

THE DETERMINANTS OF INNOVATION AND PRODUCTIVITY OF A NATION

A. Anton Arulrajah*, Samithamby Senthilnathan**

*Department of Management, Eastern University, Sri Lanka

**Quality Assurance, International Training Institute, Lot 2&3 Section 140, Scratchley Road, Badili, PO Box 6322, NCD, Papua New Guinea

Abstract

This paper synthesizes five determinants of innovation and productivity of a nation. They are: Human resources and their characteristics, Natural and physical resources and their characteristics, Systems and strategies and their characteristics, Interactions and relationships among above three aspects, and Changes in the above four aspects. Though this paper separately identifies the determinants of innovation and productivity, using them for creating innovation and productivity into a process is complex and dynamic. Hence, for instance, we suggest primarily investigate how the characteristics of human resources in a nation determine its innovation and productivity; or how national reward management of a nation can affect innovation potential of the nation, in consideration of complexity of the relationship among the variables. Further, this study proposes to explore how these five determinants influence each other and work together among them; and/or whether they work collaboratively or competitively. These studies can pave the ways for determining the actual level of innovation and productivity of a nation. This paper, as a base, contributes to that extent.

Keywords: Innovation, Productivity, Determinant, Nation

1. INTRODUCTION

Innovation is about translating new ideas into products and services for value addition. This as a process requires all stakeholders (such as individuals, organisations and society) to have flexible attitude, and willingness to adapt and welcome unprecedented levels of change (GII, 2007). Appropriate environment is apart necessary to flourish innovation in a nation. This includes institutions, legal framework, infrastructure, mindsets, incentives and culture (GII, 2008). Effective and efficient leadership and management and competencies are now seen as the key to successful innovation and competitiveness (Gray and Mabey, 2005).

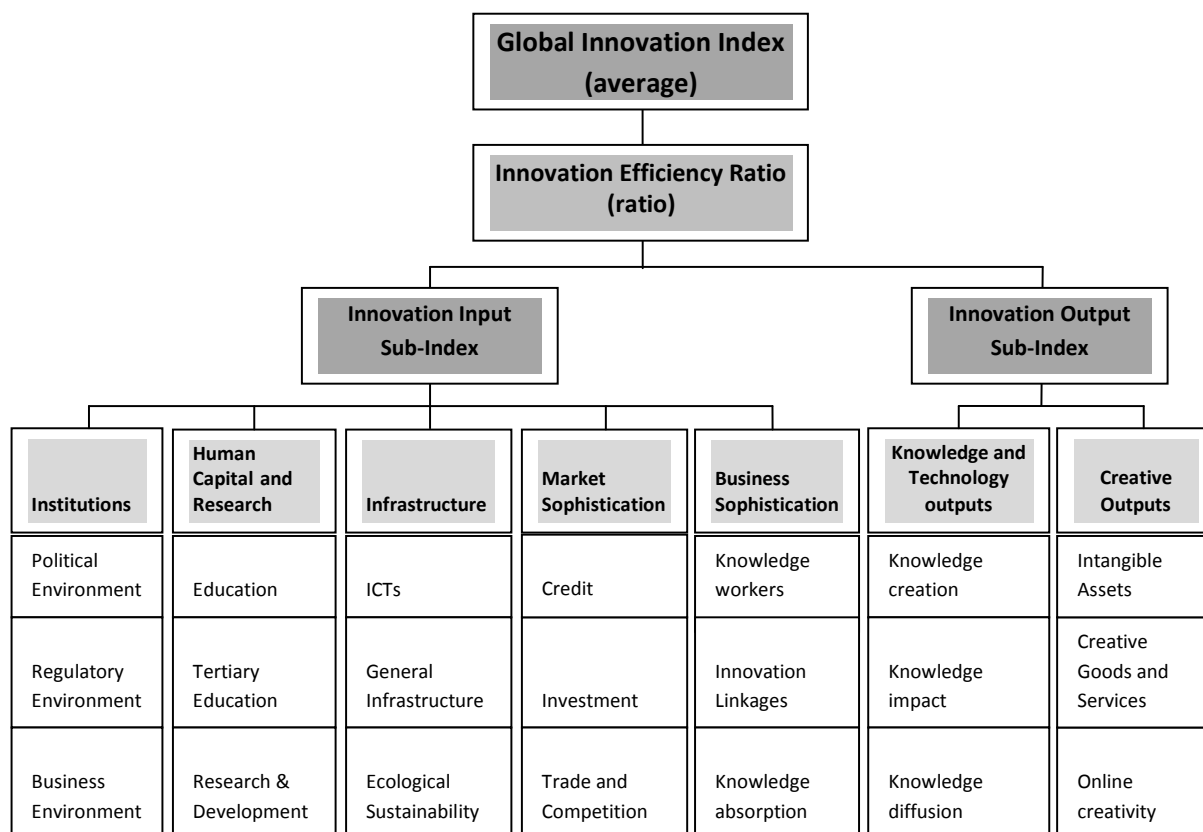
According to Crespi and Zuniga (2012), determinants of innovation are not the same for every country. They point out that the policy and business strategies designed towards an innovation should pay attention to the specific characteristics of national innovation systems and organisational innovative behaviour.

