not significantly influence the dependent variable (i.e., product innovation performance), we exclude them in the cross-country comparison analysis to keep the model parsimonious. The bias-corrected bootstrapping is also conducted to compare the indirect effects in the two countries (Malhotra et al., 2014). Table 4 summarizes the results of cross-country comparisons for the path coefficients.

Table 4 about here

The results show that the direct effect of intellectual capital on product innovation performance in China is significantly higher than that in India ($\Delta\chi^2=3.18$). In addition, the path coefficient from supplier knowledge integration to product innovation performance is positive and significant in India but insignificant in China ($\Delta\chi^2=10.73$), and the indirect effect of intellectual capital on product innovation performance through supplier knowledge integration in China is significantly lower than that in India ($\Delta b=0.30$, $p<0.01$). Thus, the mechanisms through which intellectual capital influences product innovation performance are different in China and India. Therefore, H4 is supported. The path coefficients from intellectual capital to supplier knowledge integration, from supplier knowledge integration to supply chain adaptability, and from supply chain adaptability to product innovation

1
2
3 performance are not significantly different between the two countries. The indirect
4
5 effect of supplier knowledge integration on product innovation performance through
6
7 supply chain adaptability in China is also not significantly different from that in India.
8
9

10 11 12 **5. Discussion and Conclusions**

13 14 *5.1 The Direct Effect of Intellectual Capital on Product Innovation Performance*

15
16 This study finds that intellectual capital directly improves product innovation
17
18 performance. The result is consistent with existing empirical evidence (Subramaniam
19
20 and Youndt, 2005; Hsu and Sabherwal, 2012; Lee et al., 2011) and the argument that
21
22 a firm's knowledge base helps the firm innovate (Cohen and Levinthal, 1990;
23
24 Szulanski, 1996). Therefore, using existing knowledge creatively is critical for
25
26 manufacturers who do not focus on developing state-of-the-art technological advances
27
28 in a product category to innovate. We also find that this effect is moderated by a
29
30 country's environmental conditions. Manufacturers in the countries that have
31
32 introduced more policies driving endogenous innovation and accumulated more
33
34 technological and managerial knowledge during economic development rely more on
35
36 intellectual capital for developing new products.
37
38
39

40 41 *5.2 The Indirect Effect of Intellectual Capital on Product Innovation Performance* 42 43 *through Supplier Knowledge Integration*

44
45 We find that the impact of intellectual capital on product innovation performance
46
47 is partially mediated by supplier knowledge integration and the mediation effect is
48
49 moderated by a country's institutional environment. The results are consistent with
50
51 Hsu and Sabherwal (2012)'s finding that knowledge management mediates the effect
52
53 of intellectual capital on innovation and corroborate the existing literature on the
54
55 influences of institutional environment on supply chain collaboration (Wang et al.,
56
57
58
59
60

1
2
3 2011; Jean et al., 2014; Zhou and Poppo, 2010). It is difficult for manufacturers to
4 perform adequate due diligence and to manage supply chain collaboration using
5 formal control mechanisms in the countries that lack reliable public information
6 channels, professionals (e.g., actuaries, accountants, and surveyors), and strong
7 corporate governance (Rajagopalan and Zhang, 2008; Zhou and Poppo, 2010).
8 Therefore, manufacturers in such countries do not directly use knowledge acquired
9 from suppliers for innovation because this means the manufacturers must share know-
10 how with suppliers which might be leaked to competitors as legal and political
11 institutions may fail to protect their intellectual property rights (Rajagopalan and
12 Zhang, 2008; Zhou and Poppo, 2010). In the countries that have well-developed
13 contract and intellectual property laws, manufacturers are able to apply knowledge
14 obtained from suppliers directly in innovation because their business interests can be
15 protected by legal means. We also find that intellectual capital positively affects
16 supplier knowledge integration, which is consistent with the argument that prior
17 knowledge base helps a manufacturer acquire and integrate knowledge from suppliers
18 (Tavani et al., 2013; Zhang et al., 2015).
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37

38 *5.3 The Indirect Effect of Supplier Knowledge Integration on Product Innovation* 39 40 41 *Performance through Supply Chain Adaptability* 42

43 The result reveals that supply chain adaptability mediates supplier knowledge
44 integration's effect on product innovation performance. This is consistent with the
45 existing empirical evidence that knowledge acquired from suppliers is positively
46 associated with new product development (Petersen et al., 2003; Cousins et al., 2011;
47 Tavani et al., 2013) and improves a manufacturer's supply chain capabilities (Hult et
48 al., 2004; Hult et al., 2006). Supplier knowledge integration enables manufacturers to
49 acquire knowledge related to supply chain processes. The knowledge can help the
50
51
52
53
54
55
56
57
58
59
60

