**Inter Industry Linkages and the Clustering Of Innovative Activities: Framework for Indian**

**Economy and National Innovation Policy**

Manoj .K. Singh

Gokhale Institute of Politics & Economics,Pune,India

**Abstract**

*The relationship between economic linkages and innovative linkages is examined and a theoretical framework based on various innovative surveys in France, Italy, Canada, China and Greece to determine the clustering of innovative interactions in Indian economy is recommended by using innovation interactions matrices and input output analysis*.

1. **Introduction**

My focus of analysis in this chapter is to develop a theoretical construct to facilitate an empirical analysis vis-a-vis inter-industrial linkages and the innovative activity particularly in Indian Economy by using Input out analysis and Innovation interaction metrices. It draws mainly from the work by Christain De Bresson who in his various surveys along with a team of innovation researchers tried to answer as to “how Innovation emerges from normal economic activity?” His research endeavours tried to confront the following hypothesis by reconciling inter industrial analysis with the study of innovative activities:

1. *Innovations cluster in part of the economic space (Schumpeter,1937)*
2. *Varied linkages in everyday economic life tend to favour innovative linkages and clusters(Aitken 1985)*
3. *Innovative clusters and linkages may contribute to increase the division of labour(smithian hypothesis*)

In my research endeavour, I aim to confront Schumpeter’s hypothesis and DeBresson final outcome, i.e. ***“Innovative activities are more concentrated than economic activities and that they cluster in industries that have a variety of economic and technological linkages.”(DeBresson 1995).*** The objective is to examine whether innovative activity happens to be a function of or depends on the prior economic interdependence as manifested by input output analysis and to understand the impact of Indian economic environment on the innovative activities and vice versa.

The framework can be used to demonstrate & identify whether & how industrial linkages impact clustering of innovative activities. This will also help us locate the innovative clusters, map the structure of innovative interactions in Indian Economy and establish patterns in clustering and innovative activity. The findings can be very useful for policy decisions and prescriptions to have the structural insight and develop the required Institutional support to promote learning and innovation.

**Section 2** will present ***an overview of the innovative clusters & the reasons for clustering of innovative activies***. Some of the ***surveys exploring the economic linkages and innovative activity*** will be introduced in **section 3.Section 4** deals in ***my research endeavour and the findings vis-a-vis the industrial and innovative interdependencies in Indian Economy***. Finally the **last section** talks about **the policy implications**.

Innovation here refers to the innovative activities and not the proven innovations per se as it would be known only after the adoption and diffusion whether the innovation is incremental or radical. ***Clustering of Innovative activities refers to the clusters that emerge out of various important interactions between the users and producers.***

**INDUSTRIAL LINKAGES, INNOVATIVE LINKAGES**

INDUSTRY LINKAGES, INNOVATIVE LINKAGES

**I/O TABLE**

**INDUSTRY**

**INDUSTRY**

**ECONOMIC**

**INTERDEPEDENCE**

**INNOVATION**

**INTERACTION**

**METRICES**

**USERS**

**PRODUCE**RS

**LINKAGES**

**INNOVATION**

**DOMESTIC**

**REQUIREMENTS**

**METRICES**

**INDUSTRY**

**LINKAGES**

**INNOVATIVE LINKAGES**

Source: Author

1. **Innovative clusters**

*“whenever a new production function has been set up successfully and the trade beholds the new thing done and its major problems solved ,it becomes much easier to improve upon it…Innovations are not evenly distributed over the whole economic system at random, but tend to concentrate in certain sectors and their surroundings.”(Schumpeter, 1939; 100-1)*

This section adds to the understanding as to why the innovations cluster in part of the economic space and how the various interactions between the users and producers direct such clustering. Various studies have emphasised on the interaction between the different agents involved in the Innovation process (Morgan, 1997; Lagendijk and Charles, 1999) and suggested the involvement of more than one firm or the economic agents in Innovation. Firms almost never innovate in isolation (DeBresson, 1996)

**2.1. Innovative clusters: an overview**

“*One of the most important achievements of contemporary economies and societies is the constant creation of new knowledge. Yet economic theory is still focusing on the problems central to a past epoch: universal scarcity. Economic analysis is still largely focused on the management of scarce resources, what the economists have termed the optimal allocation of factors. Yet the process which characterises today’s economy is the creation of new factors.*” (DeBresson, 1996)

