RESEARCH PAPERS

18

PATENT COUNTS AS INDICATORS OF THE GEOGRAPHY OF INNOVATION ACTIVITIES: PROBLEMS AND PERSPECTIVES

Xuan Li[1]

SOUTH CENTRE

DECEMBER 2008

---

[1] Dr. Xuan LI is Programme Coordinator in the Innovation and Access to Knowledge Programme at the South Centre, Geneva, Switzerland (li@southcentre.org). The views expressed in this paper are the personal views of the author and do not necessarily represent the views of the South Centre or its Member States. Any mistake or omission in this study is the sole responsibility of the author.

THE SOUTH CENTRE

In August 1995 the South Centre was established as a permanent inter-governmental organization of developing countries. In pursuing its objectives of promoting South solidarity, South-South cooperation, and coordinated participation by developing countries in international forums, the South Centre has full intellectual independence. It prepares, publishes and distributes information, strategic analyses and recommendations on international economic, social and political matters of concern to the South.

The South Centre enjoys support and cooperation from the governments of the countries of the South and is in regular working contact with the Non-Aligned Movement and the Group of 77 and China. The Centre's studies and position papers are prepared by drawing on the technical and intellectual capacities existing within South governments and institutions and among individuals of the South. Through working group sessions and wide consultations, which involve experts from different parts of the South, and sometimes from the North, common problems of the South are studied and experience and knowledge are shared.

ACKNOWLEDGEMENTS

I am indebted to Dr. Qin Zhang and Prof. Carlos Correa for their valuable suggestions and comments on this study. I would also like to express my appreciation to Mr. Yogesh A. Pai for his research assistance and intellectual inputs in connection with the development of some thematic configurations. I also wish to acknowledge the contributions from seminar participants who attended "Southern Engines of Global Growth: China, India, Brazil, and South Africa (CIBS)" at World Institute for Development Economics Research of the United Nations University (UNU-WIDER), Helsinki, Finland, 7-8 September 2007 and "Confronting the Challenge of Technology for Development: Experiences from the BRICS", University of Oxford, 29-30 May, 2008.

TABLE OF CONTENTS

EXECUTIVE SUMMARY .... *ix*

I. INTRODUCTION 1

II. MEASURING INNOVATION PERFORMANCE: THE HEAVY WEIGHT OF PATENT COUNTS IN WIPO AND NATIONAL SETTINGS 4

II.1 Current Practices and Interpretation in International and National Settings........ 4

II.1.1 The OECD Approach 4
II.1.2 WIPO 5
II.1.3 National Practices 6

II.2 General Characteristics of Patent Statistics Reflective of International and National Practices 7

II.2.1 The Heavy Weight Placed on Patent Counts for Cross-country Comparisons 7
II.2.2 The Heavy Weight Placed on Patent Counts for Assessing National Innovation Capacities 7

III. PROBLEMS OF PATENT COUNTS AS PROXIES TO CROSS-COUNTRY INNOVATION PERFORMANCE 9

III.1 What Constitutes a Patent? The Implication for Patent Counts and Cross-Country Innovation Performance 9

III.1.1 Definition of Patent 9
III.1.2 Different Practices Being Considered in Different Countries based on Differences in the Design of Patent Systems 10
III.1.3 Differences in Standards of Patent Examination and Outcome on Patent Statistics 13

III.2 Emerging Trends and Problems: Changes in Law, Reversal and Invalidity Rates 16

III.3 Implications 18

IV. PROBLEMS OF PATENT COUNTS AS PROXY TO GEOGRAPHY OF INNOVATION PERFORMANCE 19

IV.1 Composition of Resident Patent Applications 19

IV.2 The Qualitative Value of Patent Counts: The Difference it Makes in Understanding Innovation Capacities 21

IV.3 Patent Applications in the Area of Information Recording 24

IV.4 Assigning Value of Category of Patents: Possible Differences in Ascertaining Local Innovation due to Patentability Exclusions ... 28

IV.5 Implications ... 33

V. PATENT COUNTS AS INDICATORS: POSSIBLE SOLUTIONS AND CAVEATS IN INTERPRETATION ... 34

VI. CONCLUSIONS AND POLICY RECOMMENDATIONS ... 35

BIBLIOGRAPHY ... 36

LIST OF TABLES

Table 1 Utility Models, Plant Variety and Designs in the Definition of Patents ... 11

Table 2 US Patent Grants by Technology Category, 1981 – 1999 ... 16

Table 3 Reversal Rate based Upon Number of Previous Appeals ... 17

Table 4 Number of Patents in Litigation ... 17

Table 5 The Composition of Patents in China, 2005 ... 20

Table 6 Patent Applications by Categories of Patents, 1985-2005 ... 21

Table 7 Three Categories of Patent Applications Classified by Resident and Non-Resident Applicants (2005) ... 22

Table 8 Top Ten IPC Sub-classes of Patent Applications, 2005 ... 22

Table 9 Top Five Patented Technologies, All Applicants, 2005 ... 23

Table 10 Top Five Patented Technologies (Home Applicants), 2005 ... 23

Table 11 Top Five Patented Technologies (Foreign Applicants), 2005 ... 24

Table 12 Number of Applications ... 25

Table 13 Number of Applications by Countries and Regions ... 25

Table 14 Applications Trend, 2003 – 2005 ... 26

Table 15 Applications Nation Distribution, 2005 ... 26

Table 16 Application Comparisons between Toyota and Tsinghua University, 2005 ... 27

Table 17 A Comparison of US, EU, Brazilian and Indian Legal Provisions Concerning the Grant of Patents ... 28

Table 18 Exclusions in Software and Biotechnology Patents ... 32

List of Abbreviations

PHOSITA	A person having ordinary skill in the art
CPVR	Community Plant Variety Rights
FTC	Federal Trade Commission
IP	Intellectual property
MPK	Modern pharmaceutical knowledge
NAS	National Academy of Sciences
PVPA	Plant Variety Protection Act of 1970
R&D	Research and development
S&T	Science and technology
STI	Science, technology and innovation
SIPO	State Intellectual Property Office
EPO	The European Patent Office
EU	The European Union
US	The United States
IPC	The International Patent Classification
JPO	The Japan Patent Office
OECD	The Organisation for Economic Co-operation and Development
PCT	The Patent Cooperation Treaty
TRIPS	The Trade-Related Aspects of Intellectual Property Rights
UPOV	The Union for the Protection of New Varieties of Plants
USPTO	The United States Patent and Trademark Office
TMK	Traditional medicinal knowledge
WIPO	World Intellectual Property Organization
PATSTAT	Worldwide Patent Statistical Database

EXECUTIVE SUMMARY

Innovation in the global marketplace is at the core of the twenty-first century knowledge-based economy. Innovation is in itself a fuzzy concept and measuring it is more difficult. Innovation may encompass the invention of products and processes coupled with their commercial exploitation. In other words, innovation involves the creation, exchange and evolution of new ideas and their application in the global marketplace of goods and services, for the success of an organisation, the vitality of a nation's economy, and the advancement of society as a whole. Innovation is thus the lifeblood of modern-day economic activity. So important is innovation to firms and to nations, that countries have devised national innovation systems to systematise the process of innovation. In this context, the concept of measuring innovation performance needs no special emphasis. Measuring innovation performance can be vital in arriving at a formal link between innovation performance and economic growth. Thus multiple indicators can be used in assessing innovation performance. The use of patent statistics in this connection has been traditional. It has been besieged with challenges from its inception. Although patent statistics indicate to a certain degree indicate some measure of innovation performance, they are not free from defects. The objective of this research paper is to highlight constraints that emerge in construing patent counts as indicators of inventive activity within a particular geographical location and cross-country innovation performance comparison, and to find remedial solutions for strengthening their use as a proxy for inventive activity, specifically in developing countries, in the light of the World Intellectual Property Organization (WIPO) World Patent Report: a Statistical Review, 2007 and 2008.

There is an increasing trend among policy makers, researchers, innovation surveyors and technocrats to rely profoundly on patent statistics as indicators of inventive activity. It is now widely recognized that one of the key aims of measuring innovation performance is to help the formulation of innovation policies, thus placing overly high emphasis on interpreting indicators and statistics concerning them. Patent statistics (application/grant) do have intrinsic value as a reliable (if not an immediate proxy) indicator of innovative activity. Among various factors that contribute to the strength of patent counts, the following two are most important: Firstly, since patents (excluding utility models and design patents) are granted for inventions that pass the patentability threshold (novelty, utility/industrial application, non-obviousness/inventive step), they are considered as safe in the avoidance of double-counting of inventions. Second, their easy availability and fair authenticity presupposes strength in counts, since all patent offices keep the official records for patents filed/granted, including their aggregates.

The work of the Organisation for Economic Co-operation and Development (OECD) in compiling and interpreting patent statistics has been remarkable in this regard. Through its annual feature of a published compendium, the OECD has evolved triadic patent families (constituting the United States Patent and Trademark Office (USPTO), the European Patent Office (EPO) and the Japan Patent Office (JPO), and has also tried to measure innovation performance across various OECD countries. It provides for the latest available internationally-comparable data on patents. Patent indicators presented in this publication are specifically designed to reflect recent trends in innovative activities across a wide range of OECD member and non-member countries. The data for the most recent years are estimates (the result of a now-casting exercise). Keeping to this line of compilation and use of patent statistics, WIPO, which administers the Patent Cooperation Treaty (PCT), can be considered as another organisation with ample information and resources to compile patent statistics and interpret them accordingly. The WIPO World Patent Report was first published in 2006 and has subsequently become an annual feature, with editions in 2007 and 2008. This annual publication of compiled statistics is derived from various sources, viz. PCT statistics, and patent information shared by the national/regional patent offices. In many ways, the report is valuable in understanding the use of the patent system in both developed and developing countries, including its internationalisation. However, interpretation of such statistics as indicative of innovation performance by relying on resident patent activities, and for assessing cross-country innovation performance, does not present ample conceptual clarity, especially in the context of the rise in patent filings in developing countries. Hence, the focus of this paper as it pertains to the justifiability of the use of patent statistics for innovation performance in the light of WIPO World Patent Reports pertains to conceptual issues concerning why patent statistics are weak indicators of innovation output, especially in a developing country context with special emphasis on China and other emerging economies.

Patent statistics are broadly seen as correlative to research and development (R&D) output. Innovation is at the core of economic growth, and hence the use of patent statistics to indicate innovative activity in a geographical location would warrant decision makers' arriving at certain subjective conclusions. While patent statistics may in themselves be objective (when interpreted along with specific caveats), their subjective use and interpretation may at times run the risk of overestimating or underestimating innovation capacities, especially in developing countries. Within WIPO there is currently heavy weight placed on the use and comparison of patent statistics in understanding the geography of innovation. Even while there are multiple indicators currently in use for measuring innovation performance, there is at WIPO considerable over-emphasis on the use and validity of patent statistics. The annual World Patent Reports can be cited as a classic example. The World Patent Reports do not use multiple indicators (except where R&D statistics are used); at the same time, however, they try to link patent counts with innovation performance. This presents conceptual problems in measuring innovation within a particular geographical location, or for the purposes of cross-country comparisons. Again, the national intellectual property office will presumably rely on such statistics for taking policy decisions, and hence there is considerable risk in wrongly interpreting the quantified statistics. On a general framework of use of patent counts, therefore, the primary characteristics of compiling and interpreting patent statistics pertain to the heavy weight placed on patent counts in cross-country comparisons and the heavy weight placed on patent counts in assessing national innovation capacity.

In this connection, there are specific problem presented by patent counts as a proxy for cross-country innovation performance. What constitutes a patent is an issue of primary inquiry, which will reveal that patents are territorial grants subject to the statutory regulations of each country, even while the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement has to a large extent harmonised common binding norms. It means that patent statistics may consequently vary according to the nature of grants in different countries. Patent statistics may involve statistics concerning utility models, design patents, plant patents and so on. Thus any cross-country comparison must take note of the differences in the design of patent systems. The major implication of comparing patent statistics without heed to these specificities can highly exaggerate the patent counts in terms of numbers, thus giving a wrong picture of patent statistics quantified. Again, differences may occur due to variations in standards of examination. It must be noted that the TRIPS Agreement leaves considerable flexibility to member countries in the design of patent law thresholds. Thus patentability criteria pertaining to inventive-step, utility and novelty, and the patent-eligibility criterion with reference to "all fields of technology" may vary according to the policy priorities of each country. This has profound implications for patent statistics. Further, it has been very well documented that since all patent examiners are not equal in implementing the examination criteria, the differences can have impacts on the outcomes of statistics. Both of the above identified specificities may have implications for the nature of grants, thus making cross-country comparison through patent statistics in order to measure innovation performance less accurate.

It is also essential to know what type of patent count is used for cross-country comparison of innovation performance. The WIPO World Patent Reports contain statistics concerning both applications and grants. While the counts regarding applications are from compiled statistics concerning the PCT, the grant figures are based purely on national statistics. There is certainly doubt as to whether patent grants may to any degree constitute a measure of innovation, especially with reference to cross-country performance, since grants are heavily influenced by national laws and policy priorities. Next, applications may depend on the rate of acceptance and reversals, the rate of invalidity by courts, and so on. Thus even patent application counts are prone to a higher degree of variations and hence cross-comparisons may in some cases highly exaggerate innovation capacities. Again policy makers in national settings may be influenced by a higher number of grants or applications filed, hence making patent statistics (read without specific caveats) controversial in many ways. The WIPO World Patent Reports have evolved certain methodologies that can be helpful in the interpretation of patent statistics by reading them together with any caveats concerning them. Strong caveats within the patent statistical frameworks are *sine qua non* in indicating a healthy interpretation of patent statistics and cross-country comparisons in relation to innovation performance.

Further, there is an emerging trend in some countries where there is a rise in patent application reversal rates. These reversal rates may again be specific to territorial context, thus making a universal comparison conceptually problematic. It is noted that courts in some jurisdictions are increasingly invalidating patents due to tighter patentability thresholds. Again, there may be other pertinent reasons, such as a rise in open source models in some countries and less reliance on patents or patent reforms to weed out the future grant of questionable patents Thus these specificities have to be borne in mind when interpreting composite patent statistics for the purposes of cross-country innovation performance.

Another core argument advanced by this research paper is with reference to problems of patent counts as a proxy measure for geographic innovation performance. Firstly, measuring innovation performance through the composition of resident patent applications can lead to biased outcomes. In this regard, it would be important to revisit the concept of resident patent application as defined in the WIPO patent report to see how far strong caveats are read into it. Certain interpretations employed at national level may also be important for the conceptual understanding of resident patent activities.

Secondly, there are problems concerning the origin of patent counts/applications and problems in identifying the location of an invention**,** problems in identifying the resident applicants (inventors and applicants), and problems concerning any direct linkage between applicant and place of innovation, and concerning the issue of double counts. This has profound implications concerning the conceptual basis which makes patent counts highly susceptible as proxies for assessing the geography of innovation activities. This is due largely to patent counts' not reflecting the level of indigenous innovation, the likely representation of foreign firms in the innovation activities, and so on. Thus national innovation performance may be exaggerated to a great extent.

Thirdly, problems concerning the assigning of value to patent counts remain unresolved. Problems which reveal the disparate levels of patents based on certain parameters have to be addressed. There are various methodologies used in attaching value to patents, prominent among them being licensing revenue flows. However, not all patents have the same value in terms of inventive activity. Each individual patent has a different value, which depends on the area of invention, the importance of that particular patent in the value chain, and so on. Further, there are vital differences between a basic patent and surrounding patents. This has implications for the net total outcome of the value assigned to resident patent filings, which even if more in terms of quantity, may not be of higher value.

