# Research Proposal

## Patterns of Malaysian Innovation
*Evidence from US Patent Statistics*

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# Introduction

This paper seeks to propose a research on the patterns of innovation in Malaysia and factors influencing it. The rest of this paper will be organized under the following broad headings:

- Statement of problem
- Questions
- Literature review
- Hypothesis/propositions
- Research design
- Sources and methods for collecting and coding data
- Techniques for analyzing data

# Statement of Problem

Schumpeter (1911) elucidated that innovation is the engine of growth of the capitalist economy. Since then many economists have investigated the nature of innovation, hoping to gain understanding and insight on this phenomena. An innovator himself, Jacob Schmookler in his 1966 seminal work, *Invention And Economic Growth* established patent statistics as a proxy to measure innovation.

His innovation spawned numerous other studies utilizing patents as a proxy to investigate aspects of innovation such as the recent Dhar B. and Rao N., (2002), Moser, P., (2006). Among these studies, which included Malaysia were Lai, M.C. and Yap, S.F. (2004), Lam, V.C. and Wattanapruttipaisan, T. (2005). Studies which included Malaysia unfortunately did not provide sufficient focus and rigor. For example, the Malaysian Ministry of Science and Technology (MOSTI) publishes patent statistics in the annual Malaysian Science & Technology Indicators Report (MOSTI, 1994-2004). However these reports did nothing more than just publish statistics without detailed analysis. Hence, the investigator is left with an incomplete notion and understanding on the nature of patenting and innovation in Malaysia.

Therefore, this proposal seeks to bridge this gap while addressing the problem in a heterodox economic framework.

# Questions

This research will attempt to answer the following broad questions regarding innovation through observing patents as its proxy.

- Where is Malaysia located along the innovation trajectory in comparison to selected East Asian countries? Are we catching up or are we slowing down in terms of both gross and patents per capita?
- What are the growth rates of patents by sectors? Is there a sector that is leading innovation?

- What are the sources of innovation? Is there any spillovers? Are there any geographical concentrations of innovation?
- How has innovation in Malaysia evolved over time? Is there a time trend and time lag?
- What is the contribution and propensity of individuals, local firms, foreign firms, and public institutions towards innovation in Malaysia? What is the contribution of higher education, R&D and FDI?
- Is innovation concentrated to specific individuals, firms, institutions and industries?
- What is the efficacy of public vs. private research programs?
- What is the direction of causality between patents and GDP?
- Is there a relationship between patents and exports?

## Literature Review

> *"The consequences for human welfare are simply staggering. Once one starts thinking about [economic growth], it is hard to think of anything else."*
>
> Robert Lucas, Jr. (1988)

The quest for understanding the nature of economic growth has occupied economists for more than 230 years since Adam Smith published *Inquiry into the Nature and Causes of the Wealth of Nations* in 1776, in which he argued that personal liberty and self interest were the cornerstones of the market economy. It was here that he famously laid down his dicta that the division of labour is determined by the extent of the market and extent of the market is determined by the division of labour, hence arguing for the importance of both scale and technical change in economic progress. Division of labour requires technical change, which enlarges the market and enables a finer division of labour in a circulatory process of endogenous technical progress.

Adam theorized that economic growth was driven by a production function in the form of $Y = f(L, K, T)$ where Y=output, L=labour, K=capital and T=land. Thus, growth in output is the outcome of growth in the 3 factors of population, capital, and land. In this model, population growth is endogenous depending upon sustenance to maintain an increasing population, while capital investment depended upon endogenous savings rate. Stock of land is exogenous and could only increase through conquest. Endogenous technical progress and international trade enabled further division of labour and are the important engine of growth engendering increasing returns to scale. In this scenario, the economy continues to grow until it reaches a stationary state where population growth and capital accumulation stops. This came to be known as the Classical Growth Model.