1
2
3 manufacturers adapt and improve supply chains to commercialise new product
4 designs quickly and efficiently which is critical for the manufacturers to enhance
5 product innovation performance.
6
7
8

9 10 *5.4 Theoretical Contributions*

11 This study contributes to operations management literature in three ways. First,
12 this study provides empirical evidence that the impact of intellectual capital on
13 production innovation performance is partially mediated by supplier knowledge
14 integration. The finding clarifies the mechanisms through which intellectual capital
15 enhances product innovation performance and the joint effects of internal and supplier
16 knowledge on new product development. The majority of current studies focus on the
17 relationships between intellectual capital and a firm's internal capabilities and
18 operations (e.g., Hsu and Wang, 2012; Menor et al., 2007; Subramaniam and Youndt,
19 2005). This study links intellectual capital with supply chain learning and reveals that
20 supplier knowledge integration may carry intellectual capital's effects on product
21 innovation performance. Therefore, we suggest scholars consider intellectual capital
22 in a supply chain context to fully capture its effects. In addition, we find that the direct
23 effect of intellectual capital and the mediation effect of supplier knowledge
24 integration are moderated by the environmental conditions of a country. Hence, we
25 suggest scholars adopt a contingent view and consider the influences of political and
26 legal institutions when investigating the effects of intellectual capital (Youndt et al.,
27 2004; Zhou and Poppo, 2010).
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48

49 Second, this study finds that supply chain adaptability mediates the impact of
50 supplier knowledge integration on product innovation performance. The result shows
51 that knowledge acquired from suppliers enhances product innovation performance
52 only indirectly through supply chain adaptability in China which provides a possible
53
54
55
56
57
58
59
60

1
2
3 explanation for the mixed findings on the roles played by suppliers in product
4 innovation (Gao et al., 2015; Jean et al., 2014). The findings also indicate that a
5 manufacturer can acquire different kinds of knowledge from suppliers which enhance
6 product innovation performance either directly or indirectly by improving supply
7 chain processes and capabilities, providing insights into how suppliers contribute to
8 new product development. Therefore, to fully reap the benefits of supplier knowledge
9 integration on product innovation, we suggest scholars consider the effects of
10 knowledge obtained from suppliers on both new product development and supply
11 chain processes.
12
13
14
15
16
17
18
19
20
21
22

23 Third, this study empirically compares the joint effects of intellectual capital,
24 supplier knowledge integration, and supply chain adaptability on product innovation
25 performance in China and India. The majority of empirical studies on product
26 innovation in emerging markets focus on China (Gao et al., 2015; Jean et al., 2014;
27 Wang et al., 2011). This study is one of the first attempts to generalize and compare
28 the findings in two important emerging markets. In this way, the results enhance
29 current understandings on knowledge management and product innovation in India
30 and the impacts of economic and institutional environments on supply chain
31 management and new product development. We find that the economic development
32 path and institutional environment moderate the effects of intellectual capital and
33 supplier knowledge integration on product innovation performance. Therefore, we
34 suggest scholars consider the influences of a country's special economic and
35 institutional environments when exploring the effects of knowledge and supply chain
36 management on new product development.
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53

54 *5.5 Managerial Implications*

55
56
57
58
59
60

1
2
3 This study also provides guidelines for managers on how to develop new
4 products using existing knowledge and supply chain management. First,
5 manufacturers can improve product innovation performance by developing
6 intellectual capital and integrating knowledge acquired from suppliers. In particular,
7 manufacturers could implement training programs and job rotation to enhance
8 employees' knowledge and skills. Manuals and standard operating procedures could
9 be designed to formalize knowledge management and product development processes.
10 Organizational procedures and rules could be created and regularly adjusted to guide
11 cross-functional collaboration in new product development. Information systems and
12 databases could also be used to keep knowledge automatically and systematically, and
13 to facilitate the retrieval and implementation of knowledge in product innovation and
14 supply chain management. In addition, lateral communication channels could be built
15 for employees in different departments to share information and interact with each
16 other. We suggest managers organize formal and informal social events, such as
17 workshop, seminars, and parties, for employees to build and maintain personal
18 relationships. Moreover, manufacturers could invest in operational processes and
19 information technologies that enable them to obtain technical know-how on new
20 product and process development from suppliers. For example, network-based
21 information systems could be developed to allow real-time information sharing with
22 suppliers. Cross-boundary teams could be formed to involve suppliers in new product
23 development. This is especially important for Indian manufacturers because supplier
24 knowledge integration mediates intellectual capital's effects on product innovation
25 performance in India.