In general, a common believe is that some counties are more innovative and productive than others due to various reasons. Rather than listing them, it is useful to the less innovative and productive nations, if general and specific reasons, factors and determinants that underpin the innovation and productivity are meaningfully illustrated towards their innovative processes. Hence, this paper objectively explores the

determinants of innovation and productivity of the nations based on the existing literature. In this context, a comprehensive literature study has been conducted by employing a methodology of reviewing research papers, text books, and other related sources/materials with respect to '*innovation*', '*productivity*' and their determining '*factors*'. The rest of this paper is presented with: key factors of innovation and productivity, discussion and conclusion.

2. KEY FACTORS OF INNOVATION AND PRODUCTIVITY

As technology takes the leads for global development throughout the nations, the 'World Business' published an assessment report (2007) on how every nation was active in bringing innovations to the rest of the world. This report basically ranked 107 countries; and among them, the USA, Germany, UK, Japan, France, Switzerland, Singapore, Canada, Netherland and Hong Kong are the top 10 ranked countries in order for the innovation. According to the Global Innovation Index (GII, 2007), the innovation level of a nation will be determined by five key input factors; and their output level are determined with knowledge, competitiveness and wealth. Now, the conceptualized input and output framework was revised time to time, as per the changes in global environment.

Figure 1. Conceptual framework of the Global Innovation Index 2014


Source: Adapted from the Global Innovation Index 2014

Table 1. Overall rankings of Top Ten and some selected countries in innovation

Country	Overall Rankings						
	2014 (Score %)	2013	2012	2011	2009/2010	2008/2009	2007
Switzerland	1 (64.78)	1	1	1	4	7	6
UK	2 (62.37)	3	5	10	14	4	3
Sweden	3 (62.29)	2	2	2	2	3	12
Finland	4 (60.67)	6	4	5	6	13	13
Netherlands	5 (60.59)	4	6	9	8	10	9
USA	6 (60.09)	5	10	7	11	1	1
Singapore	7 (59.24)	8	3	3	7	5	7
Denmark	8 (57.52)	9	7	6	5	8	11
Luxembourg	9 (56.86)	12	11				16
Hong Kong	10 (56.82)	7	8	4	3	12	10
Ireland	11 (56.67)	10	9	13	19	21	21
Canada	12 (56.13)	11	12	8	12	11	8
Germany	13 (56.02)	15	15	12	16	2	2
Norway	14 (55.59)	16	14	18	10	14	25
South Korea	16 (55.27)	18	21	16	20	6	19
New Zealand	18 (54.52)	18	13	15	9	27	28
Iceland	19 (54.09)	13	18	11	1	20	20
Japan	21 (52.41)	22	25	20	13	9	4
France	22 (52.18)	20	24	22	22	19	5
India	76 (33.70)	66	64	62	56	41	23
Philippines	100 (29.87)	90	95	91	76	63	66
Sri Lanka	105 (28.98)	98	94	82	79	58	71
Bangladesh	129 (24.35)	130	112	97	120	111	98
Pakistan	134 (24.00)	137	133	105	103	93	73
Nepal	136 (23.79)	128	113	N/A	130	124	99
Total countries considered	143	142	141	125	132	130	107

Note: N/A = Not Available

Source: GII, 2007-2014

In the present context, the five key inputs of innovation are: (1) institutions, (2) human capital and research, (3) infrastructure, (4) market sophistication, and (5) business sophistication (see

Figure 1).¹ These five inputs are the pillars to represent the aspects that enhance the capacity of a nation to generate ideas and leverage them for innovative products and services. At present, this GII uses two output pillars to evaluate the benefits of successful innovation to the citizens and organisations of the country. They are: (1) knowledge and technology outputs, and (2) creative outputs (see Figure 1).² In general, these measures show an abstract view of determinants of innovation and productivity of a nation at the outset.

According to the report GII (2014), about 143 countries are ranked. Switzerland, UK, Sweden, Finland, Netherlands, USA, Singapore, Denmark, Luxembourg and Hong Kong and top ranked countries in order for 2014 innovations (see Table 1).