Fourthly, there is certain evidence in the recent past which points towards a tendency that courts, if not the legislature, will move in the direction of restrictive subject-matter interpretation of patents. In other words, patent challenges on the basis of subject matter eligibility are increasingly arising. This has significant import in tapping inventive activity in those fields which are not covered by patents. It is suggested that the patent system is highly unpredictable in terms of placing reliance on its counts based on an assumption that patents cover all fields of technology. Further, the coverage of certain crucial areas of technology such as software and biotechnology is highlighted in emerging countries such as China, India and Brazil. Important changes in the patent laws of various countries over the years make it difficult to review historical trends. This has also been one of the inherent limitations in patent counts' being used to ascertain innovation within a particular geographical location.

This article challenges the conceptual basis of patent counts being relied upon as indicators of innovation for assessing cross-country performance and for the purposes of understanding the geography of innovation in a particular location. It has been argued that the WIPO Patent Report's conclusion on changing the geography of innovation based on a sharp rise in the numbers of patents filed in north-east Asia, with an emphasis on China, should be interpreted with caution. The drawback of such an international comparison not only relates to how properly to interpret the figures on patent filings and the "resident patent filings", but also to high heterogeneity in the value of patents. On the basis of detailed analyses in China, and comparison of the legal frameworks in the European Union (EU), the United States (US), Brazil and India, it seems that hasty generalisation should be avoided regarding the changing geography innovation patterns. A full assessment requires further econometric, classificatory survey research and interdisciplinary interpretation. The way forward is to develop a proper set of indicators for monitoring changes in innovation capacities, especially in the developing countries.

I. INTRODUCTION

The core of the twenty-first century knowledge-based society lies in the science, technology and innovation (STI) policy followed by nations. The United Nations has consistently requested developing countries to review and upgrade their existing STI policies so as to garner adequate participation in the global knowledge society. To realise this goal, developing countries, as much as developed countries, must have the potential to assess the level of their STI capacities in order to develop new polices for increasing the growth of innovation, and to benchmark these capacities through cross-country analysis with reference to more developed countries. Therefore, a new set of innovation indicators are needed to measure the growth of innovation capacity of developing countries.

Innovation is a complex process, and measuring it is difficult. Innovation studies are becoming of increasing relevance in developing countries. Understanding inventive activity raises the important question of what the term actually means. Interestingly, there is still debate over an ambiguity concerning what most constitutes innovation and innovating firms, measuring output from process innovators, measuring the impact of innovation on a firm's performance and employment, achieving greater international comparability, and so on. But it is pertinent to note that most existing innovation indicators are more relevant in the context of developed countries. This has been specifically pointed out in the context of the non-suitability of OECD guidelines for inter-system analysis unless strong structural commonalities are assumed. Up until only recently there have been attempts to construct innovation indicators which are more appropriate for the developing world. Therefore, innovation indicator systems in developing countries still need to be fulfilled. One of the key aims of measuring innovation is to help in the formulation of innovation policies, which is now widely recognized, thus putting overly high stakes on interpreting indicators and statistics concerning them. Consistently, studies on innovation rely on international/national patent statistics as indicators of innovation output. Thus inarguably, developing countries need immediate measurement of their innovation capacities in order to be able to tailor their innovation policies to their successful participation in the knowledge society. While the scientific literature unfailingly includes a section on patents at the aggregate (that is, national) level and the firm level, it is also widely recognized that there are no standard methods of calculating indicators from patent data, and hence the analytical and policy lessons that can be drawn from patent statistics are widely divergent.

Patent-based indicators are the most frequently used among the few available indicators of technology output. For example the 2007 and 2008 WIPO Patent Reports highlight the changing geography of innovation with the highest patenting growth rates in North-East Asia, and particularly the sharp rise in patent filings in China. From 2004 to 2005, there was steady growth in patent filings by applicants in their country of residence (+6.6 per cent), but patent filings by non-residents had grown at a faster rate (+7.6 per cent). During the same period, the most notable increases can be seen at patent offices of emerging states. The patent office of China has the highest growth rate for resident (+42.1 per cent) and non-resident (+23.6 per cent) filings. The WIPO Patent Report highlights the fact that in China patent filings by residents increased by more than eight times between 1995 and 2005. Some of the conclusions in the report are based on the assumption that patent applications are a critical indicator of inventive activity and that resident patent filings are a reliable proxy measure of underlying inventive activity in a country.

There has been a long tradition of using patent data to assess the features of innovative activities. Patent documents usually include detailed information about the technical features of the invention (for example claims, technical classification, citations), details of inventors and applicants, and the history of the application (dates). The major advantage of patents is that they are publicly available with rather long time series and provide detailed technological information. The long time series make patents unique among innovation indicators. Using patent data, it is possible for researchers to collect data in highly disaggregated forms and to subject these to statistical analysis. In terms of costs, the cost of processing patents data is lower than that of survey-based data.

What can actually be measured using patent data? The literature review suggests that at least six attributes of innovative activities could be evaluated through patent data (Vanessa Oltra & René Kemp, 2007). The first attribute is the level of innovative activity. Patent applications are usually filed in the early stage of the research process (Griliches, 1990). Therefore, the number of patent applications can be viewed not only as a measure of innovative output, but also as an indicator of the level of innovative activity itself (Popp, 2005). Cohen et al. (2000) indicate that there is a mutual causation between R&D and patents, and that patenting tends to stimulate R&D. Lanjouw and Mody (1996) found a strong positive correlation between patents and R&D in alternative energy for the US.

Secondly, the patent data can illustrate the types of innovation and technological competencies of organisations. Actually, each patent provides a detailed description of the innovation and is classified according to the International Patent Classification (IPC), which divides the area of technology into a hierarchical structure with a range of sections, classes, sub-classes and groups. This system is efficient for the retrieval of patent documents for establishing the novelty of an invention or determining the state of the art in a particular area of technology. The description of the technology and the IPC codes can be used to distinguish between different types of technological innovation according to their degree of novelty (radical or incremental) and their technological field. Moreover, patents are also a good indicator of the directions of research and of the technological competencies of organizations. (Breschi et al., 2000).

Third, the patent data can be used to indicate the technological strengths of nations. For example, Marinova and McAleer (2003a, 2003b) analyse the technological position of the top twelve foreign patenting countries/areas in the US in the area of nanotechnology, using four technological strength indicators based on patent data, which are: (i) technological specialization index, (ii) patent share, (iii) citation rate and (iv) rate of assigned patents. The non-US countries/areas analysed are Australia, Canada, France, Germany, Great Britain, Italy, Japan, Korea, the Netherlands, Sweden, Switzerland and Taiwan.

Fourth, patent data can be used to measure technology diffusion, as patent data are available from many different countries to track patterns of diffusion (Popp, 2005). Because of the principle of territoriality, inventors must file a patent application in each country in order to enjoy protection in that country. In Europe, inventors may choose to file an application through the EPO rather than applying to national patent offices individually. However, as EPO applications are more expensive, European inventors typically first file a patent application in their home country, and then apply to the EPO if they desire protection in multiple European countries. Filing a patent application in a given country is a signal that the inventor expects the invention to be potentially profitable in that country. Thus, researchers can use these data on multiple filings of patents to track the diffusion of technology across countries (Lanjouw and Mody, 1996).

Fifth, patent data are a good source of innovation instigators and of networks of innovators. From the bibliographic data on a patent, researchers can gather the identity and home country of the inventor and of the assignee (or the applicant). Such information enables researchers to identify the sources of innovation in terms of patenting organizations. For a given technology, or a given IPC section, it is then possible to calculate the share of patents filed by private firms, universities and public laboratories. Some researchers focus on joint patent applications in order to study collaborations and networks of innovators, such as Yarime (2005)'s work on university-industry collaboration in the field of photocatalyst technologies using patents as an indicator of the relationships between organizations in the innovation process.

Sixth, patent data can indicate technological spillovers and knowledge relatedness. There have been various attempts to conceptualise relatedness among technological fields and to find appropriate measures for knowledge spillovers. Various methodologies have been proposed on the basis of patent data. The "Yale matrix" (Scherer, 1982) is constructed based on the data from the Canadian Patent Office; Jaffe (1986, 1989) measures technological relatedness among a sample of US firms by looking at the distribution of their patents across technological fields; Engelsman and van Raan (1991, 1992) analyse the concurrence of IPC codes assigned to patents to evaluate knowledge links and spillovers; while Verspagen (1995) evaluates intersectoral technology spillovers by distinguishing between the main classification IPC code and the supplementary codes. Other methodologies use patent citations, that is, references to previous patents. According to Jaffe and al. (1993), a reference to a previous patent indicates that the knowledge in the latter patent is in some way useful for developing the new knowledge described in the citing patent. For a given technology, the set of patents and the citations can be viewed as a network of ideas and their relatedness. Accordingly, Verspagen (2005) uses patent citations to describe the main paths of knowledge flows in the field of fuel cells and to map the technological trajectories underlying fuel cell development. Such a methodology made it possible to capture the cumulativeness and the dynamic character of innovation.

However, the analyses based on patent data need to be treated with caution when interpreting the geography of innovation activities. What an indicator reflects depends on the underlying methodology used to construct the indicator. Without proper adjustment, the information on patent filings as submitted by national intellectual property offices as innovation indicators is inadequate or even biased, which researchers should be aware of, particularly when undertaking international comparisons. In the next section, as a case study, Chinese patenting will be examined in detail to show the features of patent applications in China and how the use of patent data may result in misinterpretations.

The correlation between the sharp rise in patent filings and innovation capacity is not so straightforward. On the basis of detailed analyses, this paper demonstrates that it is too early to confirm the changing geography of innovation; a full assessment requires further econometric, classificatory, survey research and interdisciplinary interpretation. The way forward is to develop a proper set of indicators to monitor changes in innovation capacities, especially in the developing countries. In the case of cross-country comparison with OECD countries through the adoption of common standards, gaps and catching-up efforts could be evaluated. Many experts working in this area have suggested the adoption of multiple indicators in measuring innovation performance in non-OECD countries.

Section II of this research paper will first examine the approaches followed by the OECD, WIPO and national practices concerning the measure of innovation through patent statistics. It is highlighted that current approaches place heavy weight on patent counts. Section III will examine the problems of patent counts as proxy to cross-country innovation performance. Section IV will examine the problems of patent counts as proxy to the geography of innovation performance. Section V will examine and highlight some possible solutions and caveats for arriving at a healthy interpretation of patent statistics. Finally, section VI ends the research paper with conclusions and recommendations.

II. MEASURING INNOVATION PERFORMANCE: THE HEAVY WEIGHT OF PATENT COUNTS IN WIPO AND NATIONAL SETTINGS

The current section will review current practices in measuring innovation performance, internationally by focusing primarily on WIPO and the OECD, and nationally by focusing on practices in national intellectual property offices. A certain degree of flawed understanding exists at both levels in that all patents are automatically considered as reflecting a country's innovation performance. This needs thorough investigation, as is carried out in the sections that follow, for which this section will act as a preliminary summary of practices.

II.1 Current Practices and Interpretation in International and National Settings

II.1.1 The OECD Approach

For the OECD countries, innovation is considered to be one of the important pillars in global competitiveness. Innovation indicators have been developed over time since the 1950s, more specifically through the efforts of the OECD. The *Oslo Manual* is the leading international source of guidelines for the collection and use of data on innovation activities in industry. In 2005, the third edition of the *Oslo Manual* was published, incorporating new updates to take into account progress made in understanding the innovation process and its economic impact, and experience gained from recent rounds of innovation surveys in OECD member and non-member countries. It is important to note that there my also be substantial innovation activities in the field of non-technological activities. Thus in 2005 the *Oslo Manual* investigated for the first time the field of non-technological innovation and the linkages between different innovation types. It is pertinent to note that the manual also came up with a useful annex on the implementation of innovation surveys in developing countries. What is important in the context of this paper is to understand the approach of the OECD in measuring innovation performance from a cross-country perspective and to gauge the weight given to patents as indicators of innovation.

The *Oslo Manual* gives particular importance to patent counts with regard to understanding the level of commercial usefulness/appropriateness of inventions. Patent counts are viewed as indicators of innovation output. However, the *Oslo Manual* makes a crucial point with reference to the usefulness of placing reliance on patent counts:

> The number of patents granted to a given firm or country may reflect its technological dynamism; examination of the growth of patent classes can give some indication of the direction of technological change. The drawbacks of patents as innovation indicators are well-known. Many innovations are not patented, and some are covered by multiple patents; many patents have no technological or economic value, and others have very high value.

Thus the crucial caveats that prompt the efficacy of patent indicators have been mentioned in the *Oslo Manual*. The methodologies concerning use and interpretation of patent data is discussed in greater detail in the *Patent Manual* (OECD 1994). It must be noted that publication of the OECD *Patent Manual* marked a major step in the process of clarifying and harmonising patent-based indicators. It described the legal and economic background to patents and listed indicators that could be constructed from patent databases. It also listed a limited number of methodological problems encountered when calculating indicators based on patents. However, it fell short of analysing problems and proposing realistic solutions.

The OECD has also come up with an annual *Compendium of Patent Statistics* which provides excellent compiled data concerning patents. The OECD Patent Database was set up with the main purpose of developing patent indicators which are suitable for statistical analysis and which can help address science and technology (S&T) policy issues. This database covers data on patent applications to the EPO, USPTO and patent applications filed under the PCT that designate the EPO, as well as Triadic Patent Families. Data derive mainly from the latest version of the EPO Worldwide Patent Statistical Database (PATSTAT). The methodology adopted by the OECD is based primarily on patent counts according to priority date, which is that closest to the date of invention. New methods for now-casting patent counts have been rigorously studied to avoid time lag between the priority date and the availability of patent information. Again, resident patent activities are primarily used as being suggestive of local innovation capacities. For example, the 2007 patent compendium presents various patent indicators to reflect recent trends in innovative activity across a wide range of OECD and non-OECD countries, with seven main sections: triadic patent families, patenting at the national, regional and international level, patenting in selected technology areas, patents by institutional sectors, international co-operation in inventive activities, and science linkages in technology. Within the OECD framework there is thus heavy reliance on patent counts as suggestive of indicators of innovation.

II.1.2 WIPO

WIPO collects and publishes annual statistics on industrial property, by country and in accordance with the relevant international industrial property classification systems administered by WIPO. The statistics relate to patents, utility models, marks, industrial designs and so on. The compiled statistics are published in the form of reports, the most recent having been published in July 2008. This report is the third in the WIPO series of annual publications on statistics compiled from various sources, that is PCT statistics and patent information shared by the national/regional patent offices. In many ways, the report is valuable for understanding the use of the patent system in both developed and developing countries, including its internationalisation. The report has shown consistent improvement in providing objective and detailed information in comparison with previous years, mainly by providing extensive statistics in different fields of technology that highlight and identify key/emerging technologies, statistics pertaining to the use of utility models as an alternative to patents, technology indicators (relative specialisation index), statistics on opposition and invalidation, costs of patenting, and so on. The 2008 report has for the first time made provision for separate annexes that are extremely useful in understanding methodologies used in arriving at precise patent indicators. Apart from this, special attention has been paid to defining caveats, and a key section has been devoted to detailing the general methodology adopted. It should be noted that WIPO has relied primarily on methodologies developed by the OECD. There are certain specific problems that remain to be addressed in both the 2007 and the 2008 reports. Interestingly, compilation and interpretation of patent statistics has become one of the prominent features of WIPO activities, apart from administering intellectual property (IP) treaties. This is also revealed through its pledge to boost patent statistics activities.