26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54 Second, we suggest manufacturers invest in improving supply chain adaptability
55 when learning from suppliers for product innovation. Manufacturers could acquire
56
57
58
59
60

1
2
3 knowledge about supply chain processes, such as inventory management, delivery
4 scheduling, and process technologies, from suppliers. They could develop procedures
5 and processes to apply the knowledge to solve supply chain problems and reengineer
6 supply chains according to market changes. In this way, manufacturers are able to
7 reap the full benefits of supplier knowledge integration on product innovation. This is
8 especially important for Chinese manufacturers because supplier knowledge
9 integration only enhances product innovation through supply chain adaptability in
10 China.

11
12
13
14
15
16
17
18
19
20
21 Third, we find that the environmental conditions of a country moderate the
22 impacts of intellectual capital and supplier knowledge integration on product
23 innovation performance. Hence, we suggest managers analyse the institutional
24 environment of a country and adjust the focus of supply chain learning accordingly. In
25 particular, in a country that lacks market-supporting political and legal institutions,
26 manufacturers could focus on acquiring the knowledge that can improve supply chain
27 adaptability, such as process improvement suggestions and delivery scheduling, from
28 suppliers. If a country has a good enough institutional environment, manufacturers
29 could source the knowledge that can be directly applied into new product
30 development, such as new product ideas and new applications of existing components
31 and materials, and that can improve supply chain adaptability at the same time.

32 33 34 35 36 37 38 39 40 41 42 43 44 45 *5.6 Limitations and Future Research Directions*

46
47 Although this study makes significant theoretical and practical contributions, it
48 has limitations that open avenues for future studies. First, a manufacturer can learn
49 from different external partners, such as suppliers, customers, universities, and
50 competitors, who can bring different kinds of knowledge (Un et al., 2010; Zhang et al.,
51 2015). Future studies could explore the joint effects of the knowledge acquired from
52
53
54
55
56
57
58
59
60

1
2
3 different partners and intellectual capital on product innovation performance. Second,
4
5 we conduct this study in China and India. Manufacturers in other emerging markets
6
7 (e.g., Russia and Brazil) or developed economies (e.g., North America and West
8
9 Europe) face different economic and institutional environments compared to Chinese
10
11 and Indian manufacturers. Investigating how intellectual capital and supply chain
12
13 learning affect product innovation performance in other countries and comparing the
14
15 results with this study would be an interesting research topic. Third, the survey has
16
17 relatively low response rates, which is a limitation of this study.
18
19
20
21
22

23 **References**

- 24
25 Altenburg, T., Schmitz, H. and Stamm, A. 2008. Breakthrough? China's and India's
26
27 transition from production to innovation. *World Development* 36(2), 325-344.
28
29
30 Atuahene-Gima, K. 2005. Resolving the capability-rigidity paradox in new product
31
32 innovation. *Journal of Marketing* 69(4), 61-83.
33
34
35 Blome, C., Schoenherr, T. and Rexhausen, D. 2013. Antecedents and enablers of
36
37 supply chain agility and its effect on performance: A dynamic capabilities perspective.
38
39 *International Journal of Production Research* 51(4), 1295-1318.
40
41
42 Boeker, W. 1989. Strategic change: The effects of founding and history. *Academy of*
43
44 *Management Journal* 32(3), 489-515.
45
46
47 Braunscheidel, M.J. and Suresh, N.C. 2009. The organizational antecedents of a
48
49 firm's supply chain agility for risk mitigation and response. *Journal of Operations*
50
51 *Management* 27(2), 119-140.
52
53
54 Breznitz, D. and Murphree, M. 2011. *Run of the red queen: Government, innovation,*
55
56 *globalization, and economic growth in China.* New Haven: Yale University Press.
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000