The literature on national innovation system emphasizes that the innovation capacity of nations depends on their institutions (Freeman and Soete, 1997; Waarden, 2001). Innovation efforts and initiatives in a value creation process tend to heavily depend on employees' human capital and behavior, the key inputs at work (Chen and Huang, 2009). Adequate results showing a positive relationships of research and development (R&D) to innovation and productivity are endorsed in newly industrialized countries such as South Korea (Lee and Kang, 2007), Malaysia (Hegde and Shapira, 2007), Taiwan (Aw et al., 2011), and China (Jefferson et al., 2006).

Ayyagari et al. (2007) investigate the determinants of firm innovation in over 19000 firms across 47 developing economics. They define the innovation process broadly in view of incorporating not only core innovation (e.g. new products and new technologies) but also other types of activities that promote knowledge transfers and adapt production processes. They find that more innovative firms are large exporting firms characterized by private ownership, highly educated managers with middle-level managerial experience, and accessing of external finance. Conversely, firms that innovate less are typically state owned firms without foreign competitors. Identity of the controlling (ownership) shareholder(s) seems to be important for core innovation, since it is evidence that the private firms with financial institution(s) as the controlling shareholder(s) are the least innovative. While external finance utilization is associated with greater innovation by the private firms, it does not make state owned firms more innovative. Financing from foreign banks is associated with higher level of innovation, compared to financing from domestic banks. These findings provide us a more comprehensive view on the factors affecting innovation and productivity of an organisation and a

nation. Indicatively for a country, the firm's size, ownership, business scope (exporting or not), education and experiences of managers, competition (local as well as foreign), stakeholder controls and capacity to access finance (internally or externally and from foreign or local banks) are the determinants of the level of innovation and productivity of the country.

By examining six Latin American countries such as Argentina, Chile, Colombi, Costa Rica, Panama and Uruguay, Crespi and Zuniga (2012) endorse an evidence for the relationships of innovation input (firm size, export, non-technological innovation, foreign ownership, patent protection, co-operation, public finance, importance of market sources of information, importance of scientific sources of information, importance of public sources of information and capital or investment per employee) to innovation output (technological innovation, expenditures on innovation activities per employee and productivity-sales per employee) and productivity.

According to Gorodnichenko and Schnitzer (2013), the difficulties and cost of accessing external finance adversely affect the domestically owned firms in their innovation activities. In contrast, foreign-owned firms exhibit much less sensitivity to financial constraints. They demonstrate clear evidence that financial limitations control the innovation ability of domestic ownership firms, thus putting them vulnerable to near the technological frontier. Benavente (2002) finds the relationship of innovative activities to firm's size and market power.

Crespi and Pianta (2008) explore that the innovation in firms and industries can be associated to two different strategies: either (a) searching for technological competitiveness (*through knowledge generation, product innovation and expansion of new markets*) or (b) aiming at greater cost competitiveness (*through job reductions, labour saving investment, flexibility and restructuring*). According to their findings, the technological and cost competitive strategies are also the determinants of the innovation and productivity.

Felsenstein (2013) examines the role of human capital and physical capital in determining regional productivity and innovation and reveals that human capital has large and relatively consistent effects on earnings and innovation at regional levels. This study also supports inverse relationship of human capital mobility to innovation. This is interpreted as reflecting the 'conduit' role of the region in the innovation process. The ratios of regional capital-to-labour have inverse relationship to innovation, thus highly supporting substitution role of physical capital for human capital rather than its complementing role for.

Generally, the leaderships or leaders (leadership styles) play key roles in innovation and creativity in organisations and nations (Nam and Tatum, 1997; Bossink, 2004; Montes et al., 2005; Arago'n-Correa et al., 2007). In a Pakistan based study, Ryan and Tipu (2013) indicate highly significant positive impact on innovation propensity, while passive-avoidant leadership has a positive weak, but significant, relationship to innovation propensity.

Many studies explore how the relationship of high compensation (salary or reward paid) in cities

¹ Initially, the five input pillars were for 2007: institutions and policies, human capacity, infrastructure, technological sophistication and business markets and capital; for 2008/2009, they were revised as: institutions and policies, human capacity, general and ICT (information and Communication Technology) infrastructure, market sophistication and business sophistication; for 2009/2010, they were termed as: institutions, human capacity, ICT and uptake of infrastructure, market sophistication and business sophistication; and for 2011 to 2014, they are institutions, human capital and research, infrastructure, market sophistication and business sophistication.

² Before 2010, the innovation outputs were measured in terms of knowledge, competitiveness and wealth. For 2010 and 2011, these outputs were revised as scientific outputs, and creative outputs (and well beings). From 2012 onwards, the innovation outputs are measured with knowledge and technology outputs, and creative outputs, as in the Global Innovation Index Report 2014.

and regions (nations) with high levels of human and physical capital contributes to the innovation and productivity of the cities and regions (Glaeser and Mare, 2001; Weber and Demazlicky, 2006; Echeverri-Carroll and Ayala, 2008; Lopez-Bazo and Motellon, 2012). Countries/regions with considerable knowledge centers/institutions march with innovations and further magnify with new innovators and productive people/workforce (Fielding, 1992).

