

## CHAPTER 2 LITERATURE REVIEW

### 2.1 National Innovation System

Though the term Innovation was coined by the German Economist Riedel in 1839 and sociologist De Tarde in 1890, It was only after the release of "The Theory of Economic Development" by Schumpeter that Innovation became the central focus and the strings of debates/discussions started. The concept of the NIS however began to surface only in the late 1980s (Freeman,1987,Dosi et Al,1988,Lundvall,1992,Nelson,1993,Edquist 1997) at the same time when the new growth theory appeared (Romer,1986,1990;Lucas,1988).

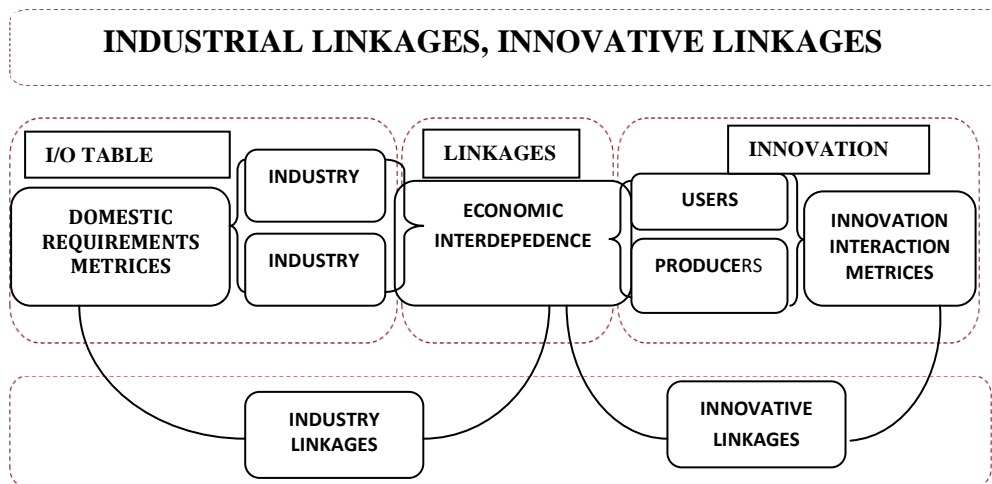
The concept of a '*system of innovation*' was introduced by B.A.Lundvall in 1985 "however, the idea actually goes back at least to the Friedrich List's conception of "The National System of Political Economy" (1841) which might also have been called "The National System of Innovation" (Freeman, 1995). Christopher Freeman coined the expression "National Innovation System". List focused on the development of productive forces rather than on allocation issues. He pointed to the need to build national infrastructure and institutions in order to promote the accumulation of mental capital and use it to spur economic development rather than just trust the invisible hand to solve all problems. While List's publications attempted to explain Germany's dominance over England in the 3rd Kondratieff wave in the late 19th century (Freeman 1988), the amazing development of the post-war Japanese economic growth and policy encouraged Freeman (Freeman 1987) to do a thorough analysis of its NIS.

The systemic approach to innovation now consists of various branches. Depending on the chosen level of analysis, the concepts of regional innovation systems (e.g. Braczyk et al. (1998), Ohmae (1995)), sectoral innovation systems (Breschi and Malerba (1997), Malerba (2002), Cooke et al. (1997)) and technological systems (Carlsson (1995, 1997), Carlsson and Stankiewicz (1995)) constitute three alternatives to the concept of national systems. In addition, related concepts like the concept of industrial clusters (e.g. Porter (1998)) have been introduced.