It is this shift in the focus of analysis that has made the study of innovative activities central and so much important to modern economics. The “creation of new factors” or “new combinations” happens due to the interactions between the different economic agents, e.g. the firms, universities, Research and development labs and private and public institutions. Though Schumpeter did mention that the “changes in economic life are not forced upon it from without but arise by its own initiative from within.” (Ibid, P.63), Research efforts focused on National Innovation Systems, cluster analysis, clusters dynamics and cluster-based policy have gained global attention only since 1980s primarily due to the emergence of endogenous theories (Romer 1983, 1986).Economists’ curiosity worldwide grew up to study and analyze the knowledge flows in national innovation systemsand how the different economic agents interact to create “new knowledge”.

The clustering of innovative activities has been a topic of interest to many of the celebrated economists. Marshall (1890) in his Principles of Economics talked about the “industrial districts “and how the interactions between people, suppliers and the skilled labor pool could benefit the localized industries.” Schumpeter (1912, 1928, 1935, 1939) talked about the bandwagon effect leading to the spatial clustering because of the imitators following the already proven innovations and the temporary monopolistic rents, i.e. entrepreneurial profit. The sectoral mega-clusters have been discussed by Porter "Nations, whatever their overall level of innovative performance, do not usually succeed across the whole range of industries, but “in clusters of industries connected through vertical and horizontal relationships” (Porter, 1990).

The Chains and Network based Cluster approach (The *Filiere* approach by Montfort,1983;Montfort & Dutaille 1983, Roelandt 1986; Witteveen,1997) demonstrated the relationship within and between the networks & how the clusters emerge out of the various agents interactions & the cooperative networks .

Many of the observations worldwide suggest the increasing importance of innovative activities & the emergence of new technologies that seem to have supported the view point of the modern endogenous growth theories. The structural change due to the digital revolution in the US is one such example. The economy has witnessed the significant growth of some of the new innovating firms. Almost 40% of the top 200 R&D-performing firms in2005/2006 were founded after 1980, while 32% of the top 200 R&D-performing firms in1980 had exited by 2005 (Hall and Mairesse, 2009). The growing contribution by the ICT to the GDP in Indian economy is another example. This may exceed the contribution made by the agriculture industry by 2020 bringing about a significant industrial change. The *microeconomics of creation and destruction today is quite visible.*

Well did Schumpeter observe:

“*The first thing to go is the traditional conception of the modus operandi of competition. Economists are at long last emerging from the state in which price competition was all they saw. As soon as quality competition and sales effort are admitted into the sacred precincts of theory, the price variable is ousted from its dominant position. However, it is still competition within a rigid pattern of invariant conditions, methods of production and forms of industrial organization in particular … that practically monopolizes attention. But in capitalist reality as distinguished from its textbook picture, it is not that kind of competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives”* **Schumpeter, 1939**

It is in these contexts that the study of economic linkages and how they influence innovative linkages become relevant and really important. Where and why in Indian economy the innovative activities are likely to occur? Do they occur in the industries having the greatest variety of economic, technological and scientific linkages? What is the strength of these linkages? Do economic linkages matter? What are the limiting factors? Can we estimate the direct and indirect impact of innovative activities? These are the questions that we need to answer with reference to Indian Economy as they have direct really important and relevant policy implications.

**2.2. The clusters analyses**

The clusters have been analyzed at micro level, meso level and macro level. Micro level refers to clusters of firms whereas meso and macro level refer to clusters of sectors /industries. The “relation between the entities in a cluster may refer to innovative efforts or to production linkages.”(Alex Hoen) (Appendix 1; Table A1.1 & Table A1.2)

There have been various techniques used for clusters analyses. (See Table A1.3.)

• *Input-output analysis.* Used for inter-industrial linkages (Hauknes, 1999; Roelandt et al, 1999; Bergman et al., 1999) and the interdependences among the innovative activities (DeBresson et al)

• *Graph analysis.* Useful to identify the shapes and patterns of the linkages between firms or industry groups (DeBresson and Hu, 1999)

• *Correspondence analysis* (such as factor analysis, principal component analysis, multidimensional Scaling and canonical correlation ):Used for similarity-based cluster analysis (Vock, 1997; Arvantis and Hollenstein, 1997; Spielkamp and Vopel, 1999).