Studies show the powerfulness of the human capital acquired from other specialized regions/nations for innovations, compared to the human capital bred locally (e.g., Simonen and McCann, 2010). Some studies demonstrate no adverse effect by mass immigrants on manufacturing productivity (e.g., Paserman, 2008), and employment opportunity and remuneration (e.g., Friedberg, 2001). Weerasinghe and Jayawardane (2013) describe how the formulation of innovation process seems complex, since the process needs to accommodate various related “*information, knowledge and feedback channels*” for innovation of ideas and solutions.

In Japan, the development of Japanese based management of stable labour relations, group formation, transfer of technology, contribution of industrial policy (industrial organisation, industrial structure and industrial location), individual entrepreneurial involvement (e.g. Toyota, Honda), binding into business, highly skilled and qualified workers and distinguishable, but unique, Japanese management practices are the major determinants of high productivity and innovation of the Japanese automobile industry (Shimokawa, 1982). Referring to Singapore experience and achievement, it is possible to argue that productivity based social movement intensity can improve the level of productivity consciousness in an organisation. Foo and Hall (1997) indicate this social movement as a force that has made the management to look for productivity based innovations. Lee and Part (2006) highlight the establishment of an ‘*innovation-friendly atmosphere*’ in the society as one of the key determinants of a nation’s innovation. Similarly, Panuwatwanich et al. (2008) indicate that ‘*climate for innovation*’ brings innovation-related outcomes. Efrat (2013) finds that most cultural aspects still have significantly lasting impacts on the tendency towards national level innovation. Efrat (2013) also indicates that though innovation based investment is a crucial force for innovation, the cultural aspects (specifically “*Individualism, Masculinity, and Uncertainty Avoidance*”) still significantly motivate innovation.

The above shows that various factors are influencing, determining and affecting innovation and productivity of a nation in different levels. They are at individual level, organisational level, society level and national level. All these levels are responsible for bringing a nation’s innovation and productivity.

3. DISCUSSION

In many cases, determinants of both the innovation and productivity are consistently the same. Doran and O’Leary (2011) demonstrate positive impacts of innovation performance on productivity and the productivity in turn influences innovation

performance. Further, the studies like Gu and Tang (2004) and Tang and Le (2007) show significantly positive statistical relationship of innovation to productivity.

Generally the literature shows five key factors that determine the level of innovation and productivity of a nation. At a glance, the mapping of five factors in the literature is given in Appendix 1. The five determinants are: (1) human resources and their characteristics, (2) natural and physical resources, and their characteristics, (3) systems and strategies, and their characteristics, (4) interactions and relationships among 1-3, and (5), changes in 1-4 over time.

Human resources and their characteristics are a crucial determinant of the innovation and productivity of a nation. It includes many aspects like stock of human capital, and its size, education and knowledge levels etc. The level and standard of education and research activities in a country are the major determinants of the nation’s innovation capacity (GIL, 2013). This includes social/a group’s norms, habits, conventions, and rules (Waarden, 2001). People and their qualities are the important sources of innovation and imply the importance of their innovative behaviours in the nation. Filippettia and Archibugia (2011) signify the role of qualified human resources in shaping the downswing effects of innovation in leading nations.

Natural and physical resources, and their characteristics are also a key determinant of innovation and productivity of a nation. A nation’s investments with limitation in innovation related resources (e.g. infrastructures, machinery, etc.) control the level of national innovation initiatives and outputs. Dutta, Reynoso and Bernard (GII, 2014) demonstrate the importance of R&D expenditure and how the R&D expenditure been affected by the recent economic setback. This crisis made global economies to control and significantly reduce the R&D expenditure in 2009. It took another 3 years for economies to replenish with reasonable R&D investment, but this seems a very good recovery from the crisis. For 2010 and 2011, the overall (public and business) growth of R&D was 3% and 4.5%, respectively. Notably, business R&D expenditure had increased by 0.6% and 4.8% respectively for 2010 and 2011 in the OECD (Organisation for Economic Co-operation and Development) countries. However, this again brought down to 3.6% increase in 2012. All these imply that nations show high concern over investing in resources, including human resource, to bring a sustainable innovation process for sustainable economic outputs and development.