## 2.2 Economic interdependence & innovative activities

Various attempts have been made to examine the relationship between economic linkages and innovative linkages. Standard Input Output Data provide for the economic linkages whereas Innovation interaction Matrices provide for the innovative linkages. Comparison of the Innovative Interaction Matrix with I/O matrices enables the policy strategists to locate the innovative activities and find out whether economic linkages drive innovative activities in a particular industry. Which are the active economic channels that support innovation? Where is innovation likely to happen? Is there innovative activity taking place in spite of the low level of the economic activity? In other words, the study of economic interdependence & innovative activities will help test the hypothesis whether *“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)

**Figure 2.1 :Economic & Innovative Linkages**



The study demonstrates & identifies whether & how industrial linkages impact clustering of innovative activities. The table 2.1 displays some of the surveys of the innovative activities undertaken. No such effort has been made for Indian Economy. The thesis sets the ball rolling in that direction. The thesis is an attempt to identify the innovative linkages and the clustering of Innovative activities in Indian economy.

**Table 2.1: Surveys of Innovative activities**

country	REPRESENTATIVENESS OF				
	Economy	IO Structure	Size of Business (employim	Regions	Survey
<b>Italy</b>	@	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.
<b>France</b>	@	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
<b>China</b>	@	40X14 innovative activity matrix; finally disaggregated 22x22 intra-manufacturing matrix	Large & medium sized	-----	15000 units
<b>Canada</b>	@	Disaggregated 40x132 innovative interaction matrix	Different sizes	Five regions; the Atlantic provinces, Quebec, Ontario the prairies & British Columbia	2000 innovative outputs from 732 firms #
<b>Greece</b>	@	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 Business here refers to a division of a firm or a single-industry firm.;@ Please refer Fig no. 2.2 for the representativeness of Economy \*the final version of the text “locating innovative activities in semi industrialized Economy-Greece”was presented in 1993.

The surveys by DeBresson et al for Italy, France, China, Canada and Greece merit attention here, as they explore the interdependencies between the innovative activities and the economy. The compilation of innovative- interactions matrices and their comparison with respective country's standard Input output tables enabled to find out the location of innovative activity within the Economy. The common features in these surveys 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 surveys aimed at exploring the interdependencies between innovative activities and the economy; examine Schumpeter's hypothesis about clustering of innovation; locate these clusters in the national economic space; compare these locations across national economies and find out whether there are recurrent patterns in the relationships between national economies and the location of innovative clusters. These surveys also helped in some cases (Canada) identify precisely the locations of the supplier establishment and the first user of an innovative output, which enables to establish the geographical distance between partners in innovative endeavors.

The industries covered in these surveys have been shown in Table 2.2.

**Table 2.2 : Industry representative of the Economy in surveys**

<b>Sector</b>	<b>Italy</b>	<b>France</b>	<b>China</b>	<b>Canada</b>	<b>Greece</b>
Extraction	Petroleum	none	all	Gold Uranium, Iron ore Non ferrous Coal, Petroleum Asbestos gas	Agriculture
<b>First transformation: materials</b>	<b>All</b>	<b>all</b>	<b>all</b>	Petroleum refining Cotton yarn Wool yarn Man-made fiber Sawmills Iron steel Smelting & refining Aluminum Plastics Industrial chemicals Other chemicals Pulp and paper	<b>Construction materials</b> <b>Plastics</b> <b>Chemicals</b> <b>paper</b>
<b>Intermediate Goods</b>	<b>All</b>	<b>all</b>	<b>all</b>	Rubber Plastics Automotive Fabrics Knitting Paper products Wood products Foundries Metal stamping Wire&cable Non metal Minerals Soap	
<b>Machines, equipment, capital goods</b>	<b>All</b>	<b>all</b>	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

<b>Final Goods</b>	<b>All</b>	<b>all</b>	<b>all</b>	Meat Fish Dairy Beverages Leather goods Shoes Clothing Drugs	Silverware Furniture Sport goods Beverages Food Shoes Clothing entertainment
<b>Utilities</b>	<b>None</b>	<b>none</b>	<b>none</b>	Transportation Gas Electricity Water/health	<b>None</b>
<b>Services</b>	<b>None</b>	<b>none</b>	<b>none</b>	Banking	

## 2.3 Cluster analysis vis-à-vis innovative activities

### 2.3.1 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). Alfred Marshall with “industrial districts”, Joseph Schumpeter with “innovation clusters”, Eric Dahmen with “development blocks”, François Perroux with “development and growth poles”, economic geographers with industrial and “high-technology” agglomerations, all repeatedly called attention to the fact that most economic phenomena – and innovation in particular – are polarised in space. (DeBresson, 1996)

### 2.3.2 Concepts & Definitions

Ever since Porter published the competitive advantage of nations, the concept of clusters has received a lot of attention in the public debate about industrial policy (Porter, 1990). However

there seems to be no consensus about the definition of and approach towards clusters. The definition and the approach used vary from country to country based on their intent and objectives.