• The *qualitative case study* approach as exemplified by the Porter country studies (Rouvinen et al, 1999; Drejer et al, 1999; Stenberg et al, 1997, Roelandt et al, 1999)

**2.3. Why would innovations cluster in economic space?**

Various theories exist exploring as to how the economic environment affects the direction of innovation & why do innovative activities cluster?

One of the observations is that the sectors with relatively higher rate of growth of demand will witness more of innovative activities as the investors are likely to invest more into the sectors that appear more promising. (Schmookler, 1966)

Another reason for clustering is the relative differences in factor endowments and allocation that can also induce a bias towards techniques that avoid the use of scarce and expensive ones but use intensely the abundant & inexpensive ones.

DeBresson tried to answer this by building a stochastic model for locating Innovative activities. He began with his hypothesis that innovative activity is a function of prior economic linkages, or

I=f (L) +r 2.3.1

r being the residual.

To enable estimation, he writes

I=a+bL+r 2.3.2

Where a is the intercept and b the coefficient relating the linkage index L (the simple index of the combined first order forward and backward linkages) to the level of innovative activity I.

Model estimations at different spatial levels had the following conclusions:

* In most of the cases except Greece, the relationship of innovative activity and domestic linkages seem to hold. Domestic economic linkages and innovative activity were found to be related in case of Italy, France and China.
* Import linkages (including only imports of goods & equipment and NOT import of new technology) do not matter as much as foreign technological linkages do. It was observed that import linkages affect innovation propensity less than domestic linkages.
* Varied economic linkages are a necessary but not sufficient condition for innovative linkages. The variety of economic contacts and information may be a limiting factor, but not the only one. Beyond a certain threshold of linkages, other limiting factors may come into play.(DeBresson, 1996)

Various other studies suggest that the networks and industrial interdependences emerge due to the *trade linkages* (Hauknes, 1999; Roelandt *et al.*, 1999; Bergman and Feser, 1999), *innovation linkages* (DeBresson and Hu, 1999), *knowledge flow linkages* (Viori, 1995; Poti, 1997; Roelandt *et al*., 1999; van den Hove and Roelandt, 1997) and *commonality of knowledge base or factor conditions* (Drejer et al., 1999). Networks of innovation are the rule rather than the exception, and most innovative activity involves multiple actors (OECD, 1999).

*“Innovation is not usually a single-firm activity; it increasingly requires an active search process in order to tap new sources of knowledge and technology and apply these in products and production processes. Systems of innovation approaches give shape to the idea that companies in their quest for competitiveness are becoming more dependent upon complementary knowledge in firms and institutions other than their own. The cluster approach focuses on the linkages and interdependencies among networked actors in the production of goods and services and in innovation. In so doing, the cluster approach offers an alternative to the traditional sectoral approach.”(OECD, 1999)*

This interdependence has its manifestation in clustering of innovative activities in part of the economic space. Schumpeter also observed that the proven innovation will encourage more imitations leading to a bandwagon effect due to the reduction of uncertainty & the expectation of the entrepreneurial profits.

*Some of the other reasons include the following:*

* *The conditional probability of adoption of complementary innovations is greater than that of adopting of substitutes. (Debresson)*
* *There exists lesser possibility that one will switch to a new technique (even if the technique is superior) (Cowan 1990)*
* *The transferability of the learning competencies (the firm can leverage on the existing knowledge base given the possibility of the transferability)*

**3. Some surveys of Innovative activity**

The innovation researchers in various parts of the world have carried out surveys of innovative activity (Appendix 3:TableA3.1).The surveys by DeBresson et al for Italy, France, China, Canada and Greece exploring the interdependencies between the innovative activities and the economy were based on compilation of innovative- interactions matrices and their comparison with respective country’s standard Input output tables to find out the location of innovative activity within the Economy. The common features that allowed the compilation of Innovative-interactions matrices and the subsequent IO analyses were as follows:

* The industries supplying and using innovative outputs can be identified or estimated.
* Suppliers include mostly the manufacturing industries.(the Italian and French Surveys being the population surveys cover all the manufacturing industries whereas The Canadian Survey covers the most economically representative industries)
* All user sectors are considered..

The manufacturing industries covered in these surveys have been shown in Appendix 2: Table 2.1.The last column shows my ongoing survey for Indian economy.