40 years later, David Ricardo (1817) continued to build upon Adam Smith's intellectual legacy by modifying the Classical Growth Model to incorporate decreasing returns to land and the negative labour-saving effects of technical progress. The former reduce profits while the latter displaces labour and reduce labour income, bringing about a quicker limit to economic growth.

Karl Marx (1867) posited that technical change is a necessary consequence of competition and modified the model further by introducing a bargaining process between capitalists and proletariat (workers), which is influenced by the amount of reserve army of labour (unemployment) in the economy. A simple illustration of Marx's rigorous model would be as follows. Assuming a static economy with no population growth will cause surplus to accumulate to the capitalists. This surplus is invested to expand output and wages are increased as a consequence of the tight labour market. Facing a drop in profits, the Capitalists will employ labour-saving technology and release workers into unemployment. Profits increase and Capitalists reinvest the surplus. This round the capitalists will have an upper-hand in the bargaining process because there are more unemployed. Therefore, wages fall and profits increase. Further reiteration will reach a point where there are no more workers that can be released and profits are low. As a result, firms go out of business and its capital bought by the surviving firm. Ultimately, capital will be concentrated in a monopoly and the proletariat will increase in misery bringing about increasingly severe crises where Marx famously predicted the demise of capitalism.

The neoclassicals R.F. Harrod (1948) and Evsey Domar (1957) theorized growth rates as a function of savings and capital accumulation through what came to be known as the Harrod-Domar Growth Model. In this model, the condition for equilibrium is $g = s/v$ where g=growth rate, s=savings rate and v=capital-output ratio. s and v are assumed to be constants and determined exogenously while $s/v$ =warranted growth rate. The model is described as a knife-edge because any deviations from the warranted growth rate will destroy the equilibrium. Take the example of the situation where actual growth rate is lower than the warranted growth rate. In this case, the excess capacity will generate surplus stock causing the capitalist to reduce investment in the next period. This will reduce demand and result in even more excess stock. The reiteration will take the economy further away from the equilibrium towards eventual collapse. Therefore, equilibrium is a tenuous knife-edge balance while there is no scope for technical progress.

The above was the precursor of Robert Solow's (1956) Neoclassical Economic Growth Model which posited that economic growth is lesser the consequence of capital accumulation and more the consequence of exogenous technical change – a significant consequence of diminishing returns to capital. The corollary is that the accumulation of capital without technical change will not contribute to economic growth.

Robert extended his model the following year (1957) to incorporate Growth Accounting, in which he cleverly solved the problem of multi-colinearity between capital and labor inputs, thus enabling the calculation of technical change's contribution to economic growth. In his calculation, technical change contributed 87.5% of US economic growth between the years 1909 to 1949. Although he had successfully measured the importance of technical change as a factor in economic growth and as a result won The Nobel Memorial Prize in 1987, Robert was unable to explain its source and consequently how exogenous invention and innovation can be accelerated.

An illustration follows where growth is a function of capital and labour with technical change making up the residual, which is also described as the Total Factor Productivity (TFP).

An example which makes use of the Cobb-Douglas production function

$Y_t = K_t^{\alpha} L_t^{1-\alpha}$ is $\ln Y_t = \alpha \ln K_t + (1-\alpha) \ln L_t + \varepsilon$,

where Y=Income, K=Capital, L=Labor, $\alpha$ =Capital's share of Income, t=period and the residual $\varepsilon$ is associated as TFP.

Interest in TFP as a measure of technical change generated a large volume of empirical research. One such study by Alwyn Young (1994) stirred considerable debate when it contended that economic growth in Newly Industrialized Countries (NIC) was merely the result of capital accumulation and not technical progress. Krugman took his cue from this study when he controversially debunked Asia's miracle when he painted Singapore as the "*virtual economic twin of Stalin's U.S.S.R.*" in his article in the same year.