According to Jacobs and De Man (1995), roughly three groups of (related) cluster notions can be distinguished

1. **Regionally concentrated industry;**
2. **Sectors or groups of sectors; and**
3. **Production chains.**

According to the best-known taxonomy of innovating firms, clusters can be categorized as:

1. **Science-based** (e.g. pharmaceuticals, aerospace);
2. **Scale-intensive** (e.g. food-processing, vehicles);
3. **Supplier dominated** (e.g. forestry, services); or
4. **Specialized suppliers** (e.g. computer hardware and software) (Pavitt, 1984).

With augmenting importance of NIS, countries have used different approaches in identifying clusters of industries. In many cases, sectors have been grouped on the basis of the different types of knowledge flows, including:

1. **Embodied technology flows** (the purchase of products and intermediate goods from other sectors) and producer-user interactions;
2. **Technical interactions** as measured by the structure of patenting, citations of patents and scientific publications in other sectors, and joint research activities;
3. **Personnel mobility** or the level and flows of skilled workers

Another classification mentions about spatial clustering based on similarity or interdependence in a production network or in a composite of production networks;

- **Horizontal (similarity):** classical sector classification at a specific level of aggregation;
- **Vertical (interdependency):** composite of production chains (supply networks and outsourcing networks), the strategically important question being: who within the network is the main cause of innovation?

- **Lateral (similarity):** ‘related’ sectors with shared capabilities and the possibility of synergy;
- **Technological (similarity):** (overlap with the lateral dimension) related technologies and technological characteristics that could link sectors;
- **Knowledge (interdependency):** relationship to relevant knowledge infrastructure (education and research); and
- **Network quality (interdependency):** nature and quality of co-operation between companies.

The Table 2.3 evidences some of the surveys undertaken based on similarity and interdependency.

**Table 2.3: Interdependency/Similarity based surveys**

<b>Name</b>	<b>Method</b>	<b>Foundation</b>	<b>Data</b>	<b>Output</b>
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 matrix



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 x 22 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	Interdependency	1991 make & use tables, 230 sectors x 650 product groups, the Netherlands	9 clusters