In this connection, it would be important to know the basic contents of reports and to have a review of some important definitions and caveats. The report provides statistical indicators, which according to WIPO sheds light on issues such as the functioning of the patent system and its use by both developed and developing countries. The report aims to provide new indicators that are relevant to current policy issues. Generally, the main content of the WIPO statistical reports pertain to patent filings and grants by offices and countries of origin with the aim of providing an overview of the level of patent activity across the world, patent statistics by field of technology which reveal key/emerging technologies, the use of utility models as an alternative to patents for protecting IP rights, international filings through the PCT, indicating the level of internationalisation of technologies, use of the patent system in emerging countries, the processing of patent applications, including pendency, volume and time, which highlight the challenges faced by patent offices with rapidly increasing numbers of patent filings, opposition and invalidation statistics, and statistics concerning costs of patenting. In the context of this paper, it is of importance to understand how these statistics have been interpreted by WIPO. The outcome of the 2007 report stated that there were higher instances of innovative activities in North-East Asia, especially China, based on residence patent filings. According to the WIPO Glossary on Industrial Property Statistics, a "resident" filing refers to "an application filed with the Office of or acting for the State in which the first named applicant in the application concerned has residence". This presents great methodological difficulty in attaching a degree of importance to resident patents. The 2007 report made specific mention to the effect that local innovation can be assessed through resident patent filings as they are a "reliable indicator of inventive activity". This was problematic in many ways as there are fine caveats to relying on the inventive activity of residents as constituting innovation within a particular geographical location.

The problems pertained mainly to the fact that for those inventive activities which take place in a particular geographical location, the inventor may file a first application (resident patent) from any patent office across the world. This at least creates theoretical problems in terms of identifying innovation activities in a particular geographical location, which at times may lead to double count. There is no practical methodology for fundamentally establishing that innovation accrued within a particular geographical location is always attached to the first filing of resident patents. Further, identifying local innovation by relying purely on patent activities by nationals/residents in a developing country may underestimate or overestimate the underlying national inventive activity. For example, cross-border acquisition/merger of a firm by a developing country resident for innovation actually accruing within a developed country's jurisdiction may lead to overestimation of local innovation capacities. This is rightly placed as a caveat in the report where it states that "due to the increase in the internationalization of R&D activity, R&D may be conducted in one location but the protection for the invention might be sought in a different one". Thus it is important to read caveats placed in the WIPO reports so as to arrive at formal methodologies concerning their interpretation of "resident" patent activities. Thus it is worth noting that WIPO relies heavily on patent counts to arrive at a measure of innovation performance, especially in the developing country context.

II.1.3 National Practices

One of the important functions of patent statistics is to arrive at policy conclusions concerning the measures to be adopted for pacing S&T. There is anecdotal evidence to the effect that policy makers have relied on patent statistics to arrive at decisions concerning national S&T developments. There is much less degree of objective understanding of patent statistics at the national level, and they may be prone to subjective abuse. Patent statistics may often create confusion for national policy makers due to their sheer volume through quantification techniques. For example: The significant rise in patent applications in developing countries can be illustrated through the Chinese experience, where in December 2007 the Chinese State Intellectual Property Office (SIPO) received its four millionth patent application since the country's first patent law was implemented way back in 1985. While it took 15 years to get to the first million, however, not more that one and a half years was needed to get to the fourth million. Now, this can be interpreted by policy makers as amounting to the greater success of the patent system in China and for the need to gear up with enforcement mechanisms. However, working through the nuances, the statistics may well need some critical interpretation, specifically pertaining to the link between innovation activity in China and the volume of patents.

II.2 General Characteristics of Patent Statistics Reflective of International and National Practices

II.2.1 The Heavy Weight Placed on Patent Counts for Cross-country Comparisons

The above analysis of various approaches followed by the OECD, WIPO and national practices suggests that currently there is a heavily weighted patent count for cross-country comparisons. On a broader framework, cross-comparing innovation performance is a positive step in understanding a country's position in the global marketplace of innovation. However, this has to be done through the use of multiple indicators of innovation and by reading into their specific caveats. The heavy weight placed on patent counts is due to the fact that most national patent offices publish statistical directories of patent counts filed in the country concerned, and analysts tend to compare the number of patents filed with the national industrial property agency in country "X" by inventors resident in country "X", country "Y", "Z" and so on. But this is without due consideration of the "home advantage" factor, which naturally leads to over-representation of a country's resident patent activities in that country's total patent filings. For instance, the share of US residents in patents granted by the USPTO is between 55 per cent and 60 per cent, while the share of Japanese residents in patent applications filed with the JPO is in the order of 85 per cent. Placing reliance on counts of "resident patents" can thus be a slippery approach for cross-country comparison. There can also be considerable bias in cross-country comparisons when national statistics stem from the fact that patent protection is operative in only one market and those other countries may or may not be as interested in protecting their inventions in any given market. This may, therefore, highly exaggerate the filings by particular nationals in particular countries, depending on contextual economics, market size and trade flows. We could call it "trade flow bias". For example, it was noted that Korean inventors have more of an incentive to seek protection in Japan (they accounted for 4.3 per cent of patents filed with the JPO by non-residents in 1998) than in Germany (1.1 per cent). This means that activities of residents concerning their filing habits can be skewed and hence cross-country comparison can lead to considerable bias.

II.2.2 The Heavy Weight Placed on Patent Counts for Assessing National Innovation Capacities

The current understanding of national innovation capacities based on patent filings is partially flawed in its approach. While it is understandable that some patents filed by residents may involve local innovation, this need not be the case. There is no formal link between patents filed in a particular geographic location by residents and the place of invention. Correctly ascertaining the place of invention is useful in understanding the relevant spread of economic growth, employment, investment in R&D and so on. However, by no stretch of the imagination should patent counts be considered for assessing innovation capacities without due reference to caveats.

The use of patent statistics in an attempt to understand or measure innovative activities within a particular geographical location is often not free from defects. Distinct from problems identified in the 2007 and 2008 WIPO reports in the form of caveats placed therein, some of the major problems in relation to the use of patent statistics are with reference to assigning indicative value to a patent count. Some patents may be more valuable than others. Hence patent quantity without proper value assigned to the quality of the patent applied for/granted would be of less help in understanding the measure of innovation. There are various ways in which a value of a particular patent can be arrived at. It may depend approximately on the licensing values attached, a low/high level of patenting activity in the particular technology field (if such a filed technology relies heavily on patents), the importance of the invented technology in global knowledge trade flows (as hi-tech or low-tech), patents that are essential to technical standards, and so on. Such nuanced distinctions concerning value assigned to a patent makes it generally difficult to cross-compare patents at micro level (firm level) and macro level (among regions/nations and so on), or as technology indicators. Generally, it is found that the relative strengths of patenting activity in developing countries (except some emerging countries with due reference to caveats) do not lie in high-technology sectors. Hence, placing undue reliance on the volume of patenting activity may not be indicative of innovative activities, as the value they generate is of less critical importance to the global knowledge trade flows.

Since patenting activity in developing countries is generally incremental (and not breakthrough), even considering that they innovate in hi-tech sectors, then in terms of value the subject matter patented may be of less critical significance to global knowledge trade flows. In this connection, it is important to look into licensing values attached to resident patent activities in emerging countries vis-à-vis their counterparts in developed countries. The same holds good for the foreign patenting activities of developing country inventors that rely on the PCT/Paris Convention route for filing applications. However, licensing terms and any ensuing royalty stakes involved are private information which firms/organisations might not be willing to disclose. Thus comparing innovative activities by relying purely on the volume of patenting activity does not signify a nuanced proposition unless other complementary factors concerning innovation, technical change and value derived out of innovation are considered.

Another predicament involved in assigning a higher degree of importance to resident patent activities as corresponding to the innovative activity of domestic firms is that a large number of patent applications filed by foreign companies through their locally-incorporated branches in developing countries may count as domestic/resident patents, and hence the mixture of foreign and local patent filings could mislead an objective assessment of the real level of local innovation capacities in the country of origin. The 2008 WIPO report, in defining a country of origin, states, "[P]atent applications include information pertaining to the country of residence of the inventor and the applicant (or assignee)". However, it has also introduced a *new* caveat which states, "Country of origin used in this report is based on the country of residence of the first-named applicant (or assignee), which will include companies that are domiciled in a country but which may be effectively owned or controlled by overseas interests. This is particularly the case in countries with large foreign direct investments." With proper caveats in place, the possible emphasis on resident patent activity in the OECD framework, WIPO, and national practices as indicators of local innovation seems to be less logical in its formulation. This shows that there is an element of statistical bias in construing weights to indicators.

III. PROBLEMS OF PATENT COUNTS AS PROXIES TO CROSS-COUNTRY INNOVATION PERFORMANCE

Conceptually, the benefit of a cross-country comparison approach is that it allows assessment of the relative share of various countries in innovation in a given national technology market, in this case country “X”’s market. Since patents protect an invention only in the country of filing, any technology used or sold in country “X” must be patented there (at least in reasonably large countries) and national authorities are interested in this domestic aspect of technology competition. As noted above, the heavy weight placed on patent counts for the purposes of cross-country comparison has some inherent limitations. In this section, the fundamental problems concerning patent counts being used for cross-country innovation performance have been examined in detail.

III.1 What Constitutes a Patent? The Implication for Patent Counts and Cross-Country Innovation Performance

III.1.1 Definition of Patent

A patent is an exclusive private property right over an invention, which gives its owner control over the use of the invention for a limited period of time and in a given territory. Patents are subject to national grants, and flow from a statute. Patents are granted by following a three-fold criterion of novelty, inventive-step (non-obviousness) and industrial applicability (utility). The nuances of this are left for individual countries to decide. The prior-art requirement in the case of novelty excludes existing technologies, pure ideas in the nature of abstract scientific theories, formulas, mathematical calculations and so on; they are considered as basic building blocks for future innovations. The economic philosophy underlying the patent law suggests that patents have a dual advantage in terms of innovation effect and diffusion of technology effect. In other words, it is understood that by being given exclusive rights for commercial exploitation, the inventor or his assignee would be able to charge monopoly prices and recoup his investment. On the other hand, the public interest argument is that a patent will bring into the public domain information which would otherwise be held secret by the inventor, thus promoting prompt diffusion of technologies for faster innovation, which benefits society as a whole. Any incentive structure in the form of a patent system can have various components. Worldwide, the patent incentive structure is divided mainly into the standard patent for inventions, utility model patents, plant patents and design patents. This reveals that patent statistics can not be presumed to be standard indicators of inventive activity for the purpose of cross-country comparisons.

The patent process involves a patent applicant’s filing a document with the patent office of the country in which he is seeking protection for his invention. The patent document is a rich mine of information on the invention it covers, information which can be used directly in constructing statistical indicators. This information pertains to the technical features of an innovation, claims, drawings, abstract, specification, class of invention, cited patents and other documents as prior art and so on. Apart from technical features, the patent document contains information regarding the inventors, assignee, applicants, history of the application, priority date, country filing date, date of publication, date of denial or withdrawal, date of grant, date of termination due to non-payment of renewal fees, and so on. However, it contains no information regarding the exact location of the invention. The inventor’s/applicant’s address is not helpful in understanding the place of innovative activity.

III.1.2 Different Practices Being Considered in Different Countries based on Differences in the Design of Patent Systems

The design of a patent system is left to individual countries provided that such systems are in consonance with the minimum standards as prescribed under the TRIPS Agreement. The problem that eventually occurs in the case of patent statistics is that sometimes utility patents may be included within the general patent system, which results in overestimation of the technical innovative capacity and confuses the geography of innovation. While the WIPO Patent Report validly makes this point, it goes no further in excluding them for analysis. The methodology used in the report is not suggestive of the interpretation that utility patents have been excluded for all purposes while collecting statistics on patents. In some cases incremental inventions, which should indeed form part of the utility models, may have been included in standard patents for invention statistics. The problems in understanding patent statistics can be illustrated through a Chinese example. During 2007, SIPO received 694,153 patent applications covering three types of patent: invention, utility and design. While this number may at first sight seem huge, the overwhelming number of applications, pegged at almost 450,000, was for utility and design patents, which are not subject to substantive examination. Only the standard invention patents receive full scrutiny involving the patentability thresholds; there were 245,161 of these submitted during 2007. Thus patent statistics from one country can be skewed due to differences in design of the patent system, and primarily the question arises as to which patent statistics will be considered for making cross-country comparisons.

These differences in design of patent systems are also primarily due to gaps in the current international legal framework, which work as flexibilities for countries in designing incentive structures for innovation - be they standard patents for invention, utility models or design patents. Thus, for instance, TRIPS allows three important flexibilities in the design of a patent system:

- The TRIPS Agreement does not obligate member countries to have utility models for protecting minor innovations and hence countries may have a utility model or they may refrain from having one. The TRIPS Agreement requires only a standard patent for an inventions system which takes care of inventions based on three threshold criteria for inventive-step, novelty and utility.

- TRIPS states that plant varieties can be protected either through patents, *sui generis* or both. Thus countries are free to provide plant patents, exclusive plant variety protection through a *sui generis* law or a combination of both. The last among the three models is not popular and is not used by any of the patent regimes across the world. Thus plants and plant varieties are protected either through patents or through *sui generis* plant variety legislations.

- While TRIPS has dedicated two important sections to protection of industrial designs, it does not specify whether they can form part of the patents scheme similar to the standard patent for inventions scheme. Thus countries are free to enact specific patent-like legislation, or separate industrial design legislation. In the case of patent-like legislation, there is always the possibility of including them with standard patents for inventions statistics and hence giving an incorrect picture of innovation geography. In many countries, designs are also protected through copyright.

The following table provides an overview of divergence in invention patents and utility models across the world. The WIPO IP statistics work has been commendable in this area and hence this table (which applies only to the EU and the US) is based largely on sources from WIPO.

Table 1
Utility Models, Plant Variety and Designs in the Definition of Patents

	US	EU	Brazil	India	China
Utility models	NO (not to be confused with "utility patents" which are synonymous with patents for inventions)	NO (allowed in a few countries based on national legislation, but not harmonised by EU law)	YES	NO	YES
Plant Patent Act	YES (both utility patents and an exclusive Plant Patent Act are in place provided they satisfy the different criteria required under different laws)	NO	NO	NO	NO
Design patents	YES	NO	NO	NO	YES

The concept of "utility patents" in the US is similar to the standard patent for inventions model followed in different countries. Since the US does not provide for utility models, the decrease in patent quality is a closely-related issue. Commentators have suggested that a law which could provide utility models could substantially avoid the proposal for recent patent reform in the US. It is seen that the lack of utility models is a reason for the lowering of the US patent law threshold requirements. This proves conclusively that many patents which are of incremental value and minor inventions may inadvertently form part of the "utility patents" scheme. The same is the case with India, which provides only for a standard patents for invention model and not the utility model. In some European countries, it is possible to register a utility model. Creations which are new and differ essentially from the known art can be registered as utility models rights in those European countries which offer this type of protection, namely Austria, Denmark, Finland, Germany, Hungary, Poland, Portugal, Russia and Spain. However, such a model is not available at the EU level. An unsuccessful harmonising attempt was sufficient proof that the EPO had to lower the inventive step criterion for providing patents which have minor and incremental value. These have led to large numbers of patents being issued. Brazil follows its own utility model apart from the patent for inventions model. The exception applicable in the case of the patent for inventions model is made equally applicable to utility models. However, the criterion of inventive step in the case of utility models is quite low when compared to the criterion of patents for inventions.