Neoclassical economists continued to assume technical change as an exogenous factor akin to the biblical manna falling from heaven. There are economists who described technical change as a black box and there have been others who described it as exogenous shocks not unlike an earthquake. This summary treatment of technical change is a consequence of continuing neoclassical orthodoxy and has become a source of ferment in the economic discipline.

The neoclassical orthodoxy has been criticized for its implicit assumptions of stylized firms and markets, where firms are perfectly competitive and profit-maximizers, markets are efficient and knowledge is a free and public good. Thus, technology is available to all firms and firms are able to choose and implement the best technology, decisions which keep the economy at the even keel of equilibrium. These abstractions do not allow for risk, imperfect competition, market imperfections, and treating knowledge as proprietary. It is at discordance with reality because observation shows the economy to be more complex, its development evolutionary, and functions at disequilibrium.

At the heart of the debate, is Schumpeter's lucid assertion that capitalism is evolutionary, innovation is a fundamentally disequilibrium process and that neoclassical equilibrium theory is deficient and incapable to model and cope with its consequences (Nelson R., 2000). He draws our attention with the following statement:

> *But in the capitalist reality as distinguished from its textbook picture, it is not that kind of competition that counts, but the competition from new commodity, the new technology. This kind of competition is much more competitive than the other as a bombardment is in comparison with forcing a door.*
>
> *In other words, the problem that is being visualized is how capitalism administers existing structures, whereas the relevant problem is how it creates and destroys them. As long as this is not recognized, the*

*investigator does a meaningless job. As soon as it is recognized his outlook on capitalist practice and its social results changes considerably.*

(Capitalism, Socialism and Democracy, p. 84, 1942)

Therefore innovation is deemed to be an important economic activity and phenomenon that ought to be investigated because insights into its nature are useful in explicating factors that engenders it. It possibly is the key to the reasons for the differences in the rates of technical progress amongst nations - an understanding which may assist policy makers to foster economic growth.

Schumpeter (1911) also explicated the role of innovation as the engine of growth of the capitalist economy, via the phenomenon of *creative destruction* where old firms are continuously destroyed by new firms acting as agents of innovation. This new paradigm found adherents and spawned an area of research and a body of literature which investigated this phenomenon.

Seminal works inter-related to the issues raised by Schumpeter were contributed by Jacob Schmookler (1966) on inventions, Richard Nelson (2000) on National Innovation Systems, Keith Pavitt (1984) on technical taxonomies, Giovanni Dosi (1993) on technical trajectories, Sanjaya Lall (1992) on technological capabilities and Paul Romer (1990, 1986) on endogenous technical change. Recent work by Rajah Rasiah (2004) explicated the role of firms and institutions in fostering technological capabilities through novel research methods which measured technical intensities, while Linsu Kim (1999) succinctly demonstrated the vital role of learning in economic development.

Schumpeter (1911) defined economic innovation as

1. The introduction of new goods —that is one with which consumers are not yet familiar—or of a new quality of goods.
2. The introduction of a new method of production, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially.
3. The opening of a new market that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.
4. The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created.
5. The carrying out of the new organization of any industry, like the creation of a monopoly position or the breaking up of a monopoly position.

Inventors disclose pertinent information regarding their innovation discoveries into public domain in the form of patent registration so that their discoveries can be replicated by a person skilled in the arts, in exchange for the exclusive right to exclude others from commercializing their discovery.

Historical accounts of patents states it as being used as early as 1474 by the Republic of Venice. Later England followed suit with the enactment of the Statute of Monopolies in 1623. These formed the basis of the modern US Patent Act 1790, which issued the first patent for the making of potash on 31 July, 1790. As at 14 November, 2006 there are more than 7 million patents registered with the US Patents and Trademark Office (USPTO). In Malaysia, patents are governed by The Patents Act 1983 which empowers SIRIM to grant local patents. The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs) under the World Trade Organization (WTO) is an attempt to harmonize and enforce Intellectual Property rights on its members.