- 1
2
3 innovation network. *Competition & Change* 13(3), 267-288.
- 4
5 Chandy, R.K. and Tellis, G.J. 1998. Organizing for radical product innovation: The
6
7 overlooked role of willingness to cannibalize. *Journal of Marketing Research* 34(4),
8
9 474-487.
- 10
11 Cheung, G.W. and Rensvold, R.B. 1999. Testing factorial variance across groups: A
12
13 reconceptualization and proposed new method. *Journal of Management* 25(1), 1-27.
- 14
15 Cohen, W.M. and Levinthal, D.A. 1990. Absorptive capacity: A new perspective on
16
17 learning and innovation. *Administrative Science Quarterly* 35(1), 128-152.
- 18
19 Cousins, P.D., Lawson, B., Petersen, K.J. and Handfield, R.B. 2011. Breakthrough
20
21 scanning, supplier knowledge exchange, and new product development performance.
22
23 *Journal of Product Innovation Management* 28(6), 930-942.
- 24
25 DiMaggio, P. J. and Powell, W. W. 1983. The iron cage revisited: Institutional
26
27 isomorphism and collective rationality in organizational fields. *American Sociological*
28
29 *Review* 48(2), 147-160.
- 30
31 Engelhardt-Nowitzki, C. 2012. Improving value chain flexibility and adaptability in
32
33 build-to-order environments. *International Journal of Physical Distribution &*
34
35 *Logistics Management* 42(4), 318-337.
- 36
37 Ernst, H., Kahle, H.N., Dubiel, A., Prabhu, J. and Subramaniam, M. 2015. The
38
39 antecedents and consequences of affordable value innovations for emerging markets.
40
41 *Journal of Product Innovation Management* 32(1), 65-79.
- 42
43 Fan, P. 2011. Innovation capacity and economic development: China and India.
44
45 *Economic Change and Restructuring* 44(1/2), 49-73.
- 46
47 Fornell, C. and Larcker, D.F. 1981. Evaluating structural equation models with
48
49 unobservable variables and measurement errors. *Journal of Marketing Research* 18(1),
50
51 39-50.
- 52
53
54
55
56
57
58
59
60

1
2
3 Gao, G.Y., Xie, E. and Zhou, K.Z. 2015. How does technological diversity in supplier
4 network drive buyer innovation? Relational process and contingencies. *Journal of*
5
6
7 *Operations Management* 36, 165-177.

8
9
10 Grant, R. M. 1996. Toward a knowledge-based theory of the firm. *Strategic*
11
12 *Management Journal* 17(S1), 109-122.

13
14 Hsu, I. and Sabherwal, R. 2012. Relationship between intellectual capital and
15
16 knowledge management: An empirical investigation. *Decision Sciences* 43(3), 489-
17
18 524.

19
20 Hsu, L. and Wang, C. 2012. Clarifying the effect of intellectual capital on
21
22 performance: The mediating role of dynamic capability. *British Journal of*
23
24 *Management* 23(2), 179-205.

25
26 Hu, L. and Bentler, P.M. 1999. Cutoff criteria for fit indices in covariance structure
27
28 analysis: Conventional criteria versus new alternatives. *Structural Equation*
29
30 *Modelling* 6(1), 1-55.

31
32 Hult, G.T.M., Ketchen Jr., D.J. and Slater, S.F. 2004. Information processing,
33
34 knowledge development, and strategic supply chain performance. *Academy of*
35
36 *Management Journal* 47(2), 241-253.

37
38 Hult, G.T.M., Ketchen Jr., D. J., Cavusgil, S. T. and Calantone, R.J. 2006.
39
40 Knowledge as a strategic resource in supply chains. *Journal of Operations*
41
42 *Management* 24 (5), 458-475.

43
44 Jean, R., Sinkovics, R.R. and Hiebaum, T.P. 2014. The effects of supplier
45
46 involvement and knowledge protection on product innovation in customer-supplier
47
48 relationships: A study of global automotive suppliers in China. *Journal of Product*
49
50 *Innovation Management* 31(1), 98-113.

51
52
53
54
55
56 Kogut, B., and Zander, U. 1992. Knowledge of the firm, combinative capabilities, and
57
58
59
60

1
2
3 the replication of technology. *Organization Science* 3(3), 383-397.

4
5 Lee, H.L. 2004. The triple-A supply chain. *Harvard Business Review* 83(10), 102-112.

6
7 Lee, J.Y., Swink, M. and Pandejpong, T. 2011. The role of worker expertise,
8 information sharing quality, and psychological safety in manufacturing process
9 innovation: An intellectual capital perspective. *Production and Operations*
10 *Management* 20(4), 556-570.

11
12 Lindell, M.K. and Whitney, D.J. 2001. Accounting for common method variance in
13 cross-sectional research designs. *Journal of Applied Psychology* 86(1), 114-121.