In the case of plant variety protection, each country has special legislation. The US has the Plant Variety Protection Act of 1970 (PVPA), 7 USC §§ 2321-2582. The PVPA gives breeders up to 25 years of exclusive control over new, distinct, uniform and stable sexually-reproduced or tuber-propagated plant varieties. The PVPA should not be confused with plant patents provided under the Plant Patent Act 1930, which are limited to asexually reproduced plants (not including tuber-propagated plants). Another problem identified in this context is the availability of patents for plants through the standard patent for inventions model. After *J.E.M. AG Supply, Inc.,* v. *Pioneer Hi Bred International, Inc.,* it is now possible to get a patent over plants by satisfying invention criteria of the standard patent criteria. In this 2001 case, the Supreme Court held that utility patents may be issued for plants under 35 USC 101 despite distinct protections available under the PVPA and the Plant Patent Act. Thus in the US there is the possibility of including inventions concerning plants within the patent for invention framework or the "utility patent" framework. This has wider implications for statistics concerning patents as it covers plant variety inventions which still remain outside the scope of patent laws in some other countries.

In Brazil, Decree No. 2366, PVP Gazette 89, published in September 2000, enacts regulations under law No. 9,456 of 25 April 1997, on plant variety protection and rules on the National Plant Varieties Protection Service (SNPC), and introduces other measures. This is a *sui generis* legislation passed to satisfy the TRIPS obligation. But the Brazilian patent for invention law does not exclude plants from patents. Sections 10 and 18 of the Brazilian law are not clear in this regard, as they do not specifically use the terms plant or plant varieties. However, the words "living beings, in whole or in part" which appear in section 18, and "natural living beings" which appear in section 10 and section 18, can be interpreted partly to exclude certain type of claims over plant varieties.

In India, the position is a little risky, considering the fact that there is the possibility of including certain plant-related inventions within the patent for invention model. This possibility is due to the expanding connotation which can possibly be given to the word micro-organism. Certain plant varieties, which have distinct micro-organisms and which satisfy the patent law threshold, can thus be within the patent framework, even while plant varieties are excluded. Here the claims can be structured to exclude plant varieties, but the main micro-organisms which give unique characteristics, distinctiveness, novelty and stability to the plant can be covered for infringement purposes. Thus there is the possibility of certain plant inventions coming within the patentability framework. There is a also a *sui generis* law in place known as the Plant Variety Protection and Farmers' Rights Act, 2001. This should in fact take care of plant-related inventions but, as discussed above, contrary situations are quite possible under the Indian plant variety or plant protection models.

In the EU, the protection of new plant varieties is a result of the procedures currently in force in member states and the procedures of Regulation No. 2100/94 (EC) on Community Plant Variety Rights (CPVR), which are generally based on the Union for the Protection of New Varieties of Plants (UPOV). The new community-wide system exists alongside national systems as an alternative. It is not possible to hold European Community and national plant variety rights simultaneously for the same variety. Furthermore, a CPVR cannot coexist with a patent. If a CPVR is granted in relation to a variety for which a national right or patent has already been granted, the national right or patent is suspended for the duration of the CPVR. This suggests that patents which have become redundant due to superseding of the CPVR must be deducted for all practical statistical purposes. Hence the filing of such patents must be discounted for the purpose of knowing the geography of innovation.

In China, the Regulation of the People's Republic of China on the Protection of New Varieties of Plants, as published in the *PVP Gazette*, Issue No. 85, October 1999, is the law in force. It is supported by implementation rules through two decrees (Nos. 13 and 3) published in 1990. In this situation, it is doubtful whether plant patents form part of the standard patents for invention scheme in China.

The design patents system is unique to the US, where it forms part of a parallel patent scheme. Chapter 16 provides patent protection for designs; it states that whoever invents any new, original and ornamental design for an article of manufacture may obtain a patent. This allows ornamental designs to come within the patent framework, which can be considered as a count. On the other hand, the EU has a system of community designs which became operational in 2003. A single registration ensures protection across all member states. The legal basis is provided by the Regulation on Community Designs (No 6/2002). The detailed rules for applications and procedures for registration are contained in Commission Regulation (EC) no. 2245/2002. The Regulation on Community Designs also provides an unregistered design right lasting for three years after a design is made available to the public. This is intended for industries which produce a large number of designs with a relatively short market life. Thus in the EU designs have a separate category of protection and therefore do not form part of the patent count. The Brazilian consolidated IP law in Title II provides for registration of industrial designs. The same is the case in India, but neither of these countries provides for unregistered designs.

III.1.3 Differences in Standards of Patent Examination and Outcome on Patent Statistics

Another drawback of international comparison-based national patent counts lies in the high heterogeneity in the value of patents. The value of a patent can be approximately defined as the contribution of the invention it protects to the economy, either in technological terms (novelty and fertility of the invention), or in economic terms (return to the patentee). There is broad recognition that the value distribution of patents is skewed; a few patents have a high value, whereas many have a very low value. Hence the significance of patent counts is limited, as they place patents of very different values on an equal footing.

As TRIPS leaves considerable flexibility to national patent regimes in adopting a patent law threshold, there can be different patterns of examination adopted by different patent offices. In fact, patent offices in different countries have issued manuals on patent examination and procedure which guide the patent office of respective countries through the granting of patents. In this section we shall examine a general trend in granting patents by lowering the patent threshold requirements of novelty, utility and inventive step. These trends have been examined in the light of the US Federal Trade Commission (FTC) and National Academy of Sciences (NAS) reports. A universalisation of these standards is also occurring widely. In other words, developing countries are increasingly stepping into the shoes of developed countries with regard to patent law standard setting. We should now take a first-hand review of the legal provisions concerning patent law thresholds and the possibility of granting low-quality patents in developing countries as well. We also examine the Manual of Patent Practice and Procedures and see how different standards of patent examination can lead to different natures of grant in developed and developing countries.

The surge in patenting as a result of decisions of the US Federal Circuit Courts which opened up the way for a more liberal patenting framework could explain the rise in the grant of ‘questionable patents’. In this regard, the threat posed by USPTO appears clearly in the 2003 FTC Report on Patents and Competition, where it states:

> …[F]ailure to strike the appropriate balance between competition and patent law and policy can harm innovation. For example, if patent law were to allow patents on “obvious” inventions, it could thwart competition that might have developed based on the obvious technology.

It defines a questionable patent as “one that is likely invalid or contains claims that are likely overly broad”. The main points detailed by the report are as follows:

1. Questionable patents can deter or raise the cost of innovation;
2. In industries with incremental innovation, questionable patents can increase “defensive patenting” and licensing complications;
3. The report suggests post-grant review of patents and challenges at USPTO rather than in the courts;
4. It suggests tightening the legal standards used to evaluate whether a patent is “obvious”;
5. Before extending patentable subject matter, the possible harm to competition should be considered, together with other possible benefits and costs before extending patentable subject matter;
6. There should be policy-oriented interpretation of the patent laws by the courts as much as is necessary for maintaining a proper balance between patent and competition laws; and
7. The PTO rules should be amended to include its twenty-first century strategic plan.

The Committee on Intellectual Property Rights in the Knowledge-Based Economy (Report of the National Research Council of the National Academies) is a report on similar lines. In fact the report has drawn attention to the deteriorating quality of patents and has suggested reinvigoration of the non-obviousness standard. It states:

> There are several reasons to suspect that more issued patents are deviating from previous or at least desirable standards of utility, novelty, and especially non-obviousness and that this problem is more pronounced in fast-moving areas of technology newly subject to patenting than in established, less rapidly changing fields.

The statement is self-explanatory. The committee also remarked that high acceptance rates, especially if increasing over time relative to comparable rates in other industrialised countries, would be a reason to look more closely at examination quality. The report also discusses the rate of approval at USPTO and states that there are reasons to be concerned about both the courts' interpretations of the substantive patent standards, particularly non-obviousness, and USPTO's application of the standards in examination, especially in emerging technologies, where fairly broad patents may be granted early on, and fewer but narrower patents are granted as the field matures, more prior art becomes available, and examiners become more familiar with it. But the report cautions that such trends in giving space for the evolutionary process of innovation must be corrected before it is too late to take measures.

Prior use which can lead to lack of novelty is restricted only to use within the country. This is unique to the US law, as TRIPS has not defined novelty, which leaves enough leeway for any favourable standard to be set. This naturally leads to a higher degree of patent filing and grant, especially in the area of traditional knowledge and use of genetic resources, since many applications of such knowledge (which have not been made known through publication) have been used outside the US. This is one instance of difference based on difference in defining prior art for the purpose of novelty. Inventive step, popularly the synonym for "non-obviousness" in the US, lays down a standard where the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art (PHOSITA) to which said subject matter pertained. This definition has been open to several interpretations by the courts in the US and has been tightened or loosened at different points in time. One recent example, where the court slightly tightened the non-obviousness standard, makes it clear that there cannot be a single set of inventive step criteria, fixed in the case of all technologies. The decision in a way fundamentally reasserts that Article 27.1 of the TRIPS Agreement includes some leeway in the establishing of a criterion on inventive step by member countries. The clause also states that patentability shall not be negated by the manner in which the invention was made. This is also a unique exemption which can be used to lower the inventive step standard. It is possible to argue that an invention which lacks sufficient intellectual labour may still form part of the patenting scheme. Further, the phrase "person having ordinary skill in the art" is left undefined. The PHOSITA test may depend on how one defines the art (that is, the area of technology) and the level of skill of such a person. In *KSR International Co.* v. *Teleflex Inc. et al.*, Justice Kennedy remarked, "A person of ordinary skill is also a person of ordinary creativity, not an automaton." This slightly unsettles the USPTO position, which grants patents to inventions based on the low-level application of the PHOSITA test. In fact, USPTO came up with new guidelines in October 2007, based on the Supreme Court's decision in *KSR*. The guidelines offer a more restrictive approach and have slightly tightened the non-obviousness standards for examination of patents. It is expected that fewer patents may have been issued after application of the *KSR* test by USPTO. The utility standard in the US is also unique in the case of patenting biotech inventions, which suggests that standards may vary according to the nature of the technology.

However, the damage done by USPTO in recent years and the subsequent FTC and NAS reports are evidence of America's deteriorating patent law standards. These conclusions on the grant of questionable patents in the US are staggering developments which need greater attention from lawmakers and innovation economists alike. In fact, the recent patent law reform legislation is a step in this direction. The problem in associating technological innovation with such low-quality patents indeed questions the sanctity of the innovation and patent links. This is just an example to prove that a higher patent count does not necessarily have any link to a higher degree of innovation. This conceptual understanding can be understood in the context of the WIPO report suggesting the changing geography of innovation. Such presumption of patent-innovation link thus stands challenged. The EU, through the EPC, states with regard to novelty that an invention shall be considered to be new if it does not form part of the state of the art. The state of art comprises everything made available to the public by means of a written or oral description, by use, or in any other way, before the date of filing of the European patent application. While prior use and prior publication is sufficient to kill novelty, inventive step requires that the invention should be non-obvious to a person skilled in the art in comparison to the prevailing state of the art. These magic words have given sufficient scope for wider interpretation, which has subsequently allowed the EPO to grant patents by lowering the inventive step criterion. An invention is considered to have industrial application if it can be made of use in any kind of industry, including agriculture. The loose interpretation of the utility concept has allowed minor software innovation fixed on a tangible medium to be patentable. The history of the patent law criteria has always been territorial, but for the recent extension through TRIPS. Even while the TRIPS Agreement does not define the patent law thresholds of novelty, utility and inventive step, there has been a conscious effort by legislators and patent offices, and sometimes even the courts, to bring down the general level of inventive step.

Again, there can be challenges posed by differences in the standards of examination adopted by patent examiners. Are all patent examiners equal? This is a very practical question which has come under greater evidence-based scrutiny in the recent past. Evidence was compiled from insights gained through interviews with administrators and patent examiners of the USPTO, and a dataset of patent examiners was analysed with reference to patent outcomes. The main finding was that patent examiners and the patent examination process are not homogeneous; examiners whose patents tend to be more frequently cited tend to have a higher probability of receiving a Court's invalidity ruling. Thus these conclusions have some relevance for the statistical outcomes.

Thus, conceptually it needs to be re-emphasised that those inventions which possess a very high degree of patent law thresholds may or may not form part of the patent scheme in different countries. In this regard, the guidelines issued by patent offices can be important. Logistically, the guidelines are important in the sense that the Act cannot be expected to explain in greater detail the nuances to be followed, especially with regard to defining the type of claim format which could be allowed for each type of patenting activity. Thus they have the potential to blur definitional requirements and standards prescribed under the Act. And hence they may be important in understanding what type of grants are allowed and disallowed. This is sufficient to suggest that different countries may follow different procedures in their patent offices, which can lead to denial or grant of a patent right. It has implications for understanding cross-country comparison of the geography of innovation if successful patent count does indeed point to it. Hence, patent counts must take the above nuances into consideration when ascertaining the geography of innovation, especially in developing countries.

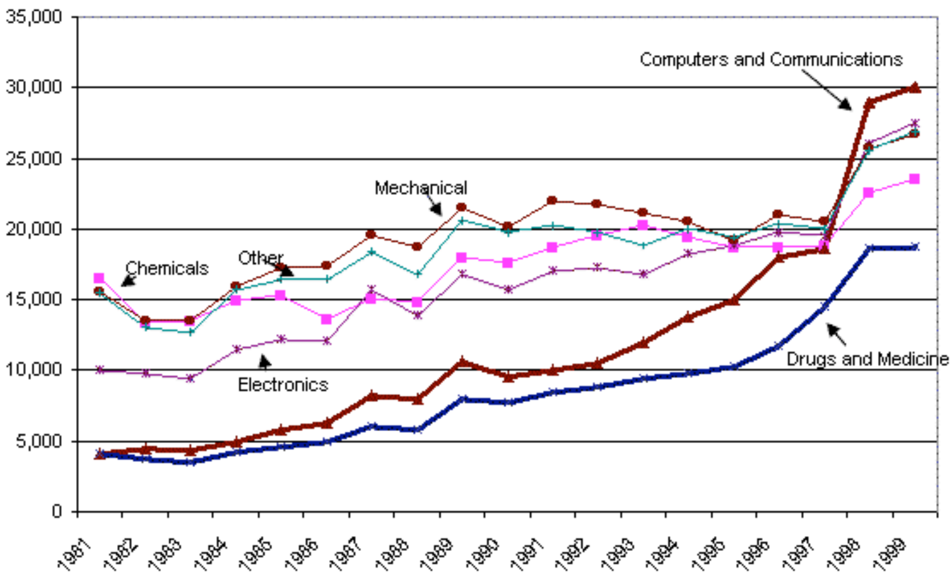
III.2 Emerging Trends and Problems: Changes in Law, Reversal and Invalidity Rates

Changes in law can substantially alter the statistical outcomes in any particular country. Thus cross-country comparison without recourse to the specificities of changes can overly exaggerate patent statistics. For example, during the 1980s the US courts opened the gates to patentability of software and biotechnology inventions. This has had consequent implications for the rates of patent being filed in these areas. Further, some judicial developments in the second half of the 1990s led to the inclusion of business method patents. This had consequent implications for the number of patents being granted. Furthermore, the Bayh-Dole Act of 1980 changed the academic patenting landscape so that federal funded institutes relied more on the patent system. For example also, the new rules allowed scientists, institutions and universities to own any patents resulting from their publicly-funded research, making China the latest of many countries to introduce a Bayh-Dole-style IP regime. This illustrates how sudden changes in law can have devastating effects on the statistical outcomes of patents.

