

CHAPTER 6 THE MEASUREMENT ISSUES

This chapter illustrates the measurement issues related to the innovations. Increasing importance has been given in recent years to the theory and measurement of innovation. Though dealt by Schumpeter and many other economists, the contribution is specific to find measurements in terms of Leontief's production function of fixed input coefficients, capital coefficients of discrete and finite number of processes that may undergo technical change on account of innovations.

Subsequent to the emergence of the new endogenous growth models (Romer 1983, 1986; Grossman & Helpman 1992; Aghion and Howitt 1998), increasing importance has been given to the study of the theory and measurement of Innovation.

The growth report by the commission on growth & development that observed 13 economies growing at an annual rate of more than 7% for more than 25 years quoted "the growth of GDP may be measured up in the macroeconomic treetops, but all the action is in the microeconomic undergrowth, where new limbs sprout, and dead wood is cleared away."

Rightly so, in order to understand and build the new economic growth policies, an economy needs to understand the microeconomic issues related to the theory and measurement of innovation as the new economic policies need to acknowledge the augmenting importance of the technological progress that may have its impact on the factor and product prices and thereby changing the microeconomics of creation and destruction-the process that characterizes the contemporary economy.

6.1 Innovation – the concept and its measurement

Thanks to work by the OECD and others, we now have a definition of innovation done by firms that is fairly standard across a wide range of countries and surveys:

"An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations."

6.2 A Taxonomy of Innovations

The taxonomy of innovations proposed by Freeman include

- Incremental Innovations-the innovations that follow each other continually and form the basis for the innovative process .However these innovations do not change the economic dynamics substantially.
- Radical Innovations-they are not uniformly distributed in time. They may arise frequently and shift to different technological groups. They consist both in capital goods, such as numerical control machines, and consumer goods, such as the television.
- New Technological Systems-the innovation that has pervasive influence on the economic system and brings about modifications in the conditions of not only in the principal sectors of production and utilisation but also in many other industrial and service sectors. Such innovations happen around the common technology basis and multiple innovations. Examples of new technological systems include the innovations in the fields of semiconductors, synthetic materials or electrical household appliances.
- Technological revolutions-innovation that changes the techno-economic paradigms and is associated with the major economic cycles. The case of steam engine, conveyor belt is known.

It is must that one of the definitions of innovation is taken as a unit of measure. As for new technological systems and technological revolutions, it is not possible to define them ex ante, since they can only be assessed on the basis of the economic effect taking place ex post.

It must be remembered that new technological systems and technological revolutions are made up of a number of interconnected innovations. It is, therefore, a question of identifying them according to the classification of incremental or radical innovation.

Another taxonomy recommended by Pavitt includes:

Supplier Dominated Firms-who do not produce majority of their innovations but source them from the suppliers. The industries in which such firms are typically found are traditional manufacture, building, and agriculture.

Scale-intensive Firms-who reap economies of scale to reduce the average cost of production. The typical sectors for firms of this kind are those of materials and, above all, those based on the conveyor belt.

Specialized Suppliers-include usually the small and medium enterprises. The typical sectors are those of machinery and scientific instruments.

Science-based Firms-are the firms with greater investment in Research & Development. They are characterized by the fact that they produce internally the majority of the innovations they use. Typical sectors are those of chemicals and electronics.

Both the taxonomy happen to be different. Freeman incorporates a sequence of breaks and subsequent re-composition whereas Pavitt, on the other hand, lays emphasis on the cumulative aspect of innovative activity, pointing out that what firms will do in the future is strongly conditioned by what they have done in the past. The nature of technological knowledge is therefore of a clearly

Though the definition by OECD is fairly standard across a wide range of countries and survey, the problem of measuring innovation still has limitations:

6.3 The measurement issues

1. Can we observe innovation in a timely enough way to act upon it? Debresson argues that innovations outcomes could be different. Some create new wealth and contribute in economic growth and development but not all innovations create wealth. Some just generate rents and redistribute existing rents (BAUMOL, 1993). Not all innovation may have been adopted at a scale large enough to have contributed economic growth (Rosenberg, 1969). David Sawers & Richard Stillerman (1958,1969) did not include computers in their writings “the sources of invention” in 1951 .The economic impact of computers would not have been same before the invention of semiconductors, integrated circuits and transistors Time bias in evaluating the importance and significance of an innovation is a pervasive and insurmountable problem.