Based on the characteristics as mentioned above, the ***innovative- interactions matrices*** were compiled. The rows show the supplier industries of the Innovating business unit whereas the columns display the user industries. These matrices were then compared with the respective country’s standard I/O tables in order to identify the location of innovative activity within the national economy.

1. **Mapping innovative interactions in Indian Economy**

In an attempt to identify the economic locus of innovative activity in Indian economy, I aim to survey the industries as mentioned in table A2.1. and A2.2. This will also help us examine the structure of innovative interactions and decide on the institutional support system.

**4.1. The Survey**

**4.1.1. Unit of analysis**

Most of the surveys (France, Italy, China, and Greece) have considered the business units for analysis .The Canadian Survey included business units as well as the innovative outputs. I have used the hybrid approach as used for Canadian survey. For each innovative output, upstream and downstream interacting partners are identified.

**4.1.2. The Indian Economy**

Our assumption here is that both the manufacturing and service industries are the suppliers of innovative outputs. The earlier surveys are representative of the manufacturing industries and assume only the manufacturing industries to be the suppliers of innovative outputs. However given the increasing economic importance of the service industries, we need to include them. The representativeness of Indian economy is shown in the Table A2.1.

**4.1.3. The IO structure**

The Input-Output tables published by central statistical organisation will be used. We begin with the study of the sectors/industries as shown in tableA4.1. The Table A4.2 shows the aggregate IO number and the description of the sector that the survey has covered. In order to analyse domestically most integrated industries from the sample ,We will need to estimate the domestic square requirement matrix at a fairly disaggregate level and subsequently the matrix will be triangularizerd in order to find the industries with the most backward or forward linkages.

**4.1.4. The businesses size.**

The survey consists of business units of different sizes.

**4.1.5.** The survey definition for the innovative activity is the introduction of a new product or a new process.

**4.2. The methods and instruments**

The survey methods include interviews with the top executives of the business units and the innovations- questionnaire. The secondary sources include the trade journals, reports of the trade and/or industry associations, Research and development laboratories, patents datas among others. The industrial experts from different industries are also asked to identify the innovations in their sectors of competence. Based on their response, the further validations have been done with the supplying industries and the user industries of the innovative activities. For each innovative output, the upstream and downstream interactions are identified so that mapping of innovative interactions as much as possible becomes feasible.

The purpose of the survey is to compile a fairly disaggregated innovative interaction matrix that would be comparable to the Indian Input output tables.

**4.2.1 Mapping innovative activity in the Indian economy with innovative interaction matrices**

The innovation interaction matrix has been complied after identifying the innovations in Indian economy .The frequency in the cell manifests the various interactions between suppliers and the users for the innovative outputs.

**4.2.2. The Findings**

The findings from the survey have been shown below (Table 1A).The innovative activities mainly happen in ICT (IT, Electronics and telecom industry).Though the innovative activities happen in Healthcare, Pharmaceuticals, Biotech, Finished steel,Cement,electrical and energy industry, there exists good scope to promote learning and innovation in these industries.

**Table 1A Innovative interactions in Indian Economy**

|  |  |  |
| --- | --- | --- |
| **INDUSTRIES** | **INNOVATIVE INTERACTIONS** | **PERCENTAGE** |
| **IT** | 233 | 21.91% |
| **Electronics** | 124 | 11.66% |
| **Telecom** | 101 | 9.50% |
| **Healthcare** | 91 | 8.56% |
| **Pharmaceuticals** | 87 | 8.18% |
| **Biotech** | 54 | 5.07% |
| **Finished Steel** | 51 | 4.79% |
| **Electricals** | 50 | 4.70% |
| **Energy** | 48 | 4.51% |
| **Cement** | 46 | 4.32% |
| **Passenger Vehicles** | 27 | 2.53% |
| **Two Wheelers** | 27 | 2.53% |
| **Commercial vehicles** | 24 | 2.25% |
| **Processed food** | 21 | 1.97% |
| **Dairy** | 19 | 1.78% |
| **fertilisers** | 13 | 1.22% |
| **Electricity** | 11 | 1.03% |
| **Beverages** | 11 | 1.03% |
| **Three wheelers** | 08 | 0.75% |
| **Packaged Drinking water** | 08 | 0.75% |
| **Coal** | 05 | 0.47% |
| **Crude Oil** | 04 | 0.37% |
| **Total** | 1063 | 100% |

**4.2.3 The structure of Innovative interactions in Indian Economy**

In the survey, we found the main suppliers and users of the innovative activities as shown in the following Tables (1B & 1C). The ICT and to some extent the cement industry happen to be the major sources of innovative activities. The policy interventions and decisions have to support the innovation building strategies by promoting cluster dynamics and directing inter industrial knowledge flows for the enhancement of establishing cooperative networks & production linkages in industries like cement,steel,healthcare,biotech and also the producer goods industries ,particularly the fixed capital goods, as we see in industrially developed economies.