There are several economic justifications for patents. The first come in the form of enabling full disclosure and dissemination of information, in return for exclusive rights. Without disclosure, it is thought that inventors would keep their innovations a secret and thus limit the transmission of knowledge. The second creates of incentives for innovation and production, which provides inventors and firms innovation rents to invest in the production of the new invention. Finally, patents also provide incentives to rival firms to invent workaround technologies to overcome limitations of patents.

Nevertheless, there has been discussion of whether patents as an instrument limit or encourage innovation. Machlup, F., (1958), Heller, M.A., & Eisenberg, R.S. (1998) and more recently Gallini, N. T. (2002) puts forth the case that patents are limiting in nature which is a discordant with neoclassicals who assume knowledge as a free public good because the grant of patents convert knowledge into private property. This controversy continued apace with the recent debate on patents for Business Methods or famously known as internet patents, where Amazon.com was awarded a patent for its one-click order method. Hall, B. (2003) has criticized the award of such patents as it leads to a proliferation of low quality patents.

Innovation cannot easily be measurable and therefore need a proxy. Schmookler (1966) established patents as a proxy for innovation and this usage was subsequently confirmed through practice by Hall, B., Jaffe, A., and Trajtenberg M., (2001), Watanabe, C., Tsuji, Y. and Griffy-Brown, C. (2001) and many others.

## Hypothesis/proposition

This paper proposes to advance the following hypothesis:

1. There is a time lag effect on the incidence of patents and GDP. *The acceptance of this hypothesis suggests a time lag effect on incidence of patents and GDP.*
2. There is a simultaneous relationship between the incidence of patents and GDP. *The acceptance of this hypothesis suggests that incidence of patents and GDP are self-reinforcing. The alternative will be that causality runs in one direction.*
3. There is a relationship between the firm's export intensity and incidence of patenting. *Acceptance suggests that firms with higher export intensities have higher propensities for patenting.*
4. Specific firm type (local vs. foreign) and specific industry have a greater propensity to patent. *The firm type or specific industry with the higher mean suggests a greater propensity to patent.*

5. There is a time lagged relationship between the R&D, number of R&D headcount and patenting. *Acceptance suggests that higher R&D and headcount leads to more patenting.*
6. There is a time lagged relationship between the exports to $\text{country}_i$ and patents registered in $\text{country}_i$ *Acceptance suggests that higher exports in* $\text{country}_i$ *leads to more patents in* $\text{country}_i$ .

## Research Design

This will be an epistemological research, where the propositions will be testable, can be falsified and parsimonious. Neoclassical assumptions of perfect competition, profit-maximizing firms, market equilibrium, market equilibrium, and knowledge as a free public good are discarded and replaced by the assumptions of Schumpeterian evolutionary process, market disequilibrium, and knowledge as proprietary good.

The 4 hypothesis to be tested are formulated as below. However, only Hypothesis #1 and #2 need to be regressed.

Hypothesis #1 -There is a time lag effect between patents and GDP.
Formula:

- $\text{Patent}_t = a + b_t \text{GDP}_t + b_{t-1}\text{GDP}_{t-1} + b_{t-2}\text{GDP}_{t-2} + b_{t-3}\text{GDP}_{t-3}$
- $\text{GDP}_t = a + b_t \text{Patent}_t + b_{t-1}\text{Patent}_{t-1} + b_{t-2}\text{Patent}_{t-2} + b_{t-3}\text{Patent}_{t-3}$

To check on coefficient significance.

Hypothesis #2 -There is a simultaneous effect between patents and GDP.
Formula:

- $\text{Patent}_t = a + b_t \text{GDP}_t + b_{t-1}\text{GDP}_{t-1} + b_{t-2}\text{GDP}_{t-2} + b_{t-3}\text{GDP}_{t-3}$
- $\text{GDP}_t = a + b_t \text{Patent}_t + b_{t-1}\text{Patent}_{t-1} + b_{t-2}\text{Patent}_{t-2} + b_{t-3}\text{Patent}_{t-3}$

Run the Haussman Specification Test to check for simultaneity.