Systems and Strategies, and their characteristics, as another key determinant of innovation and productivity of a nation, become a powerful tool in integrating first two determinants. Good systems, and appropriate national and international strategies and approaches of a country will increase productivity and innovation. For instances, when a national reward and compensation system (salary) of a country fails to attract knowledge work (labour) inflows and if the national promotion system and practices fail to recognize and promote well experienced and qualified people (due to various interferences and influences), the nation cannot retain high qualified and creative

people. To overcome this problem, just having only a policy by a nation is not sufficient, but it is the responsibility of respective government to ensure that the good governance takes place in every organisation with appropriate recognition and promotion of employees in it, consistently with the respective national policy. Similarly, when national education system seems not suitable to cater the industrial and national innovation needs, such education system needs to be redesigned to cater the needs of the nation, by exemplifying a model country for innovation. Hence, this paper argues that systems and strategies and their characteristics are one of key determinations of innovation and productivity of a nation, and their installation with good governance should take place in every organisation in a nation, even at the grass-root level. In most third world countries, like Sri Lanka, India, Pakistan, etc. (see the last 6 countries in Table 1), this is a crucial issue, where systems and strategies, and their characteristics have not been possibly handled and implemented by the respective governments with good governance in organizations.³

Apart from the above, *the interactions and relationships among the above determinants (1-3)* are a key dynamic determinant of national innovation and productivity. The empirical studies about this determinant are very rare in the literature. In practice, interactions and relationships among human resources and their characteristics, natural and physical resources and their characteristics, and system and strategy and their characteristics are very much complex, but important aspects in bringing innovation and productivity. Many countries really failed to understand these interactions and relationships among them. At the same time, it is difficult to endorse empirical studies that do fully examine the possible interplays among these three aspects in view of contributing to nations' innovative capacity.

However, Lakitan's (2013) study on establishing effective innovation system in Indonesia identifies the challenges at three levels: *core, ecosystem* and *anatomical* levels. At the core level, it was very hard to strengthen the "*communication and interaction between domestic technology developers and users*". Explicitly, efficient innovation system should drastically contribute to growth, development and welfare of an economy. Thus, at the ecosystem level, creating conducive environment for an efficient innovation system is vital, but complicated. The major challenges faced at this ecosystem level are: (a) harmonizing regulations and public policies that are favourable for developing innovation system, and (b) synchronizing prioritized programmes and activities of related institution. The role played and challenges faced by an element (including human resource) should be carefully studied to devise strategies for progressive innovation. At the anatomical level, the challenges become much complicated, since every person has identical differences with respect to his/her organs. Lakitan (2013) also indicate that every individual's behavioural and attitudinal aspect of commitment is inherently destined to be a prerequisite in establishing an innovation process.

The interactions and relationships among (a) human resources and their characteristics, (b) natural and physical resources and their characteristics, and (c) system and strategy and their characteristics ultimately influence the '*innovation value chain*' of a nation. According to Hansen and Birkinshaw (2007), innovation value chain is a process, where organizations initially input knowledge through innovation process (internally and externally), transform it into innovative outputs, and eventually use these outputs to add values for the organizations. However, innovation value chain inherently underlines the complexity of knowledge translation into business value, and the significance of investments, all resources and human skills in the value creation process. Over time, studies indicate that the innovation process involves interactive relationships among different actors, elements and factors and is a non-linearity as characterized by complicated feedback mechanisms (Edquist and Johnson, 1997; Samara et al., 2012, as in Kline and Rosenberg, 1986).

Finally, the *changes* in the above four aspects over time determine the level of innovation and productivity of a nation. It can be in short term or long term. At a certain level, the dissatisfaction of public and policy makers with the status quo of a country can lead to the changes in the above four aspects. The level of dissatisfaction varied, ranging from a nagging operational problem to a strategic threat to an impending crisis.

Tiongson (2005) indicates that education reforms have greater impacts on income, expenditure, employment and wage level of a nation. In this context, consider for instance that over a time, people of a nation may experience dissatisfaction with the existing education system due to the unemployment and underemployment of educated youth, and their subsequent uneconomical effects. This status quo of the nation regarding the education system and other related systems necessitates suitable education reforms and the changes in related (human and other) resources, systems and strategies. Nowadays, Sri Lanka is a good example for installing quality systems for bringing employable graduates. It makes lots of changes in its human and physical resources (e.g. intended formulation of five hubs for knowledge, naval and maritime, aviation, business/commerce, and energy and power).

4. CONCLUSION

This review considers: (1) human resources and their characteristics, (2) natural and physical resources and their characteristics, (3) systems and strategies and their characteristics, (4) interactions and relationships among above three aspects, and (5) changes in the above four aspects, and concludes them as contributors (positively or negatively) and determinants of the innovation and productivity of a nation. The conceptualization of these determinants spells existing gaps in the literature at various levels, because of the complexity in defining the relationships among the determinants identified. Hence, for instance, a study can primarily investigate how the characteristics of human resources in a nation determine its innovation and productivity; or how national reward management of a nation can

³ Note that the GII ranking for the last 6 countries in Table 1 have been adversely widened for the period 2007-2014.

affect innovation potential of the nation, in consideration of complexity of the relationship among the variables.