14
15 Malhotra, M.K., Singhal, C., Shang, G., and Ployhart, R.E. 2014. A critical evaluation
16 of alternative methods and paradigms for conducting mediation analysis in operations
17 management research. *Journal of Operations Management* 32(4), 127-137.

18
19 Marquis, C. and Tilcsik, A. 2013. Imprinting: Toward a multilevel theory. *The*
20 *Academy of Management Annals* 7(1), 195-245.

21
22 Menor, L.J., Kristal, M.M. and Rosenzweig, E.D. 2007. Examining the influence of
23 intellectual capital on capabilities and performance. *Manufacturing & Service*
24 *Operations Management* 9(4), 559-578.

25
26 Nahapiet, J. and Ghoshal, S. 1998. Social capital, intellectual capital, and the
27 organizational advantage. *Academy of Management Review* 23(2), 242-266.

28
29 Parayil, G. and D'Costa, A.P. 2009. *The new Asian innovation dynamics: China and*
30 *India perspective*. In: *Technology, globalisation and development*. England: Palgrave
31 Macmillan.

32
33 Peng, M. W., Wang, D. and Jiang, Y. 2008. An institution-based view of international
34 business strategy: A focus on emerging economies. *Journal of International Business*
35 *Studies* 39(5), 920–936.

36
37 Petersen, K.J., Handfield, R.B. and Ragatz, G.L. 2003. A model of supplier
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 integration into new product development. *Journal of Product Innovation*
4
5 *Management* 20(4), 284-299.

6
7 Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. 2003. Common
8
9 method biases in behavioural research: A critical review of the literature and
10
11 recommended remedies. *Journal of Applied Psychology* 88(5), 879-903.

12
13 Prahalad, C.K. and Mashelkar, R.A. 2010. Innovation's holy grail. *Harvard Business*
14
15 *Review* 88(7/8), 132-141.

16
17 Radjou, N., Prabhu, J. and Ahuja, S. 2012. *Jugaad innovation: Think frugal, be*
18
19 *flexible, generate breakthrough growth*. San Francisco: Jossey-Bass.

20
21 Rajagopalan, N. and Zhang, Y. 2008. Corporate governance reforms in China and
22
23 India: Challenges and opportunities. *Business Horizons* 51(51), 55-64.

24
25 Rungtusanatham, M., Ng, C.H., Zhao, X. and Lee, T.S. 2008. Pooling data across
26
27 transparently different groups of key informants: Measurement equivalence and
28
29 survey research. *Decision Sciences* 39(1), 115-145.

30
31 Saran, A. and Guo, C. 2005. Competing in the global marketplace: The case of India
32
33 and China. *Business Horizons* 48(2), 135-142.

34
35 Simsek, Z., Fox, B. and Heavey, C. 2015. "What's past is prologue": A framework,
36
37 review, and future directions for organizational research on imprinting. *Journal of*
38
39 *Management* 41(1), 288-317.

40
41 Song, X.M., van Der Bij, H. and Weggeman, M. 2005. Determinants of the level of
42
43 knowledge application: A knowledge-based and information-processing perspective.
44
45 *Journal of Product Innovation Management* 22(5), 430-444.

46
47 Subramaniam, M. and Youndt, M.A. 2005. The influence of intellectual capital on the
48
49 types of innovative capabilities. *Academy of Management Journal* 48(3), 450-463.

50
51 Swafford, P.M., Ghosh, S. and Murthy, N. 2006. The antecedents of supply chain
52
53
54
55
56
57
58
59
60

1
2
3 agility of a firm: Scale development and model testing. *Journal of Operations*
4
5 *Management* 24(2), 170-188.

6
7 Szulanski, G. 1996. Exploring internal stickiness: Impediments to the transfer of best
8
9 practice within the firm. *Strategic Management Journal* 17(S1), 27-43.

10
11 Szulanski, G. 2000. The process of knowledge transfer: A diachronic analysis of
12
13 stickiness. *Organizational Behaviour and Human Decision Processes* 82(1), 9-27.

14
15 Tavani, S.N., Sharifi, H. and Ismail, H.S. 2013. A study of contingency relationships
16
17 between supplier involvement, absorptive capacity and agile product innovation.
18
19 *International Journal of Operations & Production Management* 34(1), 65-92.

20
21 Un, C.A., Cuervo-Cazurra, A. and Asakawa, K. 2010. R&D collaborations and
22
23 product innovation. *Journal of Product Innovation Management* 27(5), 673-689.