The following table shows the rise in US patent grants after the 1980s in various technological fields, to illustrate how changes in law can affect patenting outcomes:

Table 2

Figure I U.S. Patent Grants by Technology Category, 1981-1999

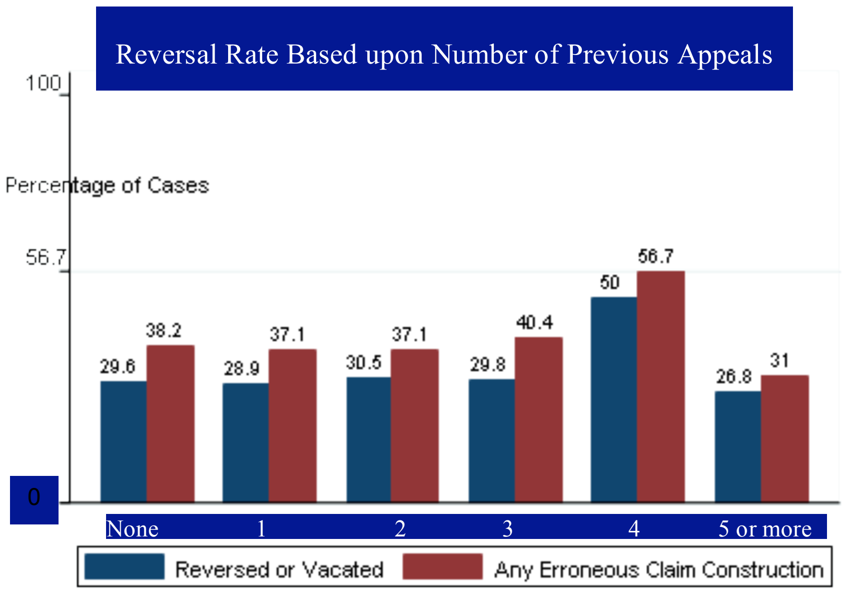


Source: NBER Patent Citation Database, Author's calculations

It may be noticed in the above table that the area of computers and communications saw a sudden increase in 1998. This was due to the decisions of the US federal courts in reducing the patentability criteria for software-related inventions through the decision in *Alappat*.

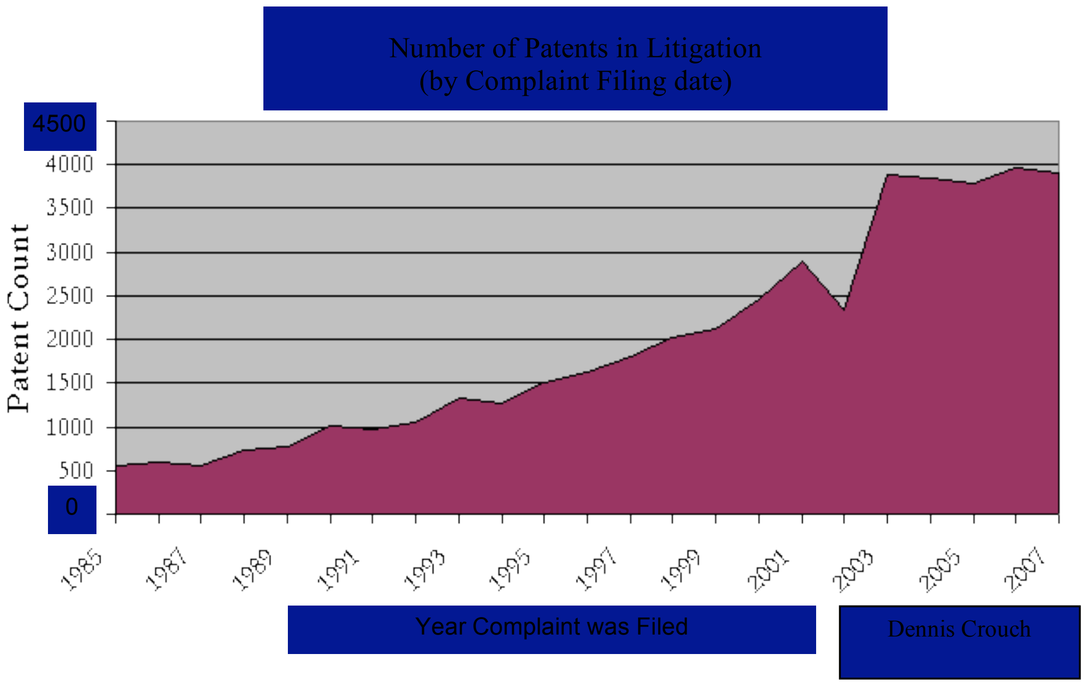
Further, there is growing evidence that patent offices have started tightening the standards of patentability, leading to differences in patenting outcomes. For example, according to statistics published in the EPO Annual Report of 2007, the number of EPO patents granted in 2007 fell as compared to 2006, despite an increase in the number of applications filed at the EPO. In 2007, the EPO granted a total of 54,699 European patents, a drop of 12.9 per cent compared to the 62,777 European patents granted in 2006. This is of considerable consequence in cross-country comparison, where reversal rates depend on patent quality assessment concerns. Also consider the reversal rate based on patent claim construction based upon previous appeals in the US:

Table 3



Source: Patently O Blog

Table 4



Source: Patently O Blog

Reversal rates refer to the rate at which filed patents are being rejected by patent offices following patent eligibility and patentability criteria. Reversal rates may also imply patent decisions by the courts where patents which were granted by patent offices or whose validity was confirmed by district courts were reversed by appellate courts. Thus reversal rates have implications for how patent statistics are interpreted for cross-country comparisons. The number of patents in litigation has increased, as shown in the table above, which consequently means that there are higher chances of invalidity, depending upon concomitant legal and policy readings followed by the judiciary. These reversal outcomes may widen the gap between patent applications filed and granted and those being subsequently reversed.

Patent reforms in some countries may also affect patenting outcomes. The inconclusive US patent reforms can be cited as a classic example. It should be noted that this particular piece of reform legislation was introduced by Congressman Lamar Smith of Texas in the United States House of Representatives. On 19 July 2007, the US Senate Judiciary Committee approved this Bill and soon the full Senate of the US Congress will approve the Bill to be enacted as law. The Bill will be called the Patent Reform Act of 2007 and proposes to amend various sections of title 35 of the United States Code (dealing with patent laws). The amendments are in response to concerns raised by the technology sector, basically the software industry, over costly infringement law suits and proper examination of patent law thresholds in the case of software, business methods and internet-related patents. Post-grant review is the focus of the Bill, which was formulated mainly in response to an increase in the issue of questionable patents by USPTO. However, the negotiations on patent reforms ended in deadlock in early 2008. Thus it is still not clear whether due to the passage of the Patent Reform Act of 2007 there could be an increase in invalidity decisions by the courts, or other measures which might deter patent filings and grants in the future.

III.3 Implications

Important conclusions can be drawn from the above analysis. These are:

- It must be ascertained what constitutes a patent for the purposes of examination of cross-country performance. Patent information in the document may be insufficient for the purposes of delivering optimal information concerning the complexities involved in ascertaining cross-country innovation.
- The differences in the design of patent systems may be important. Hence, patents may include utility models, design patents, plant patents. This highly exaggerates innovation capacities for cross-country comparisons since certain patents in some countries may not undergo the same depth of examination as they would in certain other countries.
- The policy implication of an exaggerated volume of patent numbers may have substantial impacts on the location of resources for supporting a patent-based framework at the cost of alternative models of innovation.
- Different standards of examination, and the evidence concerning a tendency for patent examiners not to apply criteria for grant outcomes, and so on, have profound implications for cross-country comparisons.
- Recent emerging trends concerning patent reversal rates, higher invalidity through claim constructions, possible patent law reforms and so on can have different outcomes in different countries. Thus cross-country comparisons can lead to skewed outcomes.

IV. Problems of Patent Counts as Proxy to Geography of Innovation Performance

Patent counts are often used to ascertain the relevant innovation activities being performed in a particular geographical location. This is done primarily through quantifying the resident patents of a particular country. In this section, certain aspects of the wrongful interpretation of resident patents as denoting local innovation are highlighted.

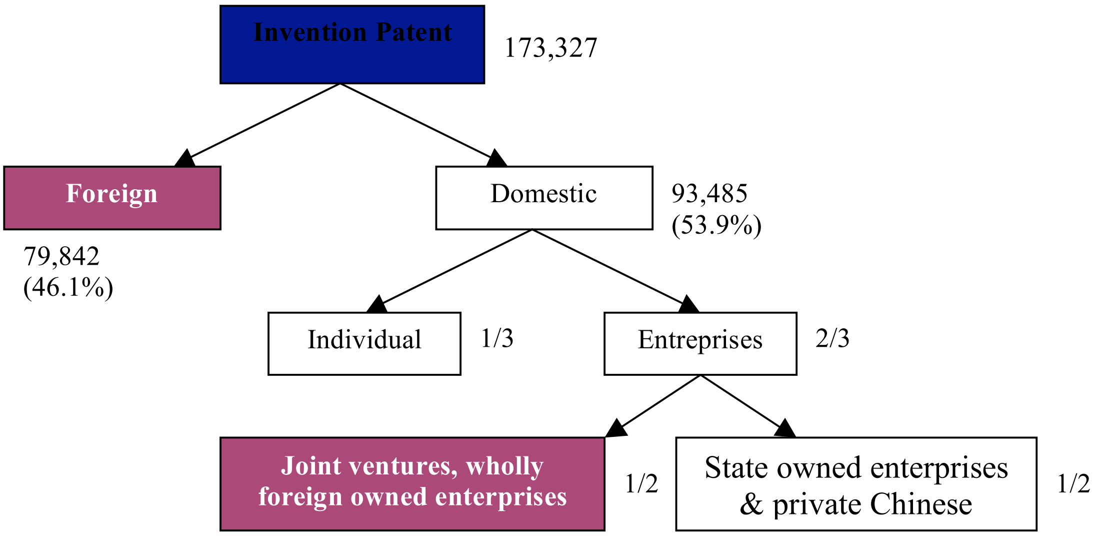
IV.1 Composition of Resident Patent Applications

The WIPO Patent Reports define "resident" patent application as "an application filed with the Office of or acting for the State in which the first named applicant in the application concerned has residence". Here, taking China as a country- specific example, it is argued that resident patent applications are not a reliable indicator of local innovation activities.

The WIPO Patent Reports identify the patenting activity of both residents and non-residents. Resident patent applications mean those where the first-named applicant or assignee is a resident of the state or region concerned. Non-resident patent applications are filed by applicants outside the relevant state or region. On this basis, the pattern of changing geography of innovation is established, as WIPO considers resident patent filings to be a reliable proxy measure of underlying inventive activity in a country.

However, a resident patent in China is not defined as a patent filed by Chinese nationals, but includes patents filed by foreigners. This is because equity joint venture, contractual joint venture and wholly foreign-owned enterprises are considered as domestic enterprises according to Chinese law. Accordingly, the patents filed by these foreign-owned enterprises are counted as domestic patents; for instance, a patent filed by LG Electronics China Branch is counted as a Chinese domestic patent. In other words, the connotation for resident patent under Chinese law is much broader, since the patents filed by branches of multinational corporations in China are considered as domestic patents. To illustrate this, the total number of invention patents in 2005 was 173,327, of which, 46.1 per cent were filed by foreigners outside China (Table 5). Of 93,485 domestic patent applications, one third was filed by Chinese individuals and two thirds filed by enterprises. As a large number of patent applications filed by foreign companies' branches in China are counted as domestic patents, the mixture of foreign and local patent filings is misleading and hence affects the objective assessment of the real level of local inventiveness capacity in China.

Table 5
The Composition of Patents in China, 2005



Source: 2005 SIPO Annual Report, compiled by the author

The above-mentioned factors should be taken into consideration when assessing the increasing trend of patent applications in China. In China, patents are classified into the following three categories: (1) utility models, which are new technical developments relating to the shape or structure, or their combination, of a product which is fit for practical use, (2) design patents, which concern the visual design of objects, and (3) invention patents, which may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement thereof. According to the Chinese patent regime, no substantive patent examinations are required for the utility model and industrial design categories. This implies that no technical threshold is needed for an applicant to be granted a "patent". As such, the number of patents filed in China, and hence overall Chinese innovation capacity, may be overstated. A closer look at the composition of patents in 2005 and increases in patent applications in China over the last five years demonstrates (Table 6) that: (a) utility models and industrial designs, with a total of 302,937, have a majority share in the total number of patent applications of 476,264; that is, 64.1 per cent, (b) all three categories of patents experienced fast growth, of which industrial designs (163,371) grew by 47.4 per cent compared to 2004, utility models (139,566) grew by 23.7 per cent, and invention patents (173,327) grew by 32.2 per cent. Therefore, the total numbers of utility models and industrial designs outweighed the number of invention patents and the growth rate in industrial design is higher than that of invention patents; so the sharp rise in patent filings in industrial design and utility models does not represent a significant improvement in innovation capacity in China.

Table 6
Patent Applications by Categories of Patents, 1985-2005

	Total			
	Total	Invention	Utility model	Design
1985-2005				
Accumulated total				
	203,573	63,204	79,722	60,647
	19.3%	22.1%	15.8%	21.0%
	252,631	80,232	93,139	79,260
	24.1%	26.9%	16.8%	30.7%
	308,487	105,318	109,115	94,054
	22.1%	31.3%	17.2%	18.7%
	353,807	130,133	112,825	110,849
	14.7%	23.6%	3.4%	17.9%
	476,264	173,327	139,566	163,371
	34.6%	33.2%	23.7%	47.4%

Source: 2005 SIPO Annual Report

Thus a large number of patent applications filed by foreign companies' branches in developing countries are counted as domestic patents; the mixture of foreign and local patent filings is misleading and hence affects the objective assessment of the real level of local inventiveness capacity in these countries. While inventive activities take place in a particular geographical location, the inventor may file the first application (resident patent) from any patent office across the world. This creates at least theoretical problems in terms of identifying innovation, and may at times lead to double count. There is no practical methodology fundamentally establishing that innovation accrued within a particular geographical location is always attached to the first filing of resident patents. This is an inherent limitation in attaching importance to patent counts as being reflective of the geography of innovation within a particular territorial location.

IV.2 The Qualitative Value of Patent Counts: The Difference it Makes in Understanding Innovation Capacities

It must be noted that a patent count is not same as the value it encompasses. One patent may be more valuable or less valuable than another. Within the WIPO scheme of patent count interpretation, there is currently no differentiation made concerning the value assigned to each patent. Thus there can be disparity of levels in patents based on certain parameters. Various methodologies can be used in attaching value to patents, prominent among them being licensing revenue flows. However, not all patents have the same value in terms of inventive activity. Each individual patent has a different value, which depends on the subject matter of the invention, the importance of that particular patent in the value chain, and so on. Further, there are vital differences between a basic patent and surrounding patents. This has implications for the net total outcome of the value assigned to resident patent filings, which even if more in terms of quantity, may not be of higher value.

The values of the three categories of patents differ substantially. The invention patents have the highest added value. From the composition of Chinese patent applications, it can be seen that the resident patent applications are mostly those for utility models and industrial designs; the invention patents, although increasing in number, represented 24.4 per cent of the total in 2005. Non-resident patent applications are mostly invention patents, representing 85.8 per cent of total patent applications by non-residents. (see Table 7).