Hypothesis #3 - There is a relationship between the export intensity and incidence of patenting
Formula: $\text{logit}\left(p_i\right) = a + b\left(\text{export}_i\right)$
Run t –test to check for significance

Hypothesis #4a - Specific firm type (local vs. foreign) has a greater propensity to patent.
Rule: The firm type with the higher mean has a greater propensity to patent.

Hypothesis #4b - Specific industry type has a greater propensity to patent.
Formula
Rule: The industry type with the higher mean has the greater propensity to patent.

Hypothesis #5 – there is a time lagged relationship between the R&D, number of R&D headcount and patenting

Formula:

$$Patent_t = a + b_t R\&D_t + b_{t-1} R\&D_{t-1} + b_{t-2} R\&D_{t-2} + b_{t-3} R\&D_{t-3}$$
$$+ c_t headcount_t + c_{t-1} headcount_{t-1} + c_{t-2} headcount_{t-2} + c_{t-3} headcount_{t-3}$$

To check on coefficient significance.

Hypothesis #6 – There is a time lagged relationship between the exports to $country_i$ and patents registered in $country_i$

Formula: $Patent_{it} = a + b_t export_{it} + b_{t-1} export_{it-1} + b_{t-2} export_{it-2} + b_{t-3} export_{it-3}$

To check on coefficient significance.

Statistic diagnostic test such as heterocedasticity, multicollinearity and auto-regression will be conducted on the above regressions as specified by Gujarati, D. (2003).

## Sources and Methods for Collecting Data

The main data that will need to be collected will be as follows:

1. Patent Statistics
2. Annual GDP
3. Export volume
4. Firm Type
5. Industry Type
6. R&D expenditure, grants and headcount

The main source for collecting data on patents will be from the online database at the US Patent Office (USPTO) website www.uspto.gov The database provides full text data from 1976 and full page images from 1790. However for the purpose of this research, only full text data from 1976 will be used because searches based on searches from 1790 to 1975 are limited to only the patent number and not searchable by inventor country. The search option at the USPTO website allows the investigator to retrieve patents based on assignee name, assignee country, inventor name, inventor country and US Classification and other fields (see Figure:1 and Figure:2).