24
25 Wang, L., Yeung, J.H.Y. and Zhang, M. 2011. The impact of trust and contract on
26
27 innovation performance: The moderating role of environmental uncertainty.
28
29 *International Journal of Production Economics* 134(1), 114-122.

30
31 Youndt, M.A., Subramaniam, M. and Snell, S.A. 2004. Intellectual capital profiles:
32
33 An examination of investments and returns. *Journal of Management Studies* 41(2),
34
35 335-361.

36
37 Zhang, M., Zhao, X., Lyles, M. and Guo, H. 2015. Absorptive capacity and mass
38
39 customization capability. *International Journal of Operations & Production*
40
41 *Management* 39(5), 1275-1294.

42
43 Zhang, M., Zhao, X. and Qi, Y. 2014. The effects of organizational flatness,
44
45 coordination, and product modularity on mass customization capability. *International*
46
47 *Journal of Production Economics* 158, 145-155.

48
49 Zhou, K.Z. and Poppo, L. 2010. Exchange hazards, relational reliability, and contracts
50
51 in China: The contingent role of legal enforceability. *Journal of International*
52
53

Business Studies 41(5), 861-881.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Appendix Measurement items

	China	India
Intellectual capital		
Human capital	AVE=0.70, CR=0.87, Alpha= 0.78	AVE=0.72, CR=0.89, Alpha= 0.81
	.857	.943
Employees in the company are highly skilled in their respective jobs.	.781	.777
Employees in the company are experts in their particular jobs and functions.	.700	.733
Our employees always develop new ideas and knowledge.	.729	.776
Structural capital	AVE=0.71, CR=0.88, Alpha= 0.79	AVE=0.65, CR=0.85, Alpha= 0.73
	.717	.977
Much of this company's knowledge is contained in manuals, archives, or databases.	.765	.652
We usually follow the sequence of written procedures and rules.	.707	.686
Our company embeds much of its knowledge and information in structures, systems, and processes.	.779	.744
Social capital	AVE=0.68, CR=0.87, Alpha= 0.76	AVE=0.64, CR=0.84, Alpha= 0.72
	.762	.853
There are ample opportunities for informal conversations among employees in the company.	.633	.589
Employees from different departments feel comfortable calling each other when the need arises.	.825	.720
People are quite accessible to each other in the company.	.726	.747
Supplier knowledge integration	AVE=0.71, CR=0.87, Alpha= 0.87	AVE=0.63, CR=0.87, Alpha= 0.81
We are able to obtain a tremendous amount of technical know-how from suppliers.	.820	.803

We rapidly respond to technological changes in our industry by applying what we have learned from suppliers.	.807	.708
As soon as we acquire new knowledge from suppliers, we try to find applications for it.	.744	.659
Suppliers' technological knowledge has enriched the basic understanding of our innovation activities.	.778	.692
Supply chain adaptability	AVE=0.68, CR=0.89, Alpha= 0.84	AVE=0.68, CR=0.89, Alpha= 0.84
Our supply chain partners can help us to quickly change product designs.	.724	.797
We can quickly solve supply chain problems.	.835	.825
Our supply chain can adapt to market changes easily.	.861	.695
We can quickly conduct engineering changes to adapt to customer's needs.	.631	.725
Product innovation performance	AVE=0.72, CR=0.91, Alpha= 0.87	AVE=0.67, CR=0.89, Alpha= 0.84
Percentage of total sales stemming from new products.	.660	.760
Number of new products.	.807	.756
Speed of introducing new products.	.841	.707
Frequency of new product introductions.	.870	.780

Note: AVE: average variance extracted; CR: composite reliability; Alpha: Cronbach's α