This paper critically and typically explores how the role of qualified human resources in shaping the innovation process and why the nations should have high concern over investing in human and other resources to bring a sustainable innovation process for sustainable economic outputs and development. This study also emphasizes that good systems, and appropriate national and international strategies and approaches of a country will increase productivity and innovation. This is somewhat a crucial issue in innovation, since systems and strategies, and their characteristics have not been appropriately handled and implemented by the respective governments with good governance in organizations. In practice, interactions and relationships among human resources and their characteristics, natural and physical resources and their characteristics, and systems and strategies and their characteristics are very much complex, but are important in bringing innovation and productivity. As it is difficult to endorse empirical studies that do fully examine the possible interplays among these three aspects in view of contributing to nations' innovative capacity, this paper provides an insight, as an implication, why these interplaying roles of such variables should be investigated. This is further endorsed with the proposition that the *changes* in the first four aspects over time determine the level of innovation and productivity of a nation.

A common believe is that understanding and adapting national innovation system of some leading innovative and productive nations can provide solutions to less innovative and productive nations. This is true to a certain extent. However, this review also observes dynamic changes in conceptualizing the innovation and productivity of a nation over time. This is applicable even in future.

Creating innovation and productivity as a process is a complex and dynamic. Therefore, this review suggests investigating how these five determinants influence each other and work together among them; and/or whether they work collaboratively or competitively. These studies can pave the ways for determining the actual level of innovation and productivity of a nation. This paper as a base contributes to that extent.

REFERENCES

1. Arago'n-Correa, J.A., Garc'a-Morales, V.J. and Cordo'n-Pozo, E. (2007). "Leadership and organizational learning's role on innovation and performance: lessons from Spain", *Industrial Marketing Management*, Vol. 36, No. 3, pp. 349-359.
2. Aw, B.Y., Roberts, M. and Xu, D. (2011). "R&D Investment, Exporting, and Productivity Dynamics." *American Economic Review*, Vol. 101, No. 4, pp. 1312-1344.
3. Bossink, B.A.G. (2004). "Effectiveness of innovation leadership styles: a manager's influence on ecological innovation in construction projects", *Construction Innovation*, Vol. 4, No. 4, pp. 211-228.
4. Ayyagari, M., Demircuc-kunt, A. and Maksimovic, V. (2007). *Firm Innovation in Emerging Markets*, World Bank Publications.
5. Benavente, J.M. (2002). "The Role of Research and Innovation in promoting productivity in Chile", *Economics of Innovation and New Technology*, Vol.15, No. 4-5, pp.301-315.
6. Chen, C. and Huang, J. (2009). "Strategic human resource practices and innovative performance: the mediating role of knowledge management capacity", *Journal of Business Research*, Vol. 62, No. 1, pp. 104-114.
7. Crespi, F. and Pianta, M. (2008). "Demand and innovation in productivity growth", *International Review of Applied Economics*, Vol. 22, No. 6, pp. 655-672.
8. Crespi, G. and Zuniga, P. (2012). "Innovation and Productivity: Evidence from Six Latin American Countries", *World Development*, Vol. 40, No. 2, pp. 273-290.
9. Doran, J. and O'Leary, E. (2011). "External Interaction, Innovation and Productivity: An Application of the Innovation Value Chain to Ireland", *Spatial Economic Analysis*, Vol.6, No. 2, pp.199-222.
10. Echeverri-Carroll, E. and Ayala, S.G. (2008). "Wage differentials and the spatial concentration of high technology industries", *Papers in Regional Science*, Vol. 88, No.3, pp. 623-641.
11. Edquist, C. and Johnson, B. (1997), "Institutions and organisations in systems of innovation", in Charles Edquist (ed.), *Systems of Innovation: Technologies, Institutions and Organisations*, London and Washington, DC: Pinter Publishers/Cassell Academic.
12. Felsenstein, D. (2013). "Factors Affecting Regional Productivity and Innovation in Israel: Some Empirical Evidence", *Regional Studies*, DOI: 10.1080/00343404.2013.837871.
13. Fielding, A. (1992). "Migration and social mobility: South East England as an escalator region", *Regional Studies*, Vol. 26, No. 1, pp. 1-15.
14. Filippettia, A. and Daniele Archibugia, D. (2011). "Innovation in times of crisis: National Systems of Innovation, structure, and demand", *Research Policy*, Vol. 40, pp. 179-192.
15. Foo, C. T. and Hall, K. (1997). "Productivity innovation as a social movement: the case of Singapore", *The International Journal of Human Resource Management*, Vol. 8, No. 5, pp. 720-742.
16. Friedberg, R. (2001). "The impact of mass immigration on the Israeli labor market", *Quarterly Journal of Economics*, Vol. 116, No.4, pp.1373-1408.
17. Freeman, C. and Soete, L. (1997). *The Economics of Industrial Innovation*, 3rd ed, Pinter, London.
18. Glaeser, E. L. and Mare, D.C. (2001). "Cities and skills", *Journal of Labor Economics*, Vol.19, pp. 316-342.
19. Global Innovation Index (GII) Reports (2007-2014). INSEAD (sources: <https://www.globalinnovationindex.org/userfiles/file/GII-2007-Report.pdf>, <https://www.globalinnovationindex.org/userfiles/file/GII-2008-2009-Report.pdf>, <https://www.globalinnovationindex.org/userfiles/file/GII-2009-2010-Report.pdf>, <https://www.globalinnovationindex.org/userfiles/file/GII-2011-Report.pdf>, <https://www.globalinnovationindex.org/userfiles/file/GII-2012-Report.pdf>, <https://www.globalinnovationindex.org/userfiles/file/reportpdf/GII-2013.pdf>, <https://www.globalinnovationindex.org/content.aspx?page=gii-full-report-2014>).
20. Gorodnichenko, Y. and Schnitzer, M. (2013). "Financial Constraints and Innovation: Why Poor