Table 7
Three Categories of Patent Applications Classified by Resident and Non-Resident Applicants (2005)

	Invention	Utility model	Industrial design	Total
Resident	93,485	138,085	151,587	383,157
Non-resident	79,842	1,481	11,784	93,107
Total	173,327	139,566	163,371	476,264

Source: 2005 SIPO Annual Report

It has long since been understood that the mere counting of patents at any level of aggregation does not provide good value indicators. It is remarkable to note that the intrinsic value of innovations varies significantly, either within the same field of technology or among different fields, and hence single patent counts, which weigh all patents equally, lead to skewed analysis of the value attached to patents. The distribution of patent applications in various technical sectors was as follows, based on IPC applications in 2005: (1) The applications under A61K for medical, dental and toilet purposes ranked the highest with 80 per cent filed by residents; the applications under G06F for electronic data processing ranked second, with nearly 50 per cent filed by residents; the applications under H04L for digital data transmission ranked third, with more than 50 per cent filed by residents. Applications under A61K and G06F have been consistently ranked among the top three for ten years. (2) The top ten applications by non-residents are: information storage (G11B), semi-conductor ware (H01L), optical systems or instruments (G02B), representing more than 65 per cent of the total. Therefore, the resident applications are concentrated in traditional industries while the non-resident applications are concentrated in high-tech IT and communications technologies.

Table 8
Top Ten IPC Sub-classes of Patent Applications, 2005

Invention	Sub-class	Quantity	Resident invention	Sub-class	Quantity	Non-resident invention	Sub-class	Quantity
1	A61K	12,514	1	A61K	10,047	1	G06F	4,335
2	G06F	8,455	2	G06F	4,120	2	H01L	3,728
3	H04L	6,305	3	H04L	3,364	3	H04L	2,941
4	H01L	5,428	4	H04Q	2,007	4	H04N	2,796
5	H04N	4,498	5	H04N	1,702	5	A61K	2,467
6	H04Q	3,145	6	H01L	1,700	6	G11B	2,141
7	G11B	2,698	7	G01N	1,526	7	C07D	1,491
8	C07D	2,497	8	A23L	1,426	8	G02F	1,441
9	G01N	2,445	9	H04M	1,394	9	G02B	1,267
10	G02F	2,286	10	C07C	1,201	10	H04B	1,248

Among the invention patent applications, the resident ones are dominant in the following areas: traditional Chinese medicine with 98 per cent, soft drinks with 96 per cent, food products with 90 per cent, Chinese language computer inputs method with 79 per cent. The non-resident applications are dominant in the high-tech areas as follows: wireless transmission with 93 per cent, mobile communications with 91 per cent, television systems with 90 per cent, semi-conductors with 85 per cent, Western medicine with 69 per cent, and computer applications with 60 per cent. It is clear that the patent applications by non-residents are mostly in high-end and high value-added areas.

Currently, China relies on imports for its requirements for all civil aeroplanes, and most high-end medical equipment, semi-conductors, digital integrated circuits manufacturing equipment and fibre optics. Many important equipment and manufacturing systems are imported, and multinationals control the core technologies for up to 80 per cent of petrochemical equipment, 70 per cent of digitally-controlled machine tools and advanced textile equipment, and 50 per cent of colour televisions and mobile phones. While China's external trade volume ranked number three in the world in 2005, its exports of the high-tech products developed by self-innovation represented only two per cent of the total trade volume.

In terms of Chinese invention patents, applications for 2005 from both home and foreign inventors reveals that the top five sectors of technical innovation were: (1) computers, (2) telephone and data transmission systems, (3) natural products, (4) fermentation technology, and (5) computer peripherals. (See Table 9 for details)

Table 9
Top Five Patented Technologies, All Applicants, 2005

Rank no.	Items	Term	Definition
1	18,649	T01	Digital Computers
2	12,997	W01	Telephone and Data Transmission Systems
3	9,146	B04	Natural Products and Polymers
4	5,334	D16	Fermentation Industry
5	4,838	T04	Computer Peripheral Equipment

Comparison of national applications with foreign applicants in China shows substantial differences. In 2005, Chinese inventors filed most applications in natural products, closely followed by digital computers (Table 10), whilst foreign applicants focused on digital computers and telecoms patents (Table 11).

Table 10
Top Five Patented Technologies (Home Applicants), 2005

Rank no.	Items	Term	Industry
1	8,196	B04	Natural products and polymers
2	6,355	T01	Digital computers
3	4,718	W01	Telephone and data transmission systems
4	3,497	D16	Fermentation industry
5	2,976	D13	Other foods, food treatment including additives

Table 11
Top Five Patented Technologies (Foreign Applicants), 2005

Rank no.	Items	Term	Industry
1	12,985	T01	Digital computers
2	8,655	W01	Telephone and data transmission systems
3	7,207	L03	Electro- conductors, etc.
4	6,629	W02	Broadcast, radio and line transmission systems
5	6,336	U11	Semiconductors, materials and processes

IV.3 Patent Applications in the Area of Information Recording

The technology of information recording has been developing very rapidly together with the emergence of DVD as a new medium for information and image recording, different from VTR in the 1970s and CD in the 1980s. This is a high-tech product which combines laser, precision electronics and data storage compression technologies. In recent years, there have been more and more patent applications relating to DVD. In 2005, there were 448 patent applications under G11B (information storage), among which 402, or 89.7 per cent, were filed by non-residents. These non-residents were mainly from Japan, Korea, the US, France (in descending order), with 278 applications filed by Japan, or 62.5 per cent of the total number of applications. There were only 46 applications by residents, mainly the research institutes of the Via Technologies Corp. from Taiwan, Tsinghua University, Shanghai Jiaotong University, and the Shanghai Optical Precision Instrument Institute.

China has a limited number of patents filed in high technology, such as IT and internet technologies. This technology has become increasingly easy to copy, edit, and transact audio and video works, which has made the protection of intellectual creations more difficult. Accordingly, the technologies to protect audio and video works have also developed rapidly, as shown in Table 12 in terms of patent applications in this area. Having started with very low figures in the early 1970s, the number of applications has exploded in recent years. It can be seen in Table 13 that most patents in the area of audio and video works protection are filed by non-residents.

Table 12
Number of Applications (1972-2004)

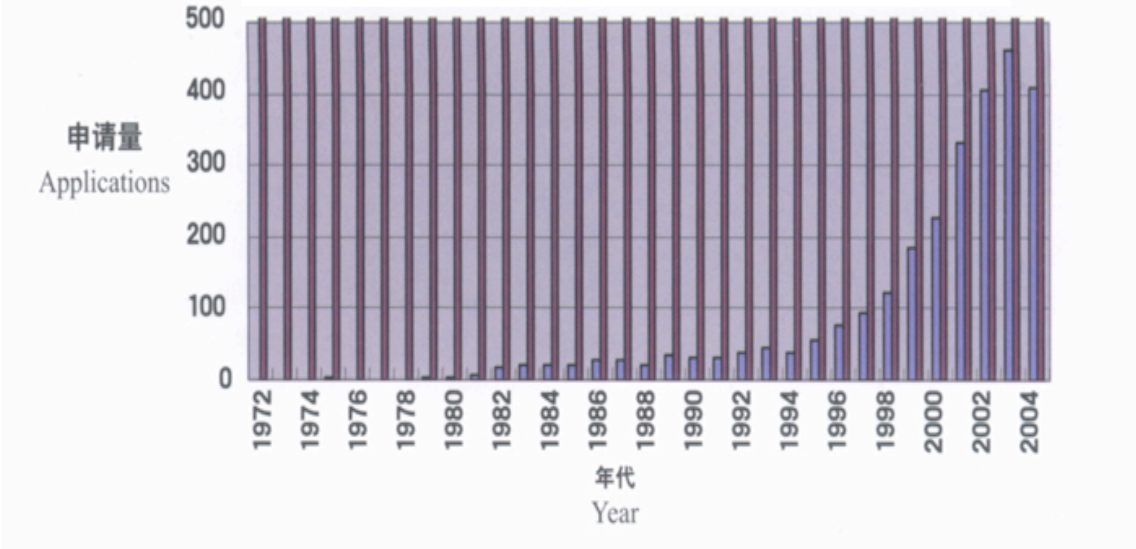
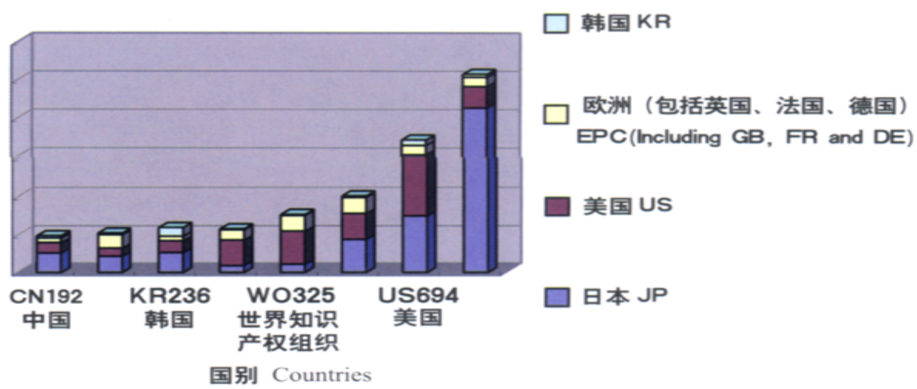


Table 13

图 2 不同国家和地区的申请量
Fig.2 Number of Applications by Countries and Regions



As shown in Table 12, as at June 2005 the patents for audio and video-related technologies are controlled by Japan, the US, Europe and Korea, with very few patents held by the Chinese. Further, patent inventions can be classified into new and novel invention, composite invention and improvement invention. Among these, initial invention is fundamental. Composite invention refers to invention by integrating existing technologies to form a new one, while improvement invention is a follow-on invention based on an existing technology. There is substantial evidence to suggest that the distributional value of patents is highly skewed towards low-end innovation (that is, surrounding patents), with a long and thin tail on the high-value side. Currently, resident patent applications filed by Chinese residents are mostly improvement inventions with few new and novel inventions.

For example, hybrid cars which combine a conventional propulsion system with an on-board rechargeable energy storage system to achieve better fuel economy than a conventional vehicle have attracted interest from international automobile makers as well as research institutes. Table 14 shows the trend of patent applications in this area between 2003 and 2005 in China. In 2005, the number of applications dropped compared to the levels of 2003 and 2004. In 2003, there were over 100 known applications relating to hybrid cars, with a substantial number of applications in the area of core technologies of hybrid cars' power transmission and structural devices. In 2004, there were 96 known applications, with a substantial number of applications concerning control methodologies. In 2005, the number of applications was only 65, with a reduced number of applications concerning core technologies, but many applications are for hybrid cars' peripheral technologies such as a test platform for fuel cells, control calibrations and so on. Table 15 shows the distribution of applicants by country. It can be seen that in recent years there have been many applications from Japan and the US, particularly from Toyota, Honda and Nissan, the three car makers in Japan. In 2005, however, the number of resident applications increased significantly, at 55 per cent of the total. These resident applicants include more than 20 enterprises and research institutes including Tsinghua University, Shanghai Jiaotong University, the China First Auto Works Group and the Shanghai Automotive Industry Corp. Research Institute. However, these applications were mainly related to peripheral technologies.

Table 14

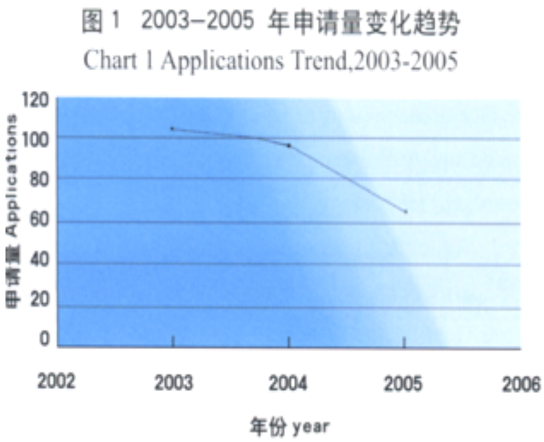
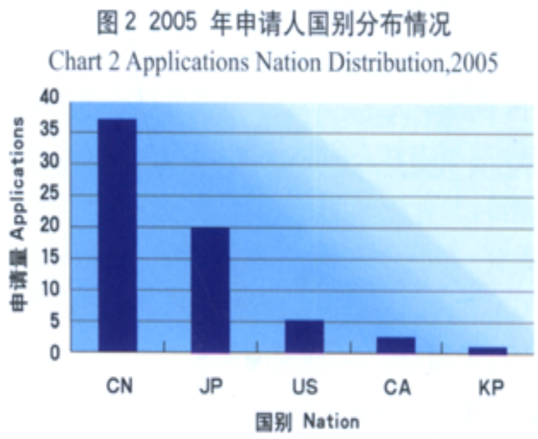


Table 15



To demonstrate the basic patents and surrounding patents, Table 16 shows the number and content of the patent applications filed by Toyota, Japan, and Tsinghua University, China, in 2005. It can be seen from the table that the applications filed by Toyota were concentrated in the key areas of driving devices? and hybrid cars' control systems, while Tsinghua University's applications were widespread, covering several areas including core technologies of hybrid power systems and power train controllers, but also peripheral systems such as control calibrations and test platforms. In the area of hybrid cars, the developed countries such as Japan and the US have taken a lead in their research and have controlled many of the core technologies, while China's research work has only recently taken off and has few comparative advantages in core technologies except in peripheral technologies.

Table 16
Application Comparisons between Toyota and Tsinghua University, 2005

Applicant	Amount	Title
Toyota	8	Drive unit for hybrid electric vehicle (HEV)
		Control device for HEV equipped with transmission
		Control system for HEV
		Drive system and method for parallel HEV
		Hybrid drive unit for vehicle
Tsinghua University	6	Standardisation method for HEV controller
		Shift control method without operation of clutch for parallel HEV
		Test and research system for fuel cell hybrid drive system
		Multi-energy power unit assembly controller for HEV
		Hybrid drive system for fuel cell vehicle

There can be considerable differences attached to patent value based on the difference between product and process patents. As demonstrated earlier, the patent applications under A61K for medical, dental and toilet purposes ranked number one in all applications, of which 80 per cent were resident inventions. Traditional medicinal knowledge (TMK) patents constitute the major components under IPC-A61K. Given the inherent difficulties in determining the structure of TMK, only ''product-by-process'' can apply, which has limited market power. From 1985 to October 2005, a total of 31,435 patent applications regarding traditional medicines were accepted by SIPO and 7,985 patents on traditional medicines were granted with a patent grant rate of 25.4 per cent. From 1985 to 1992, the average annual number of patent applications for traditional medicine was only 107. The number of patent applications for traditional medicine went up from 312 in 1992 to 675 in 1993, and continued this upward trend to 6,982 in 2005. From 1993 to 2005, annual patent applications for traditional medicine reached 2,534 on average.

Product patents provide for absolute protection of the product, whereas process patents provide protection in respect of the technology and method of manufacture. A process patent system promotes a more competitive environment and a check on prices, as compared with the monopoly system created through product patents. This form of claim is known to confer ''absolute product protection'' because it carries no limitation, either as to the process by which the compound is made or as to the end use to which the compound may be put. TMK-related pharmaceutical products that can be patented fall into the following four types.

The characteristics of TMK make it difficult to determine active components as precisely and accurately as its counterpart modern pharmaceutical knowledge (MPK). As a consequence, TMK innovation can hardly be described as a formula and the inventiveness can hardly be assessed by comparing the chemical structures. As TMK has characteristics distinguishing it from chemical pharmaceutical products, different criteria need to be applied for determining the differences between the prior art and the claims at issue. Accordingly, the herb composition of inventiveness claimed, instead of a formula, becomes decisive. It substantially increases the difficulties of patent examination (Li, 2007). Determination of the difference between the prior art and the claims at issue is less objective because most TMK is a mixture of many unknown substances. To mitigate against possible failure, Chinese patent practice adopts the method of "product-by-process" in the context of TMK, as TMK can be characterized by the process by which it is obtained and not by its elements and structure. However, under product-by-process claims, protection is extended only to a product obtained by means of the claimed process; if obtained by another process, the same product would not infringe an existing claim. In terms of coverage of protection, a product-by-process patent has significantly narrower coverage than a product patent. As chemical pharmaceutical products have long been protected under the product patent, which is the strongest form of patent protection, the effectiveness of patent protection is questionable and incomparable for TMK.