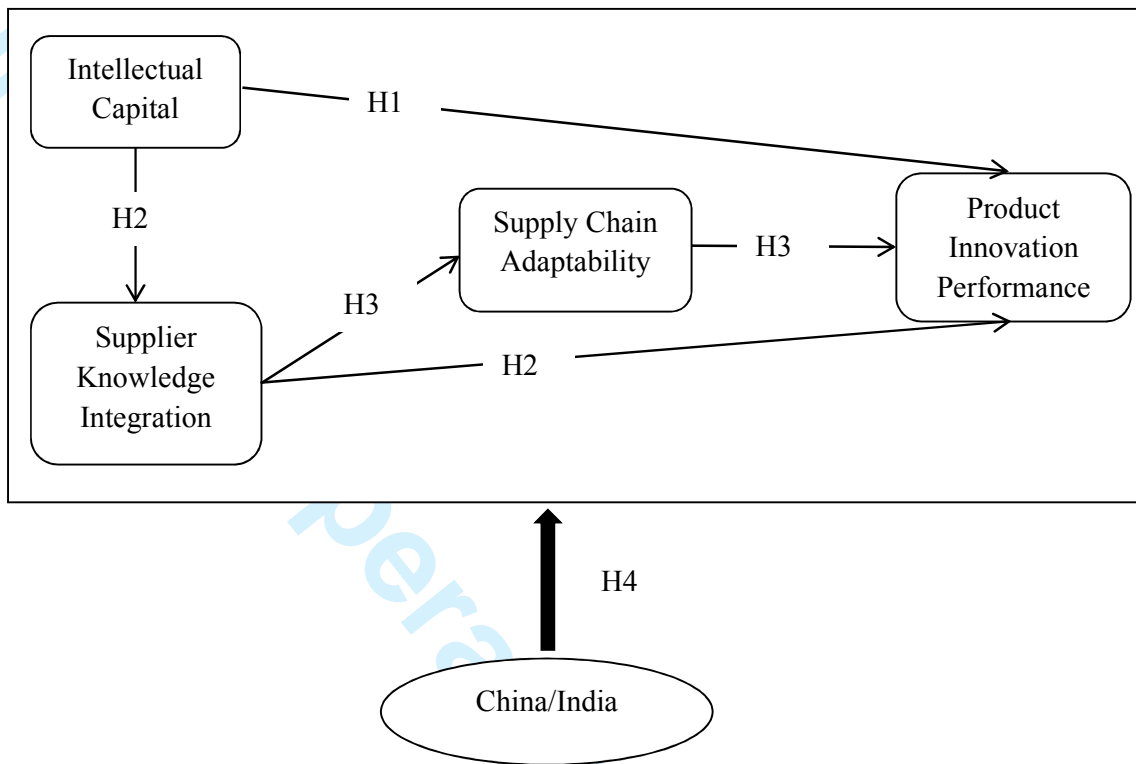
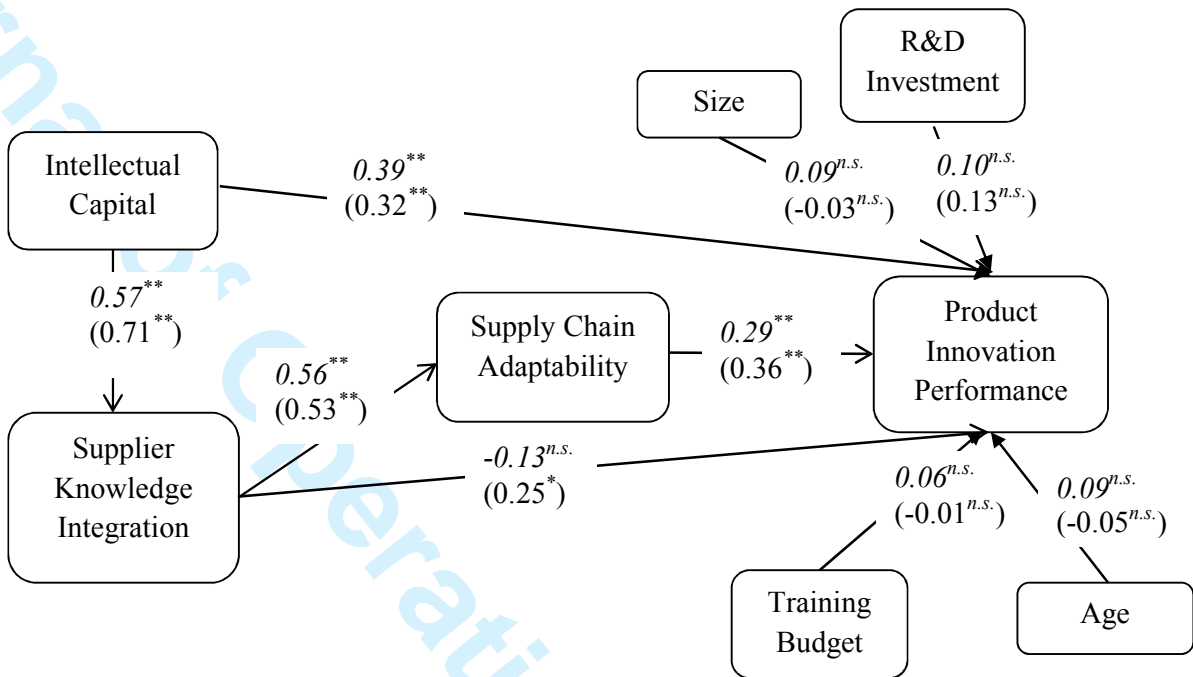


Figure 1. Conceptual framework



Note: ** $p < 0.01$; * $p < 0.05$; n.s.: not significant. The results of the Chinese sample are shown in italic font and those of the Indian sample are shown in parentheses.