**Table 1B The main suppliers of innovative output in India**

|  |  |  |  |
| --- | --- | --- | --- |
| **Industries** | **frequency** | **percentage** | **Number of users** |
| IT | 38 | 5.62 | 21 |
| Electronics | 29 | 4.28 | 18 |
| Telecom | 19 | 2.81 | 18 |
| Cement | 17 | 2.51 | 14 |
| Steel | 09 | 1.33 | 13 |
| healthcare | 08 | 1.18 | 08 |
| Biotech | 08 | 1.18 | 08 |
| Automobile | 07 | 1.03 | 07 |
| Sub-total | 135 | 19.94 |  |
| Total | 676 | 100.00 |  |

**Table 1C The main users of innovative output in India**

|  |  |  |  |
| --- | --- | --- | --- |
| **Industries** | **frequency** | **percentage** | **Number of suppliers** |
| Automobile | 27 | 3.99 | 11 |
| Cement | 24 | 3.55 | 09 |
| Steel | 21 | 3.10 | 08 |
| Healthcare | 20 | 2.95 | 08 |
| Pharmaceuticals | 18 | 2.66 | 07 |
| Biotech | 16 | 2.36 | 06 |
| Energy | 11 | 1.62 | 06 |
| Telecom | 11 | 1.62 |  |
| Sub-total | 151 | 21.85 |  |
| Total | 676 | 100.00 |  |

**4.2.2. Comparing the innovative matrix with I/O matrices**

Comparing the innovative matrix with I/O matrices enables the policy analyst to answer the questions as to where in the economy are the innovations likely to occur. Do Economic linkages impact innovative linkages or learning? What is the shape and pattern of clustering? As my survey is still ongoing (though nearing completion), the next exercise will be to compare the Innovative matrix with I/O matrices and try answering these questions.

**5. The policy implications**

India faces an innovation challenge. The Global Innovation Index reports conclude that India needs to improve the innovation performance to enhance its global economic competitiveness and bridge the innovation gap when compared to the innovating developed economies. The research efforts related to the *innovation ecology, the structure of innovative interactions, industrial interdependencies and the Government policies can help us plan and develop the cluster based policies to supplement the National Innovation Policy.*Such research efforts and the outcomes will be able to help us

* Understand the structural analysis and build the institutional support mechanism for fostering learning and innovation,
* Stimulate interactions and knowledge exchange between the various actors in systems of innovation,
* Plan for the cluster initiatives and the cluster improvement policies,
* Strengthen the economic dynamism of existing clusters and to improving the opportunities for new clusters to emerge,
* Build unique profiles of specialized capabilities to strengthen the relative competitiveness in the global economy,

**APPENDIX 1**

|  |  |  |
| --- | --- | --- |
| **TABLE A1.1** | Innovative efforts | Production linkages |
| Micro | Diffusion of technologies and knowledge between firms, research institutions ,etc. | Suppliers and buyers in a value added or production chain of firms |
| Meso | Diffusion of technology and Knowledge between sectors | Backward and forward linkages between sectors; partial analyses |
| Macro | A split up of the economic system in sectors that diffuse knowledge or technologies | A split up of the economic system in sectors that form value added or production chains. |

SOURCE: ALEX HOEN

**TABLE A1.2**

|  |  |  |
| --- | --- | --- |
| Level of analysis | Cluster concept | Focus of analysis |
| National level  (macro) | Industry group linkages in the economy as a whole | Specialisation patterns of a  national/regional economy  Need for innovation and upgrading of products and processes in mega-clusters |
| Branch or industry  level (meso) | Inter- and intra-industry linkages  in the different stages  of the production chain of  similar end product(s) | SWOT and benchmark analysis of  industries  Exploring innovation needs |
| Firm level (micro) | Specialised suppliers around  one or more core enterprises  (inter-firm linkages) | Strategic business development  Chain analysis and chain management  Development of collaborative innovation  projects |