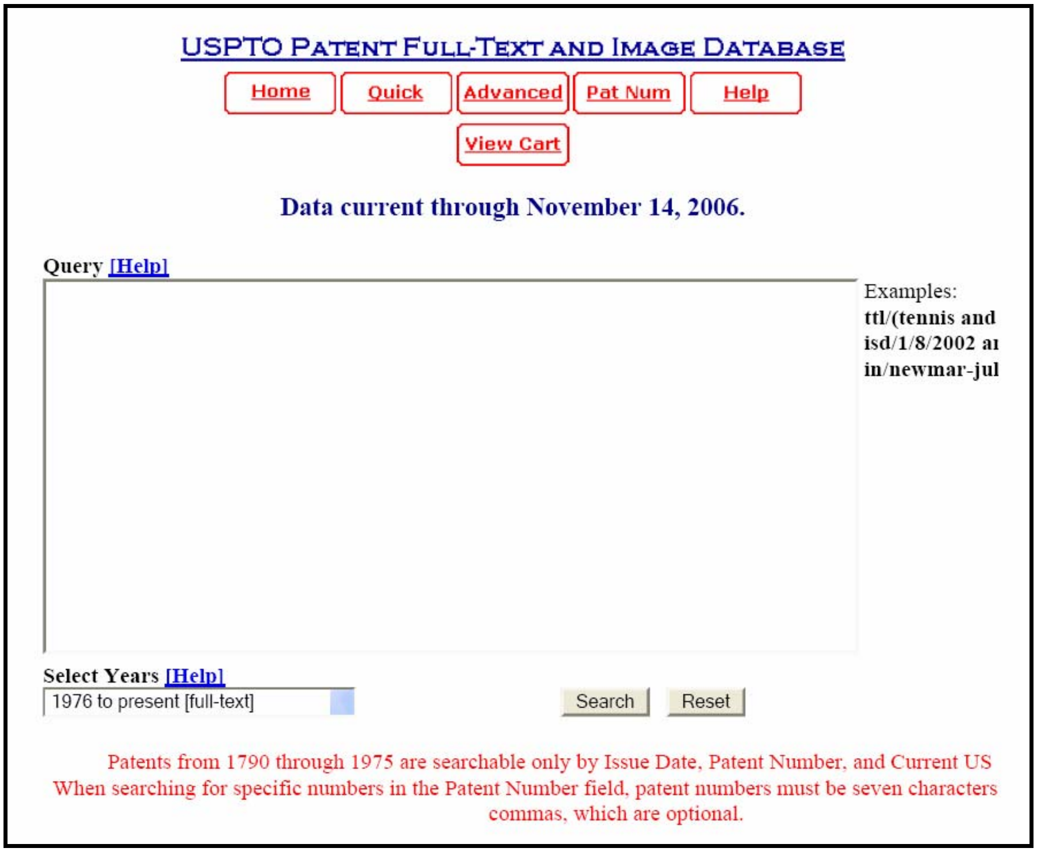


**Figure 1: USPTO Advance Query Form**

| Field Code | Field Name | Field Code | Field Name |
|---|---|---|---|
| PN | Patent Number | IN | Inventor Name |
| ISD | Issue Date | IC | Inventor City |
| TTL | Title | IS | Inventor State |
| ABST | Abstract | ICN | Inventor Country |
| ACLM | Claim(s) | LREP | Attorney or Agent |
| SPEC | Description/Specification | AN | Assignee Name |
| CCL | Current US Classification | AC | Assignee City |
| ICL | International Classification | AS | Assignee State |
| APN | Application Serial Number | ACN | Assignee Country |
| APD | Application Date | EXP | Primary Examiner |
| PARN | Parent Case Information | EXA | Assistant Examiner |
| RLAP | Related US App. Data | REF | Referenced By |
| REIS | Reissue Data | FREF | Foreign References |
| PRIR | Foreign Priority | OREF | Other References |
| PCT | PCT Information | GOVT | Government Interest |
| APT | Application Type | | |

**Figure 2: USPTO Advance Query Search Fields**

Following USPTO convention, the nationality of a patent is dependant upon the country location of the first inventor. Therefore, patents in the USPTO database which has Malaysia as the inventor country are considered as Malaysian patents. There are a 1085 Malaysian patents as at 14 November 2006 which will be the basic data for this paper. An example of a patent record is included as Figure 3.

( 1 of 1085 )

**United States Patent** — **7,135,932**
**Quadir , et al.** — **November 14, 2006**

Transimpedance amplifier

**Abstract**

A transimpedance amplifier, which is useful as an optical fiber preamplifier, is disclosed. The illustrative embodiment exhibits four characteristics. First, it minimizes the equivalent input noise current. Second, it has a wide bandwidth. Third, it has a reasonably large output voltage, and fourth, it is stable over wide temperature and voltage ranges. The illustrative embodiment comprises a transimpedance stage and a gain stage. Both stages employ a pure NMOS design which contributes to the above four advantages. Bandwidth is further increased over the prior art by the use of inductive loads. The inductive loads of the illustrative embodiment are not physical inductors, but transistor-based "active" inductors: the combination of a resistor connected in series with the gate of an NMOS transistor.