IV.4 Assigning Value of Category of Patents: Possible Differences in Ascertaining Local Innovation due to Patentability Exclusions

International comparisons based on patent applications are questionable due to the different propensity to patent and the different value of patents across countries. The characteristics of national patent systems in terms of protectable subject matter, substantive examination standards, scope of right and the first-to-file versus the first-to-invent system substantially influence patent propensity. These differences in patent regulations make it difficult to compare patent application counts across countries. While the TRIPS Agreement does harmonise national patent laws to a large extent, there can be considerable differences which make it difficult to ascertain local innovation capacities.

Four patent regimes are analysed to illustrate how different interpretations can be possible, leading to divergence in the grant of patents, with a comparison of two developed patent regimes and two developing patent regimes in respect of four vital areas, namely definition of invention, definition of field of technology, definition of patent law thresholds and disclosure requirements. Table 17 presents the presence or absence of legal moulds, which forms the genesis of divergence in patent law. A miscellaneous section deals with additional provisions which can have significant divergence, while the issue of compatibility with TRIPS remains unaddressed.

Table 17
A Comparison of US, EU, Brazilian and Indian Legal Provisions Concerning the Grant of Patents

	United States (National)	EU (Regional)	Brazil (National)	India (National)
Definition of invention	35 [in full?]USC 100 (a) defines the term “invention”. 35 USC 101 defines? inventions patentable	Not defined by the statute.	Not defined by the statute.	Section 2(j) defines “invention”.
Definition of patent law thresholds (i.e. novelty, utility and inventive step)	35 USC 102 defines conditions for patentability, novelty and loss of right to patent. 35 USC 103 defines conditions for patentability, non-obvious subject matter.	Article 52 (1) prescribes the legal threshold. Article 54, 56 and 57 defines novelty, inventive step and industrial application in relation to an invention.	Article 8 prescribes the legal threshold. Article 11 defines novelty in relation to inventions. Article 13 defines when an invention shall be deemed to involve inventive activity. Article 15 defines industrial application in relation to inventions and utility models.	Section 2(1)(ja) defines “inventive step”. Section 2 (1) (ac) defines the term ”capable of industrial application”. Section 2(l) defines the term “new invention” .

Other exclusions from patent eligibility	No specific statutory exclusions	Article 52(2) (3) and (4) lists the exclusions from patent eligibility.	Article 10 provides a list of items that are not considered as inventions. Article 18 provides for non patentable inventions and utility models.	Section 3 defines what are not inventions within the meaning of the Act.
Disclosure of invention	35 USC 112 defines the content of the specification which should accompany a patent application.	Article 83 defines the standard of disclosure needed for the grant of European patents.	Articles 24 and 25 define the standard of disclosure in relation to an invention.	Section 10(4) lays down the standard of disclosure in relation to a patentable invention.
Miscellaneous	35 USC 104 deals with foreign inventions. 35 USC 105 deals with inventions in outer space.	--	--	Section 4 provides that inventions relating to atomic energy are not patentable.

In the US, patents are granted for all inventions which form part of any of the four categories mentioned in 35 USC 101. A patentable invention must be either a product or process, or composition of matter, or any new and useful improvement thereof. This gives enough space to include "anything under the sun made by man" to be patented. The patent philosophy in the US is extremely market oriented and the markets rely largely on a patent-based framework. While "field of technology" is not defined by the statute, an analogy can be drawn from the four categories available for patenting inventions. Thus some degree of technicality is expected, to encompass all four categories.

The issue of the patent eligibility of inventions, especially in the areas of software and biotechnology, has for a long time been a subject of much debate in the US. The increasingly blurred distinction in the US between invention and the discovery of patentable inventions has led to widespread patenting activity, unlike in other jurisdictions which rely on certain specific exclusions. The courts in the US have a larger role in defining the limits of patentability and hence the patent eligibility criterion is structured by the US Federal Circuits (which are exclusively responsible for patent disputes) and the US Supreme Court. The cases of *Diamond* v. *Chakrabarthy*, *Diamond* v. *Diehr*, *In re Alappat*, *State Street Bank* v. *Signature Financial Corp., AT&T* v. *Excel Communications Inc*, have fashioned the patent eligibility criteria for various types of subject matter in US. Since the US patent code does not specifically exclude or include subject matter based on the field of technology it was been quite possible for the USPTO and the courts to draw expansive interpretations, especially in the case of patents relating to biotechnology, software, internet and business methods, even while the US Supreme Court in its prior decisions has identified a narrow category of exclusions. This is unlike other patent jurisdictions where patent eligibility is prescribed by the statute itself. The lack of proper statutory definition for defining patent eligibility criteria and the free hand given to the courts has created an environment conducive to a higher degree of patenting in the US.

The disclosure standard in the US, which is a criterion for a valid grant of patent, is also unique in nature. While best-mode disclosure is one of the indicia of proper disclosure, the requirement is marred by loose exception wherein 35 USC 112(6) provides that "an element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof". This "means plus function" clause is crucial in determining what is disclosed in a patent application. Hence a lower standard of disclosure can ensure easy grant of a patent, leading to a higher propensity to patent.

On the other side of the Atlantic, the EPC provides a list of exclusions. Article 52(2) of the EPC lists certain items which shall not be regarded as inventions for the purpose of patent eligibility. They relate basically to: discoveries; scientific theories and mathematical methods; aesthetic creations; schemes; rules and methods for performing mental acts; playing games or doing business; programmes for computers; and presentations of information. However, 52(3) limits such exclusions only to the extent to which a European patent application or European patent relates to such subject matter or activities "as such". This terminology has been used by the EPO and the Technical Board of the EPO to deliver judgments based on the pulse of time. Article 52 (4), unlike in the US, provides for the exclusion from patentability of inventions which relate to methods for treatment of the human or animal body by surgery or therapy and diagnostic methods practised on the human or animal body. This exclusion is based on the criterion of lack of industrial application.

Even the courts, especially the EPO Technical Board of Appeals, have been quite active in rendering decisions which have expanded the scope of patentability in the EU. Most prominently, the *Vicom*, *Harvard Oncomouse*, *Plant genetic systems* and *Pension benefit scheme* cases have largely shaped EU law in the area of software, biotechnology and plant patents and business methods and internet-related patents. However, the EPO uses the technical character of invention test to determine whether the invention is within the EPC. This largely settles the field of technology position, which is undefined by the EPC.

In Brazil, Article 10 of the Brazilian Intellectual Property Law (1996) provides an exhaustive list of items which are not considered to be inventions or utility models. They relate basically to discoveries, scientific theories and mathematical methods; purely abstract concepts; schemes, plans, principles or methods of a commercial, accounting, financial, educational, publishing, lottery or fiscal nature; literary, architectural, artistic and scientific works or any aesthetic creation; computer programmes per se; presentation of information; rules of games; operating or surgical techniques and therapeutic or diagnostic methods for use on the human or animal body; natural living beings, in whole or in part, and biological material, including the genome of germ plasma of any natural living being, when found in nature or isolated therefrom, and natural biological processes. These broad exclusions are significant in determining the nature and extent of innovation that form part of the patent scheme in Brazil. While there have been no significant cases which could interpret the provisions of section 10, it is certain that certain exclusions may involve issues of TRIPS compatibility. But from the fact that these provisions have remained unchallenged since the inception of section 10 in 1996, it can safely be concluded that there is wider consensus over whether or not such exclusions should form part of the patenting scheme.

Again, Article 18 of the Brazilian patent law provides for inventions which are not patentable, based on well-defined parameters of public morality, good customs and public security, order and health; substances, matter, mixtures, elements or products of any kind, as well as the modification of their physical-chemical properties and the respective processes of obtaining or modification thereof, when resulting from the transformation of the atomic nucleus; and living beings, in whole or in part, except transgenic micro-organisms meeting the three patentability requirements. With such a definition in place, it is quite possible to argue that certain categories of gene patents are excluded by the Brazilian law, especially when read in conjunction with Article 10 (IX). In the case of software patents, the Brazilian law excludes computer programmes *per se*, which gives sufficient space for excluding the intrinsic patentability of software but including combinational claims which include hardware. However, there is no specific exclusion in the case of business method patents. They can be interpreted as excluded if Article 10(I) and (II) are read together. A business method along with computer software (non *per se*) can still be patented in Brazil. This brings Brazil closer to the EU position where such types of combinational claims are allowed, provided they possess a technical character. Thus the filing and grant of business method and biotechnological patents may vary in accordance with the provisions of the Brazilian patent laws.

It appears that the Brazilian law, through its Articles 24 and 25, does not require best-mode disclosure in each and every case. Thus without disclosing the best mode, it facilitates easy filing and makes the patent system more attractive to applicants. The use of the words "…to carry it out and to indicate, when applicable, the best mode of execution…" reaffirms that there is some divergence in the Brazilian patent law with regard to disclosure of inventions.

In India, section 3 excludes certain subject matter from the patentability scheme. This can at times be interpreted as going beyond the TRIPS exclusionary framework, and hence questions on TRIPS compatibility are yet to be analysed and answered. Domestically, for example, section 3(d) of the Indian Patent Act 1970 was challenged in India, but was held to be constitutionally valid. The subsection excludes certain forms of innovation which are incremental or minor by bringing in a higher inventive-step criterion for patentability examination. This substantially excludes patents for inventions which are in the nature of modifications, unless proved by increased efficacy. There are also a few other areas which are excluded from patentability or are not considered to be inventions for the purpose of patent law. They prominently include exclusions based on *ordre public* and morality, prejudice to health and environment, discovery of any living or non-living substance occurring in nature, plants and animals in whole or in part (except micro-organisms), essentially biological processes, seeds, plant varieties, mathematical and business methods, computer programmes *per se*, algorithms, presentation of information, subject matter that is covered under copyright, traditional knowledge (excluding value additions) which are more than a mere admixture of things.

There is also another identified problem in defining inventive step criteria, wherein the economic significance of an innovation leading to patentability is expressly provided for. Here, economic contribution reduces the technical contribution criteria and thus lowers the inventive step threshold. This, when read in conjunction with the section 3 exclusions, may give a contrary meaning. Thus, at the core of the patent law subject matter availability in India lies the important exclusions, which can substantially shape the issue of patent availability in India. For example, business methods and certain categories of software and internet-related patents are excluded from the patentability framework. On the disclosure front, the standard appears to be higher when compared to other jurisdictions. It includes three important requirements, namely, full and particular description of the invention and its operation or use and the method by which it is to be performed; disclosure of the best method of performing the invention which is known to the applicant and for which he is entitled to claim protection; and ending with a claim or claims defining the scope of the invention for which protection is claimed. However, some commentators are of the view that the best-mode requirement in patent laws (especially the US patent law) has remained a statutory requirement without casting sufficient obligations on the patent applicant.

As shown in the following table, software (including business methods) patents and biotech patents can be used as an example to show how exclusions can affect patent grant numbers and thus provide a different picture of innovation.

Table 18
Exclusions in Software and Biotechnology Patents

	US	EU	Brazil	India
Software and business method patents	Patentability of software is allowed in all forms provided it has a concrete and tangible result. Business methods (including internet- related patents) are allowed.	Software patents are allowed provided they make a technical contribution and possess technical character (stricter criterion than in the US) and produce a technical effect. Business method patents are allowed when claimed in combination with software but technical effect is required, hence narrowing the scope.	Computer programmes *per se* are not allowed, thus allowing partial patentability. Business methods are not specifically excluded.	Computer programmes *per se* are excluded, as are algorithms. Hence certain applied technologies lacking inventive step are excluded. Business method patents are clearly excluded.
Biotechnology patents	All biotech-related patents are allowed provided they satisfy a higher utility criterion when compared to the rest of the subject matter. Plants (expressing the genotype and phenotype) and animals are included within biotech patents.	Not specifically excluded by the EPC law. The Board's interpretation allows, and the EPC allows, micro-organisms but natural biological processes are excluded. Plant varieties and animal species are specifically excluded.	Living beings in whole or in part except micro-organisms are excluded. Natural living beings, in whole or in part, and biological material, including the genome of germ plasma of any natural living being, when found in nature or isolated therefrom, and natural biological processes, are excluded.	Excludes plants and animals but includes micro-organisms. The criterion of the patent law threshold is higher and certain micro-organisms may be excluded.

The above table represents varying degrees of patentability in two prominent areas of technology. It proves that minor distinctions in national patent laws can have a major influence on the availability of patents for ascertaining the figures on grant. While WIPO and the OECD do highlight these differences in their work on patent statistics as indicators, they do not seem to have incorporated these exclusions into their respective publications, except for a broad caveat concerning possible exclusions arsing out of differences in laws.

IV.5 Implications

The above analysis demonstrates that the conclusion of the 2007 and 2008 WIPO Patent Reports, read along with specific caveats, is not convincing in terms of changing geography of innovation based on patenting growth rates in China. The issue relates not only to how to interpret correctly the figures on patent filings, but also to the question of quality of patent filings. In terms of patent quantity, utility model and industrial design are counted as patents in China. This significantly increases the number of patents filed in China and hence overall Chinese innovation capacity. As a result, the sharp rise in patent filings in industrial design and utility model does not mean a significant improvement in innovation capacity there. In terms of patent quality, a closer look at the distribution of patents filed by Chinese nationals shows that most of them belong to the two types of low-value patents, which do not require substantive patent examination. In addition, most patents filed by Chinese nationals are in traditional industries which have less market value in comparison to patents in high technology filed by foreigners. Few basic patents are filed by Chinese nationals which prevail on surrounding patents in terms of market power. Similarly, most process patents and product-by-process patents acquired by Chinese nationals have less monopoly power as compared to product patents held mostly by foreigners. Therefore, the apparent sharp increase in patent applications does not represent China's real innovative capacity. Accordingly, hasty generalisations on changing geography innovation patterns should be avoided when interpreting sharp rises in Chinese patent filing.

Furthering these above implications, certain differences in subject matter exclusions can result in considerable divergence in the grant and measurement of local innovation capacities. In the above analysis, it is argued that there can be a high level of exaggeration concerning patent statistics, and in turn miscalculation of local innovation capacities. Thus patents may be granted in some countries in some areas and may be excluded in others. Conceptually, this gap makes a considerable difference in understanding local innovation, even while considering resident patents.

V. Patent Counts as Indicators: Possible Solutions and Caveats in Interpretation

It must be noted that the WIPO reports of both 2007 and 2008 have some specific inbuilt caveats concerning the interpretation of patent statistics. Taking this further, the following can be broadly set out as some kind of solution to the patent count interpretation problem.

Studying the patent counts based on filings, grants, priority dates and resident patents: Considerable improvement can be brought in by using consistency in cross-country analysis. For example, the use of data by basing them upon patent families, priority years and country of invention and so on leads to selective interpretation. This can to a large degree lead to greater parity in cross-country analysis.

Defining the operating space of patent counts as indicators: The WIPO Patent Reports lack conceptual clarity in arriving at a formal link between patent indicators and innovative activity in developing countries. Such a link is not straightforward, due to inherent limitations placed by patent indicators. Only a broader approach of specifying the area of innovative activities engaged in by the developing countries can be fruitful for making a cross-country analysis. The possible solution could be to explain resident patent data in each field of innovation and thereby explain the types of innovation that developing countries are currently performing. Thus it may be interesting to divide resident patenting activities into high tech, medium tech and low tech patenting activities to compare them with those in developed countries.