Source: Boosting innovation: the cluster approach, OECD proceedings, 1999

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE A1.3** | | | | | | | | | |
| **Country** | **Level of analysis** | | | **Cluster**  **technique** | | | | | **Cluster**  **concept** |
|  | **micro** | **meso** | **macro** | **I/O** | **Graph** | **Corres** | **Case** | **Other** |  |
| AUS |  | x | x | X |  | x | x |  | Networks of production, network of innovation |
| AUT |  | x | x |  |  |  |  | Patent data & trade performance | Marshallian industrial districts |
| BEL | x |  |  |  | x |  |  | Sciento- metrics | Networks or chains of production, innovation & cooperation |
| CAN |  | x | x | X |  |  | x |  | Systems of innovation |
| DK | x | x |  | X | x |  | x |  | Resource areas |
| FNL | x | x |  |  |  |  | X |  | Clusters as unique combinations of firms tied together by knowledge |
| GER | x | x |  | X |  | x |  |  | Similar firms & innovation styles |
| IT |  | x |  | X |  |  |  |  | Inter-industry knowledge flow |
| MEX |  | x | x |  |  |  | x |  | Systems of innovation |
| NL |  | x | x | X |  |  | x |  | Value chains & networks of production |
| SP |  | x |  | X |  |  | x |  | Systems of innovation |
| SWE |  | x |  |  |  |  | x |  | Systems of interdependent firms in different industries |
| SWI | x | x |  |  |  | x | x | Patent data | Networks of innovation |
| UK | x | x |  |  |  |  | X |  | Regional systems of innovation |
| USA |  | x |  | X |  |  | X |  | Chains & networks of production |
| Source:DeBresson 1995 | | | | | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sector | Italy | France | China | Canada | Greece | India\* |
| extraction | petroleum | none | all | Gold  Uranium, Iron ore  Non ferrous  Coal, Petroleum  Asbestos  gas | agriculture | agriculture |
| First transformation:  materials | all | all | all | Petroleum refining  Cotton yarn  Wool yarn  Man-made fiber  Sawmills  Iron steel  Smelting & refining  Aluminum  Plastics  Industrial chemicals  Other chemicals  Pulp and paper | Construction materials  Plastics  Chemicals  paper | Construction materials  plastics |
| Intermediate goods | All | All | All | Rubber  Plastics  Automotive  Fabrics  Knitting  Paper products  Wood products  Foundries  Metal stamping  Wire&cable  Non metal  Minerals  Soap |  | Automotive  Plastics |
| Machines, equipment,  capital goods | All | All | All | Automobiles  Trucks  Aircraft  Railroad  Ships & Boats  Electrical Appliances  Electric Industry  Radio& TV  Communications  Mechanical  Agricultural  Office  Machine shops  instruments | Medical/Health  Pumps  Textiles  Motors  Generators  Electric Industry  Electrical Appliances  Telecommunication  Mechanical  Agricultural  Electronics  Aerospace  Shipbuilding | Medical  Health  Textiles  Motors  Electric industry  Electrical appliances  Telecommunication  Agricultural  electronics |
| Final Goods | All | All | All | Meat  Fish  Dairy  Beverages  Leather goods  Shoes  Clothing  Drugs | Silverware  Furniture  Sport goods  Beverages  Food  Shoes  Clothing  entertainment | Beverages  Food  Clothing  entertainment |
| Utilities | None | None | None | Transportation  Gas  Electricity  Water/health | None | Transportation  Gas  Electricity  water |
| Services | None | None | None | Banking |  | IT  Software  Hardware  Equipments |

APPENDIX 2 **TABLE A2.1**

\*My survey will include the industries as indicated. The findings in the papehave been shown for the industrial surveys completed .

**TABLE A2.2**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| country | REPRESENTATIVENESS OF | | | | |
| Economy | IO Structure | Size of Business (employment) | Regions | survey |
| Italy | @ | 1976 domestic requirement matrix;75 disaggregated most integrated industries chosen | Different sizes | All regions adequately covered | 35000 manufacturing business units  Surveyed with more than 20 employees. |
| France | @ | 1990 output domestic requirement matrix | Different sizes | Information available for Respondent’s business establishments’ locations allowing for the estimation of regional agglomeration | 24,643 enterprises surveyed |
| China | @ | 40X14 innovative activity matrix;finally disaggregated 22x22 intra-manufacturing matrix | Large & medium sized | ----------------- | 15000 units |
| Canada | @ | Disaggregated 40x132 innovative interaction matrix | Different sizes | Five regions;the atlantic provinces,quebec,Ontariothe prairies & british columbia | 2000 innovative outputs from 732 firms # |
| Greece | @ | Recent available I/O Table \* | Very small businesses | The entire country | 900 businesses |

# the Canadian survey is representative of both Canadian businesses and innovative outputs. The Businesss here refers to a division of a firm or a single-industry firm.