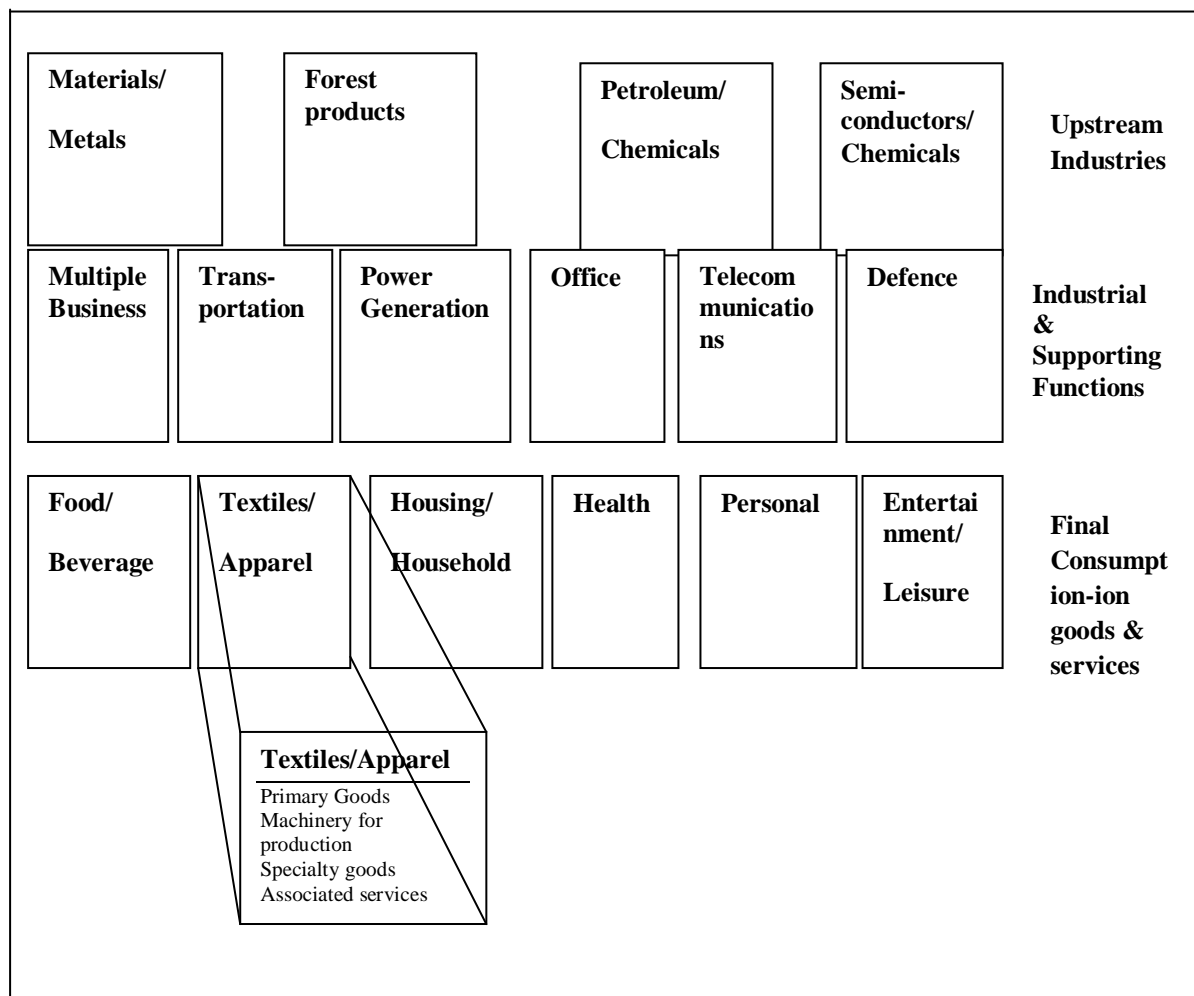
	products main supplier			
DeBresson et al,1994	Compilation of Innovation interaction matrices	Interdependency	1981-85 survey data, Italy	43 x 66 Innovation interaction matrix
DeBresson et al,1994	Compilation of triangularized Innovative activity matrix	Interdependency	1981-85 I/O-tables and survey data, 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

Well did Rolandt & Den Hertog (1998) state that “Clusters can be characterized as being economic networks of strongly interdependent firms (including specialized suppliers), knowledge producing agents (universities, research institutes, engineering companies), bridging institutions (brokers, consultants) and customers, linked to each other in a value-adding production chain. The cluster approach focuses on the linkages and interdependence between actors in the network of production when producing products and services and creating innovations.”

### 2.3.4. Sectoral Mega Clusters

The cluster analyses gained momentum with Porter talking about the sectoral mega clusters and the roles they play in building the competitiveness of the nation. His approach incorporates standardised model of sixteen possible clusters, sub divided in three industry groups (upstream, support, consumption) at four different levels (goods, machinery, input, services), per group and level dependent on similar framework conditions. Each nation's cluster chart is constructed by identifying the industries that establishes its success in significant exports or Foreign Direct Investment. He introduced the sectoral approach linking the sectors in mega clusters.