- Countries Don't Catch Up", *Journal of the European Economic Association*, Vol.11, No.15, pp.1115-1152.
21. Gray, C. and Mabey, C. (2005). "Management Development Key Differences between Small and Large Businesses in Europe", *International Small Business Journal*, Vol. 23, No.5, pp. 467- 485.
 22. Gu, W. and Tang, J. (2004). "Link between innovation and productivity in Canadian manufacturing industries", *Economics of Innovation and New Technology*, Vol.13, No.7, pp. 671-686.
 23. Hansen, M.T. and Birkinshaw, J. (2007). "The innovation value chain", *Harvard Business Review*, Vol. 85, No. 6, pp. 121-130.
 24. Hegde, D. and Shapira, P. (2007). "Knowledge, technology trajectories, and innovation in a developing country context: Evidence from a survey of Malaysian firms", *International Journal of Technology Management*, Vol. 40, No.4, pp. 349-370.
 25. Jefferson, G.H. Huamao, B. Xiaojing, G. and Xiaoyun, Y. (2006). "R&D performance in Chinese industry", *Economics of Innovation and New Technologies*, Vol. 15, No. 4-5, pp. 345-366.
 26. Kline, S. Rosenberg, N. (1986). "An overview of innovation". In: Landau, R., Rosenberg, N. (Eds.), *National Systems of Innovation*, Oxford University Press.
 27. Efrat, K. (2014). "The direct and indirect impact of culture on innovation", *Technovation*, Vol. 34, pp. 12-20.
 28. Lakitan, B. (2013). "Connecting all the dots: Identifying the "actor level" challenges in establishing effective innovation system in Indonesia", *Technology in Society*, Vol. 35, pp. 41-54.
 29. Lee, K. and Kang, S.M. (2007). "Innovation types and productivity growth: Evidence from Korean manufacturing firms", *Global Economic Review*, Vol. 36, No.4, pp. 343-359.
 30. Lee, J.D. and Part, C. (2006). "Research and development linkages in a national innovation system: Factors affecting success and failure in Korea", *Technovation*, Vol. 26, pp. 1045-1054.
 31. Lopez-Bazo, E. and Motellon, E. (2012). "Human capital and regional wage gaps", *Regional Studies*, Vol. 46, No.10, pp. 1347-1365.
 32. Montes, F.J.L., Moreno, A.R. and Morales, V.G. (2005). "Influence of support leadership and teamwork cohesion on organizational learning, innovation and performance: an empirical examination", *Technovation*, Vol. 25, No. 10, pp. 1159-1172.
 33. Nam, C.H. and Tatum, C.B. (1997). "Leaders and champions for construction innovation", *Construction Management and Economics*, Vol. 15, No. 3, pp. 259-270.
 34. Panuwatwanich, K., Stewart, R.A. and Mohamed, S. (2008). "The role of climate for innovation in enhancing business performance, The case of design firms", *Engineering, Construction and Architectural Management*, Vol. 15, No. 5, pp. 407-422.
 35. Paserman, D.M. (2008). "Do High-Skill Immigrants Raise Productivity? Evidence from Israeli Manufacturing Firms, 1990-1999". IZA Discussion Paper Number. 3572, Institute for the Study of Labor (IZA), Bonn.
 36. Ryan, J.C. and Tipu, S.A.A. (2012). "Leadership effects on innovation propensity: A two-factor full range leadership model", *Journal of Business Research*, Vol. 66, pp. 2116-2129.
 37. Samara, E., Georgiadis, P. and Ioannis Bakouros, I. (2012). "The impact of innovation policies on the performance of national innovation systems: a system dynamics analysis", *Technovation*, Vol. 32, pp. 624-638.
 38. Simonen, J. and McCann, P. (2010). "Knowledge transfers and innovation: the role of labor markets and R&D co-operation between agents and institutions", *Papers in Regional Science*, Vol. 89, No.2, pp. 295-309.
 39. Shimokawa, K. (1982). "Entrepreneurship and social environment change in the Japanese automobile industry: On the key elements of high productivity and innovation", *Social Science Information*, Vol. 21, pp. 273-300.
 40. Tang, J. and Le, C.D. (2007). "Multidimensional Innovation and Productivity", *Economics of Innovation and New Technology*, Vol. 16, No. 7, pp. 501-516.
 41. Tiongson, E.R. (2005). "Education Policy Reforms," in S. Paternostro and A. Coudouel, eds., *Analyzing the distributional impact of reforms* (Washington: World Bank, 2005).
 42. Waarden, F.V. (2001). "Institutions and Innovation: The Legal Environment of Innovating Firms", *Organization Studies*, Vol. 22, No.5, pp. 765-795.
 43. Weber, W.L. and Domazlicky, B.R. (2006). "Capital deepening and manufacturing's contribution to regional economic convergence", *Journal of Regional Analysis and Policy*, Vol. 36, No.1, pp. 31-44.
 44. Weerasinghe, R.N. and Jayawardane, A.K.W. (2013). *Innovation Versus Imitation: The Applicability of Reproducing Established Categories Ethically*, *Proceedings of the 10th International Conference on Business Management*, Faculty of Management Studies and Commerce, University of Sri Jayewardenepura, Sri Lanka, pp. 94-118.