@ Please refer Table no. A2.1 for the representativeness of Economy

\*the final version of the text “locating innovative activities in semi industrialized Economy-Greece”was presented in 1993.

**APPENDIX 3**

**TABLE A3.1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Method | Foundation | Data | Output |
| Schmookler,1966 | Compilation of intermediary technology flow matrix | Interdependency |  |  |
| Scherer,1982 | Compilation of intermediary technology flow matrix | Interdependency | 1974 R&D expenditures & 1976-77 patent data,USA | Technology flow matrix,41 rows(suppliers) x 53 columns(users) |
| Montfort& Dutailly,1983 | Linking supplier to its main user and user to its main supplier | Interdependency | 1981 I/O Table, 90x90 sectors, France | 19 clusters |
| Roelandt,1986 | Linking supplier to its main user and user to its main supplier | Interdependency | 1977 I/O-table,24 x 24 sectors, the Netherlands | 6 clusters |
| Christian DeBresson,1984,1986 | Compilation of triangularized innovative-interaction matrix | interdependency | 1945-1979 survey data,Canada;I/O -tables | 40x132 innovative interaction metrix |
| Shiqing Xu,DeBresson & Xiaoping Hu,1992 | Aggregate compilation of innovative-interaction matrix | interdependency | Stratified random pilot survey in 1992 of 1500 enterprises;40 x 14 innovative activity matrix | 22 x22 intra manufacturing matrix ;location of innovative activities in China. |
| Sergio cesaratto,sandro Mangano & Silvia Massini,1993 | Linking technological behaviour & interdependence | interdependency | Survey data 1981-1985,Italy(2701 business units);I/O table | 6 types of clusters based on the taxonomic approach |
| Philippe Kaminski,Debresson & Xiaoping Hu,,1993 | Triangularized french domestic requirement matrix with location of innovative activity | interdependency | 1986-1990 survey data ,the 1990 output domestic requirement matrix,france | 5 industries dominate the innovative activity matrix |
| Nikos Vernardakis | Compilation of the industry shares of inventive and innovative activities in Greece |  |  | Weak economic linkages;the minimum threshold to sustain innovative activities not yet reached. |
| Hanel,1994 | Compilation of patent weighted intermediary technology flow matrix | Interdependency | 1978-1989 patent data and I/O-tables, Canada | Patent-weighted intermediary technology flow matrices |
| Van Der Gaag, 1995 | Linking supplier for its main product with products main user & linking user for its main product with products main supplier | Interdependency | 1991 make & use tables,230 sectors x 650 product groups, the Netherlands | 9 clusters |
| DeBresson et al,1994 | Compilation of Innovation interaction matrices | Interdependency | 1981-85 survey data, Italy | 43 x 66 Innovation interaction matrix |
| DeBresson et al,1994 | Compilation of triangularized Innovative activity matrix | Interdependency | 1981-85 I/O-tables and survey data, Italy | 30 x 66 triangularized domestic requirement matrix |
| Feser & Bergman, 1997 | Linking industries that have similar buying & selling patterns | similarity | 1987 I/O-table 478 x 478 sectors,  USA | 23 clusters |
| Witteveen 1997 | Linking supplier to its main user and user to its main supplier | Interdependency | 1993, I/O –table,213 x 213 sectors, the Netherlands | 10 clusters |
| Bergeron et al 1998 | Constructing technology-industry table, linking industries & technologies united by proximity | similarity | 1985-1990 patents by French firms in USA | 12 techno-industrial clusters |
|  |  |  |  |  |