**Figure 2.2: Mega Clusters**

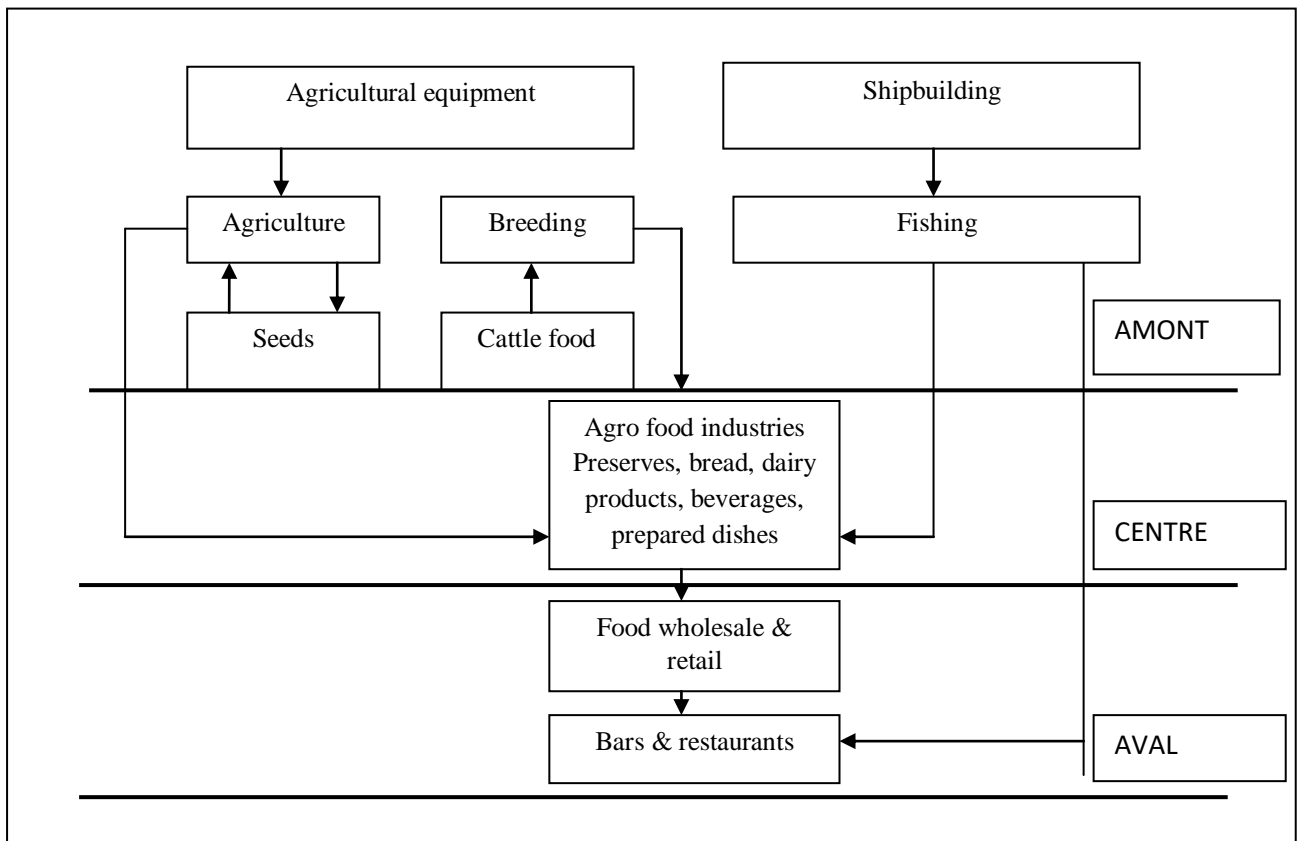


Source: Porter, 1990

### 2.3.5 Chains and networks

Monfort analysis of “filieres” in France is another good example of clustering of the activities because of the increased interactions and the cooperative networks in the value chain. He found nineteen French ‘filieres’ (Montfort & Dutailly, 1983). Montfort bases analysis on significant intermediary supplies as in input-output tables, and divides his analysis in an upstream (‘amont’), a centre (‘centre’) and a downstream (‘aval’) part.

**Figure 2.3: The French Agro Food Filiere**



Source: Montfort, 1983