Evolving methods for attaching value to patent counts: It is important to bear in mind that patent differs in value when interpreting patent counts. Patent quantity does not reflect value of patent. Reading patent counts along with other parameters such as licensing value earned, the value of patents in standards, the subject matter of inventions, whether they are high-tech or low- tech inventions, product or process inventions and so on should be considered in order to ascertain the value of patent counts.

Caveats on composition on resident patent applications and ascertaining local innovation: The WIPO patent reports' definition of resident patent applications is misleading. However, it is of considerable importance to build in parameters concerning the contextual interpretation of resident patent activities as constituting local innovation. Possible solutions may include formulating apposite methods for locating the place of invention by asking for relevant data concerning the geography of inventions in patent applications themselves. The collection and compilation of firm data would be important in this case.

Caveats on cross-country patent counts and their relation to innovative activity in a particular geographical location: Cross-country comparisons can be advantageous only when statistics pertaining to a country are contextualised with the degree of local innovation capacities in absolute terms. Solutions in this area may include placing caveats in the nature of finer differences within the patent system, recourse to different standards of examination, understanding reversal rates and invalidation statistics, examining the impact of patent reforms on grant and enforcement, and so on.

Caveats on differences in the patent system: Differences in the patent system are inherent in the territoriality principle of patent laws. Hence no profound or long-lasting solution can be found to this except interpreting caveats mentioned in WIPO reports with greater degree of caution.

Caveats on differences in the design of patent systems: Again, differences in the design of patent systems are unavoidable. A possible solution could be clearly to demarcate statistics concerning each of the incentive models. The work of WIPO in its 2008 report is commendable in this direction.

VI. CONCLUSIONS AND POLICY RECOMMENDATIONS

This research paper has argued that due to certain inherent limitations, patent statistics should not be relied upon by policy makers in order to arrive at a formal link between patent counts and innovation performance in developing countries, and more specifically in China. It is argued that patent counts cannot be an efficacious indicator for cross-country innovation performance, and that resident patent activities do not represent the local innovation capacities of nationals. While this paper specifically targets the limitations of interpreting patent count, it has relied on the WIPO Patent Reports of 2007 and 2008. It is argued that the WIPO Patent Report conclusion on the changing geography of innovation, based on a sharp rise in the number of patent filings in North-East Asia with an emphasis on China, should be interpreted with caution.

The drawback of such an international comparison relates not only to how properly to interpret the figures on patent filings and “resident patent filings” given the diversified patent law across countries, but also to high heterogeneity in the value of patents. A detailed analysis of Chinese patent applications from patent quantity and patent quality perspectives illustrates that the apparent sharp increase in patent applications does not represent China’s real innovative capacity. Beyond the example of China and with illustrations of how differences in administration and interpretation of patent filings can lead to misinterpretation, this article identifies the sources of misinterpretation by comparing US, EU, Brazilian and Indian patent legislation and regimes.

On the one hand, the characteristics of national patent systems in terms of protectable subject matter, substantive examination standards, scope of right, and the first-to-file versus the first-to-invent system strongly influence patent propensity which makes it difficult to compare patent application counts across countries. On the other hand, the value distribution of patents is highly skewed as a few patents have high value, whereas many have very low value. The significance of patent counts is limited, therefore, as they put on equal footing patents of very different values. To facilitate appropriate policy responses, developing countries should be cautious in reading the WIPO interpretation of the counts on patent filings. Furthermore, it is necessary to make efforts to develop a proper set of indicators system to monitor the changes in innovation capacities in each and every place, especially in the developing countries.

BIBLIOGRAPHY

- A Brief History of the Patent Law of the United States. Available at: http://www.ladas.com/Patents/USPatentHistory.html
  Available at: http://www.wipo.int/ipstats/en/statistics/patents/pdf/patent_report_2007.pdf

- Bogota Manual, "Standardisation of Indicators for Technology Innovation in Latin American and Caribbean Countries", RICYT/OAS/CYTED (2001).

- Breschi, S., Malerba, F. and Orsenigo, L. (2000) 'Technological Regimes and Schumpeterian Patterns of Innovation', *Economic Journal,* 110**,** 388-410.

- Bresson, K. (et. al), "Estimating Disparities, Complementarities and Gaps between Regions and Countries: The Case of China and its Provinces in 1993", in William Blankley, Mario Scerri, Neo Molotja, Imraan Saloojee (eds), *Measuring Innovation in OECD and NON-OECD Countries*, Selected seminar papers (2006). Available at: http://www.hsrcpress.ac.za/product.php?productid=2133

- Chinaprayoon, Chinawut, "Science, Technology and Innovation Composite Indicators for Developing Countries", Georgia Institute of Technology, (2007), available at http://etd.gatech.edu/theses/available/etd-07082007-163713/unrestricted/chinaprayoon_chinawut_200708_mast.pdf

- Cockburn , Iain M., Samuel S. Kortum and Scott Stern, "Are all Patent Examiners Equal? The Impact of Examiner Characteristics on Patent Statistics and Litigation Outcomes", NBER Working Paper No. 8980 (2002).

- Cohen, W. M., Nelson, R. R. and Walsh, J. P. (2000) Protection their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not), In *NBER Working Paper Series*, Vol. 7552 National Bureau of Economic Research.

- Cooper, Charles, "Relevance of Innovation Studies in Developing Countries". Available at: www.unu.edu/unpress/unupbooks/uu31te03.htm

- Dernis, Hélène and Dominique Guellec, "Using Patent Counts for Cross-country Comparisons of Technology Output", OECD, STI Review No. 27 (2001). Available at: http://www.oecd.org/dataoecd/26/11/21682515.pdf

- Dernis, Hélène, "Nowcasting Patent Indicators", STI working paper 2007/3, Statistical Analysis of Science, Technology and Industry. Available at: http://www.oecd.org/dataoecd/0/20/39485567.pdf

- Duke L. & Tech. Rev. 0006, Software Patent law: EU and US Compared (2003). Available at: http://www.law.duke.edu/journals/dltr/articles/2003dltr0006.html, EC Council resolution. Available at: ECOSOC (United Nations Economic and Social Council) Resolution 1995/54. Available at: http://www.un.org/documents/ecosoc/res/1995/eres1995-54.htm

- Engelsman E.C. and van Raan A.F.J. (1991) *Mapping of technology*, Policy Studies on Technology and Economy (BTE), # 15, The Hague.

- Engelsman E.C. and van Raan A.F.J. (1992) A patent-based cartography of technology, *Research Policy* 23, 1-26.

- EPO Press release, "Fewer patents granted as EPO focuses on quality", June 2008.
- European Patent Convention (1973), Available at: http://www.epo.org/patents/law/legal-texts/html/epc/1973/e/ma1.html
- FTC Report, To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy (2003). Available at: http://www.ftc.gov/os/2003/10/innovationrpt.pdf
- Griliches, Z. 1990. Patent statistics as economic indicators: A survey. *Journal of Economic Literature* 28: 1661-1707.
- Guellec, Dominique, "Innovation Surveys: Lessons from the Experiences of OECD Countries", in William Blankley, Mario Scerri, Neo Molotja, Imraan Saloojee (eds), *Measuring Innovation in OECD and NON-OECD Countries*, Selected seminar papers (2006). Available at: http://www.hsrcpress.ac.za/product.php?productid=2133
- Guellec, Dominique, Patents as Indicators of Technology Output: A Review, OECD DSTI/EAS. Available at: http://isi.cbs.nl/iamamember/CD2/pdf/1025.PDF
- Hall, Bronwyn H., "Market Value and Patent Citations: A First Look", NBER Paper [online]. Available at: http://www.card.iastate.edu/research/stp/papers/hall-jaffe-trajtenberg.pdf
- Harhoff, Dietmar (et. al), "Citations, family size, Opposition and the Value of Patents", Research Policy 32 (2003), pp. 1343-1363.
- Harhoff, Dietmar, "Patents in Europe and the European Patent System", Panel on Lisbon Agenda on Economics of Innovation and Patents on Knowledge Related Processes". EPO.
- *In re Alappat*, 31 USPQ2d 1545, U.S. Court of Appeals Federal Circuit, July 29, 1994, available at http://digital-law-online.info/cases/31PQ2D1545.htm
- Indian Patent Act, 1970 (as amended in 2005). Available at: http://ipindia.nic.in/ipr/patent/patents.htm
- Jaffe A.B. (1986) Technological opportunity and spillovers of R&D: Evidence from firms' patents, profits, and market value, *American Economic Review* 76 (5), 984-1001.
- Jaffe A.B. (1989) Characterising the "technological position" of firms, with application to quantifying technological opportunity and research spillovers, *Research Policy* 18, 87-97.
- Jaffe, A.B., M. Trajtenberg and R. Henderson (1993). Geographic localization of knowledge Spillovers as evidenced by patent citations. *Quarterly Journal of Economics,* 108, 577-598.
- Kahin, B., "Through the lens of intangibles: What patents on software and services reveal about the system", Paper presented at proceedings of the OECD, Paris, 28-29 August 2003, pp. 209-225. Available at: http://www.si.umich.edu/~kahin/Lens.doc
- *KSR International Co. v. Teleflex Inc. (et al.)*, 550 US ___ (2007). Available at: http://www.supremecourtus.gov/opinions/06pdf/04-1350.pdf
- Ladas and Parry LLP, EU withdrawal of Proposed Directive on the Law of Utility Models. Available at: http://www.ladas.com/BULLETINS/2006/20060500/EUUtilityModelLawUnification.shtml

- Ladas and Parry LLP, Patentable Subject Matter. Available at: http://www.ladas.com/Patents/Biotechnology/USPharmPatentLaw/USPhar03.html.
- Lanjouw, J. O., and A. Mody (1996) "Innovation and the International Diffusion of Environmentally Responsive Technology," *Research Policy* 25: 549–71.
- Li, Xuan, "Inadequacy of Patent Regime on Traditional Medicinal Knowledge - A Diagnosis of 13-Year Traditional Medicinal Knowledge Patent Experience in China", *Journal of World Intellectual Property*, Volume 10, Issue 2, (2007), pp. 125-148.
- Marinova, Dora and McAleer, Michael, 2003, Environmental Technology Strength: International Rankings Based on US Patents, available at http://www.e.u-tokyo.ac.jp/cirje/research/dp/2003/2003cf204.pdf
- Marinova, Dora and McAleer, Michael, 2003, nanotechnology Strength Indicators: International Rankings Based on US Patents, available at http://www.e.u-tokyo.ac.jp/cirje/research/papers/mcaleer/mcaleer2.pdf
- MPEP briefing of the United States Patent and Trademark office. Available at: http://www.uspto.gov/web/offices/pac/mpep/documents/2100_2105.htm
- National Academies, USA, A Patent System for the 21st Century (2004). Available at: http://www.nap.edu/html/patentsystem/
- Noonan, Kevin E., Could Creating a US "Utility Model" Patent Fulfill the 'Need' for Patent Law Reform? Available at: http://patentdocs.typepad.com/patent_docs/2007/05/could_creating_.html
- OECD Oslo Manual (2005). Available at: http://213.253.134.43/oecd/pdfs/browseit/9205111E.PDF
- OECD, Compendium of Patent Statistics 2005, P 43. Available at: http://www.oecd.org/dataoecd/60/24/8208325.pdf
- Oh, Cecilia, Patents and Monopoly Prices, Third World Network. Available at: http://www.twnside.org.sg/title/twr131b.htm
- Oltra, Vanessa and Kemp, René, Patents as a measure for eco-innovation, University of Bordeaux and UNU-MERIT, 16 June, 2007.
- Patently O Blog. Available at: http://www.patentlyo.com
- Popp D., Lessons from patents: Using patents to measure technological change in environmental models, (2005) Ecological Economics, 54 (2-3), pp. 209-226.
- PRC Government Webportal, Promoting the Quality of Intellectual Property with Harmonious Growth in Patent Quality and Quantity, 23 April 2007.
- Samuelsson, Pamela, Legally Speaking: Why Reform the US Patent System? Available at: http://people.ischool.berkeley.edu/~pam/papers/cacm%20patent%20reform.pdf
- Scerri, Mario, "The Conceptual Fluidity of National Innovation Systems: Implications for Innovation Measures" in William Blankley, Mario Scerri, Neo Molotja, Imraan Saloojee (eds), *Measuring Innovation in OECD and NON-OECD Countries*, Selected seminar papers (2006). Available at: http://www.hsrcpress.ac.za/product.php?productid=2133

- Scherer, F. M. "Interindustry Technology Flows and Productivity Growth."*Review of Economics and Statistics*, 64 (1982): 627-34.

- Shiva, Vandana, "US Patent System Legalizes Theft and Bio-Piracy", *The Hindu*, 28 July 1999. Available at: http://www.organicconsumers.org/Patent/uspatsys.cfm

- SIPO Annual Report 2005, available at http://www.sipo.gov.cn/sipo_English/laws/annualreports/ndbg2005/

- Sloan, Brian, "Developing the Linkage Between Policy and Innovation Measurement" in William Blankley, Mario Scerri, Neo Molotja, Imraan Saloojee (eds), *Measuring Innovation in OECD and NON-OECD Countries*, Selected seminar papers (2006). Available at: http://www.hsrcpress.ac.za/product.php?productid=2133

- Stoll, Robert R., *Business Method Patents: A US Perspective*, Available at: http://www.wipo.int/edocs/mdocs/ecommerce/en/wipo_ec_conf_01/wipo_ec_conf_01_spk_3a.pdf

- Suthersanen, Uma, Utility Models and Innovation in Developing Countries, UNCTAD publication (2006). Available at: http://www.unctad.org/en/docs/iteipc20066_en.pdf

- The Global Competitiveness Report, 2007-08, p. 6. Available at : http://www.gcr.weforum.org/J

- Trajtenberg, Manuel, "A Penny for your Quotes: Patent citations and the value of innovations", 21(1) *Rand Journal of Economics*, 172 (1990) p. 185.

- Verspagen B. (1995) Measuring inter-sectoral technology spillovers: Estimates from the European and US patent office databases, Research Memorandum, 2/95-007, Merit, Maastricht.

- Verspagen, B. (2005), Mapping Technological Trajectories as Patent Citation Networks: A Study on the History of Fuel Cell Research, *ECIS Working Paper 05-11*.

- Walmsley, Steven B., "Best Mode: A Plea to Repair or Sacrifice this Broken Requirement of US Patent Law", *Michigan Telecommunications and Technology Law Review*, Vol. 9:125 (2002).

- Wild, Joff, "Ever Increasing Circles: Thomson Scientific 2008 Patent Focus Report" (2008). Available at: www.scientific.thomson.com/newsletter

- WIPO Glossary of terms, Available at: http://www.wipo.int/ipstats/en/statistics/glossary.html

- WIPO index of Patent Systems. Available at: http://www.wipo.int/ipstats/en/resources/patent_systems.html

- WIPO Press Release: Geneva, 19 September 2003, Press Release PR/2003/354. Available at: www.wipo.int

- WIPO, WIPO World Patent Report, Statistics on Worldwide Patent Activities, (2007).

- WIPO, World Patent Report: A Statistical Review (2008) Available at: http://www.wipo.int/ipstats/en/statistics/patents/wipo_pub_931.html#g13

- Yarime M. (2005), "Coevolution of Environmental Regulation and Innovation Network: The Development of Lead-Free Solders in the United States, Europe, and Japan" Paper presented at the Fourth European Meeting on Applied Evolutionary Economics, Utrecht, The Netherlands, May 19-21 (2005).

🕮 Zekos, Georgios I., *Utility and Biotechnology Patenting*, 5 Web JCLI (2006). Available at: http://webjcli.ncl.ac.uk/2006/issue5/zekos5.html