The New York Times in 1939 did not see future in television.

“Television will never be a serious competitor for radio, because people must sit and keep their eyes glued on a screen; the average American family hasn’t time for it.” The forecast for the mobile subscriptions by 1999 was about one million by one of the leading consulting companies to AT&T. In fact the number of subscribers passed 70 million in that year.

The usage of LASER technology in chemistry, medical field, for the high quality reproduction of music CDs is another example. The behaviour of lasers had been predicted, on a purely theoretical basis, by Einstein, using no more than a blackboard and a piece of chalk, as long ago as 1916. But it took over 40 years before scientists could actually create a laser beam (Light Amplification by Stimulated Emission of Radiation). (Rosenberg)

2. A given innovative product or process for a given economic unit at a given time can be seen either as complement or a substitute. But at a macro level over time it may change radically. Semiconductor based computing was first used by IBM as a complement to punched cards. Then transistor electronics replaced punched cards in digital computers. Thus complement and substitute are not stable concepts.

3. The disruptive economic impact of an innovation is mostly due to an accumulation of improvements, complements and adaptations.

4. The proof of an innovation is in its adoption. That leads to another issue due to the analytical approaches that take into account innovation from the point of view of the innovation output or the business unit.

5. Innovation is new to the firm or new to the market? As innovation produces implementation of new or significantly improved product or process, it does not really say whether innovation is “new to the market” or “new to the firm” The difference in the extent & nature of novelty could have different impact on the economic growth and development and overall innovation ecosystem. This view of the “skewness” of innovation values is supported by a large amount of research on the valuation of patented inventions (Harhoff et al., 1999; Scherer and Harhoff, 2000; Hall et al., 2005).

6. Radical or incremental: Some innovations can be radical –the adoption of which can (E.G. aircraft, Peniciline, Semiconductors, Telephone) have profound impact on the economic growth and development. But some can be incremental. In one of the surveys by by Acs and Audretsch (1982), Over 85% of the innovations were modest improvements of existing products and none were radical enough to create entire new market.

7. The innovation surveys have typically measured innovation in two ways: first, by asking whether the firm introduced any innovation of a certain type (product, process,

organisational, marketing, etc.) during a preceding period (usually the past three years) and second, by asking the contribution of the innovation output to the sales revenue in the similar period. Some surveys have also included the degree of novelty, the share of exports revenue and the cost of innovative endeavours.

8. Many of the researchers study the share of sales of innovative products, which does give a good indication of how important the innovation(s) were overall for the firm in question. But this measure is useful only for goods and services and cannot be used to capture process or organisational innovation. (Bronwyn Hall)

9. Another problem exists vis-a-vis monitoring innovations whether it should be done on the level of individual productive unit (divisions) or at the industrial group level. The issue becomes more relevant in case of the multinational companies. The level of analysis chosen can impact the result especially with regard to the relationship between innovation and firm size.

10. In case of the finished products, it is practically not possible to determine a single sector of utilisation. The problem becomes more complex as many of the finished products are also used as the intermediary products.

As we deal with the measurement issues, it will be in the fitness of the things to mention about the following Institutions and their contributions:

SPRU –One of the biggest contributions in this field of the measurement and classification of innovation has been from Science Policy Research Unit of Sussex University. The innovations were classified on the basis of three criteria:

1. The “technological” group the innovation belongs to- such as “chemicals,” “electronics,” “Pharmaceuticals” etc. These are homogeneous innovations based on technical and engineering characteristics are grouped in technological categories
2. The prevalent economic activity of the body producing the innovation (or sector of production), and,
3. The sector of the utilization of the innovation, understood as the sector of the first application of the innovation.

This classification however may coincide for some innovations such as a chemical process produced by a chemical firm and used by the same firm or others in the chemical industry. In other cases, they may be different, e.g., a coffee machine (under the first criterion, the technological group is that of “machinery”) produced by an automobile firm (under the second, the production sector is that of “means of transport”) and used in restaurants (under the third, the utilization sector is that of “catering”. (Daniele Archibugi’1988)

The *FRASCATI Manual* and *OSLO Manual* provide some guidelines for the measurement of innovation.