Figure 2. Results of statistical analysis

Table 1. Economic growth in China and India

	1990		2000		2005	
	China	India	China	India	China	India
GDP (current US\$, Billion)	359	327	1205	477	2269	834
GDP growth (annual %)	3.93	5.53	8.43	3.84	11.35	9.28
Foreign direct investment, net inflows (current US\$, Billion)	3.49	0.23	38	3.58	111	7
Exports of goods and services (% of GDP)	15.90	6.93	20.68	12.77	33.70	19.28
High-technology exports (% of manufactured exports)	n/a	3.94	18.98	6.26	30.84	5.80

Source: World Development Indicators, the World Bank

Table 2. Firm profiles

	China	India
Annual sales (USD)		
Less than 50 million	62.3	78.0
50 to 100 million	17.0	10.5
100 to 250 million	12.0	4.5
More than 250 million	8.7	7.0
Industry		
Biology & pharmaceuticals	6.0	16.0
Computer & telecommunication equipment	11.3	6.5
Chemicals	17.0	9.5
Medical equipment	9.3	3.5
Electronics & electrical equipment	18.0	21.0
Industrial machinery	16.3	27.5
Transportation equipment	11.7	6.0
New materials	10.3	4.0
Years of operation		
Less than 10 years	26.7	25.0
11 to 20 years	46.6	44.0
21 to 30 years	11.0	19.5
More than 30 years	16.7	11.5
Number of employees		
Less than 200	22.3	64.8
201 to 500	41.7	16.6
501 to 1000	17.3	9.1
More than 1000	18.7	9.5
R&D investment (% of annual sales)		
Less than 0.5%	12.3	24.0
0.51% to 1.0%	8.7	38.5
1.1% to 2.0%	15.0	13.5
2.1 to 4.0%	48.0	8.0
More than 4.0%	16.0	16.0
Training budget (% of annual sales)		
Less than 1.0%	68.3	27.0
1.1% to 2.0%	18.0	40.5
2.1% to 4.0%	13.7	19.5
More than 4.0%	0.0	13.0

Note: The numbers in the China and India columns are percentages of manufacturing firms.

Table 3. Correlations, means, and standard deviations

		HC	StC	SoC	SKI	SCA	PIP
China	Human capital (HC)	0.84					
	Structural capital (StC)	0.44	0.84				
	Social capital (SoC)	0.51	0.45	0.82			
	Supplier knowledge integration (SKI)	0.33	0.31	0.38	0.84		
	Supply chain adaptability (SCA)	0.51	0.49	0.44	0.47	0.82	
	Product innovation performance (PIP)	0.48	0.25	0.27	0.19	0.41	0.85
	<i>Mean</i>	4.99	5.71	5.69	5.25	5.32	4.65
	<i>Standard deviation</i>	0.96	0.95	0.90	1.00	0.95	1.10
India	Human capital	0.85					
	Structural capital	0.70	0.81				
	Social capital	0.59	0.66	0.80			
	Supplier knowledge integration	0.54	0.49	0.39	0.79		
	Supply chain adaptability	0.50	0.46	0.46	0.39	0.82	
	Product innovation performance	0.60	0.50	0.45	0.53	0.58	0.82
	<i>Mean</i>	5.76	5.56	5.70	5.58	5.39	5.45
	<i>Standard deviation</i>	0.83	0.87	0.76	0.86	0.83	0.80

Note: The square root of average variance extracted (AVE) is shown on the diagonal of each matrix in bold. Inter-construct correlation is shown off the diagonal of each matrix. All of the correlations are significant at the 0.01 level.

Table 4. Results of cross-country comparison

Equal Paths	ΔCFI	ΔTLI	$\Delta \chi^2$
Intellectual capital → Product innovation performance	0.000	0.000	3.18⁺
Intellectual capital → Supplier knowledge integration	0.000	0.000	0.14
Supplier knowledge integration → Supply chain adaptability	0.000	0.000	0.01
Supplier knowledge integration → Product innovation performance	-0.002	-0.002	10.73*
Supply chain adaptability → Product innovation performance	0.000	0.00	0.05

Note: *p<0.05; ⁺ p<0.1