**APPENDIX 4**

**TABLE A4.1**

|  |  |
| --- | --- |
| **SECTOR** | COVERAGE |
| ICT | * IT * ELECTRICALS * ELECTRONICS * TELECOM |
| HEALTHCARE | * MEDICAL &HEALTH |
| BIOTECH | * AGRICULTURE * VACCINES |
| INFRASTRUCTURE | * CRUDE OIL * PETROLEUM REFINERY * COAL * ELECTRICITY * CEMENT * FINISHED STEEL |
| PHARMACEUTICALS | * MACHINERY * MEDICINES |
| AUTOMOBILE | * PASSENGER VEHICLES * COMMERCIAL VEHICLES * THREE WHEELERS * TWO WHEELERS |
| AGRICULTURE | * PROCESSED FOODS & VEGETABLES * MEAT PRODUCTS * DAIRY * FISHING * CONSUMER FOODS (PASTA, CAKES, PASTRIES) * BEVERAGES(ALCOHOLIC/NON ALCOHOLIC) * PACKAGED DRINKING WATER * ORGANIC FOOD PRODUCTS |
| ENERGY | * SOLAR * GAS * ELECTRICITY |
| EDUCATION | * EDUCATION * RESEARCH LABS * SCIENTIFIC CENTRES |
| TEXTILES | * TEXTILES * MACHINERY * READY MADES |
| BANKING | * BANKS |
| INSURANCE | * LIFE INSURANCE * GENERAL INSURANCE * BANKASSURANCE |
| TRANSPORTATION | * OCEAN FREIGHT/AIR FREIGHT * RAILWAYS * SURFACE |
| ENTERTAINMENT | * INFORMATION & BROADCASTING * ADVERTISEMENT * PRODUCTION(TELE/FILMS) * SPORTS (Ee.g.BOWLING/BOATING) |

**TABLE A4.2**

|  |  |  |
| --- | --- | --- |
| **Aggregated sector no** | **Description** | **Items** |
| 1 | Food crops | Paddy,wheat,jowar,bajra,maize,gram,pulses |
| 2 | Cash crops | Sugarcane,groundnut,jute,cotton,tobacco |
| 3 | Plantation crops | Tea,coffee,rubber,coconut |
| 4 | Other crops | Other crops |
| 7 | Fishing | Fishing |
| 8 | Coal and lignite | Coal & lignite |
| 9 | Crude petroleum & natural gas | Crude petroleum, natural gas |
| 10 | Iron ore | Iron ore |
| 12 | Sugar | Sugar  Khandsari,boora |
| 13 | Food products excluding sugar | Hydrogenated oil(vanaspati),edible oils other than vanaspati, tea & coffee processing, miscellaneous food products |
| 14 | Beverages | Beverages |
| 15 | Tobacco products | Tobacco products |
| 16 | Cotton textiles | Khadi,cotton textiles in handlooms, cotton textiles |
| 17 | Wool, silk & synthetic fiber textiles | Woolen textiles, silk textiles, art silk, synthetic fiber textiles |
| 18 | Jute, hemp& Mesta textiles | Jute, hemp & Mesta textiles |
| 19 | Textile products including wearing apparel | Carpet weaving, readymade garments & made up textile goods, miscellaneous textile goods |
| 26 | Petroleum products | Products of petroleum refineries |
| 30 | fertilizers | Fertilizers |
| 31 | Paints, varnishes &lacquers | Paints,varnishes.lacquers & dyestuffs, waxes & polishes |
| 32 | Pesticides, drugs and other chemicals | Pesticides, drugs & medicines,soaps,cosmetics,glicerine,synthetic fibres,resin |
| 33 | cement | Cement |
| 35 | Iron & steel industries & foundries | Iron & steel Ferro alloys, iron& steel casting & forging, iron & steel foundries |
| 38 | Agricultural machinery | Tractors & other agricultural implements |
| 39 | Industrial machinery for food & textiles | Industrial machinery for food & textile industries |
| 40 | Other machinery | Industrial machinery except food & textile, machine tools, office computing and accounting machinery |
| 41 | Electrical, electronic machinery & appliances | Other non electrical machinery |
| 45 | Construction | Construction |
| 46 | Electricity | Electricity |
| 47 | Gas & water supply | Gas,LPG,Gobar Gas & water supply |
| 49 | Other transport services | Buses,taxies,cycles,shipping transport etc |
| 54 | Banking | Banking |
| 55 | Insurance | Insurance |
| 57 | Education & research | Education ,scientific & research services |
| 58 | Medical & health | Medical and health services |
| 59 | Other services | Real estate, information & broadcasting, recreation & entertainment |

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