Appendix 1. Summary of the literature and mapping of five factors

Authors	<i>Determinants: 1) Human resources and their characteristics; 2) Natural and physical resources, and their characteristics; 3) System and Strategies, and their characteristics; 4) Interactions and relationships among 1-3; 5) Changes in 1-4 over time</i>	1	2	3	4	5
Global Innovation Index (2007)	Institutions and polices			x		
	Human capacity	x				
	Infrastructure		x			
	Technological sophistication		x	x		
	Business markets and capital		x	x		
Lee and Part (2006); Panuwatwanich et al. (2008)	Innovation-friendly atmosphere/ climate for innovation	x		x		
Freeman and Soete (1997); Waarden (2001)	Institutions			x		
Benavente (2002)	Firm size			x		
	Market power			x		
Chen and Huang (2009)	Human capital	x				
	Behaviour at work	x				
Jefferson et al. (2006); Lee and Kang (2007); Hegde and Shapira (2007); Aw et al. (2011)	Research and development (R&D)			x		
Glaeser and Mare (2001); Weber and Demazlicky (2006); Echeverri-Carroll and Ayala (2008); Lopez-Bazo and Motellon (2012)	Reward & compensation system of cities & regions (nations)			x		
	Higher levels of human capital	x				
	Higher levels physical capital		x			
Felsenstein (2013)	Human capital mobility					x
	Human capital stock	x				
Shimokawa (1982)	Labour Management Relations	x		x		
	Groupism	x				
	Technological transfer			x		
	Industrial policy			x		
	Individual entrepreneurship	x				
	Business tie-ups			x		
	Well qualified workers	x				
	Japanese management types	x		x		
Fielding, (1992)	Concentration of knowledge centers & institutions	x	x	x		
Simonen and McCann (2010)	Mobile human capital					x
Efrat (2014)	National Culture	x				
Ayyagari et al. (2007)	Firm Size			x		
	Exporting Firms			x		
	Ownership of Firm			x		
	Education level of Managers	x				
	Education Level of employees	x				
	Experience	x				
	Access to external finance			x		
	Foreign competition			x		
	Controlling shareholders	x		x		
	Financing from foreign/domestic sources	x	x	x		
	Crespi and Zuniga (2012)	Firm size			x	
Export				x		
Non-technological innovation		x		x		
Foreign ownership				x		
Patent protection				x		
Co-operation		x		x		
Public finance				x		
Importance of market sources of information				x		
Importance of scientific sources of information				x		
Importance of public sources of information				x		
Capital or investment per employee	x		x			
Weerasinghe and Jayawardane (2013)	Diverse information			x		
	Diverse knowledge	x				
	Feedback channels			x		
Gorodnichenko and Schnitzer (2013)	Ownership of Firms (Domestically Vs foreign)			x		
	Financial constraints			x		
Crespi and Pianta (2008)	Technological competitiveness	x	x	x		
	Cost competitiveness	x	x	x		
Nam and Tatum (1997); Bossink (2004); Montes et al. (2005); Arago ´n-Correa et al. (2007); Ryan and Tipu (2013)	Leadership/Leaders/Leadership styles	x				