| | |
|---|---|
| Inventors: | **Quadir; Nasir Abdul** (Cyberjaya, *M)~INNM Alias; Farrah Azlin Binti ~INCI Kuala Lumpur ~INST N/A ~INCO MY ~INNM Krishnarajoo; K. Selvarajah K. ~INCI Selangor ~INST N/A ~INCO MY* |
| Assignee: | **Sires Labs Sdn. Bhd. (MY)** |
| Appl. No.: | **10/615,725** |
| Filed: | **July 8, 2003** |

| | |
|---|---|
| **Current U.S. Class:** | **330/308** ; 330/311 |
| **Current International Class:** | H03F 3/08 (20060101) |
| **Field of Search:** | 330/308,311,310,98,150 |

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| | | |
|---|---|---|
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| 6515547 | February 2003 | Sowlati |
| 6724270 | April 2004 | Kozu |

*Primary Examiner:* Choe; Henry
*Attorney, Agent or Firm:* DeMont & Breyer, LLC

***Claims***

What is claimed is:

1. An apparatus comprising: a first transistor having a gate terminal, a drain terminal, and a source terminal; a first resistor having a first terminal and second terminal, wherein said first terminal of said first resistor is electrically connected to said gate terminal of said first transistor; a second transistor having a gate terminal, a drain terminal, and a source terminal, wherein said drain terminal of said second transistor is electrically connected to said source terminal of said first transistor; and a second resistor having a first and a second terminal, wherein said first terminal of said second resistor is electrically connected to said gate terminal of said second transistor, and wherein said second terminal of said second resistor is electrically connected to said drain terminal of said first transistor; wherein a first voltage connected to said second terminal of said first resistor is greater than a second voltage connected to said drain terminal of said first transistor by at least the gate-to-source threshold voltage of said first transistor.

**Figure 3: A Patent Record**

A patent record includes details pertaining title, abstract, patent number, date, inventor name, inventor country, assignee, classification, reference cited, referenced by and claims. This allows the database used for a number of purposes such as:

a. By inventor country to make inter-country comparison
b. By inventor name to count number of patents per inventor

c. By assignee to count number of patents per company or individual holding the rights
d. By classification to count number of patents per class or sub-class
e. By reference cited to trace lineage of prior patents upon which the patent depended
f. By referenced by to trace spillovers through subsequent patents depending upon a particular patent.
g. By keyword in the abstract or claims to count number of patents having a particular word

There are several limitations to the use of patents as proxy for innovation in a particular country. The first is that patents represent only a subset of all inventions and discoveries. Inventions may not be patentable if they are trivial or if the scientific discovery has no immediate applicability. Additionally, the inventor may refrain from filing a patent due to strategic reasons for withholding disclosure such as keeping an invention secret or the negative barrier of registration costs and procedures. There are also situations of simultaneous inventions by different inventors where the inventor who was late in filing a patent is denied a patent. The second issue is with regards relevancy of using patents registered in the US as a proxy instead of patents registered domestically because it can be argued that only innovations destined for the US market are patented in the US.

Schmookler (1966) justified the use of patent statistics as a proxy for innovation because it is the best approximation in the absence of a better candidate. Additionally, innovations that are patentable are inherently of commercial and economic value. It is also relevant in this instance to use US patent statistics because US is Malaysia's largest export market accounting for approximately 20% of total merchandise exports in 2005 (MITI, 2006). Therefore, it may be suggested that any innovation that are of commercial value and destined to the US will be patented in the US to protect property rights in the target market. Lall (2003) suggested that foreign inventors filing their patents in US may have been led pecuniary, technological, and legal motives. Furthermore, registering a patent in the US implies that the innovation is of world class standard given the very stringent requirement of USPTO.

There is also a time lag factor to be considered. Presently, the time lag between date of filing and date of award is three years. However, a cursory examination of the date shows that the lag is variable and differs from class to class and also the year of the application. It could also be for human reasons of examiner productivity which contributed to this variance.

Annual GDP data can be collected through annual reports of the Malaysia Central Bank. Firm type and industry type data will have to be gathered through deduction and investigation.

R&D expenditure, grants, headcount, and other data related to science and technology can be compiled from the various issues of National Survey of Research & Development and Malaysian Science & Technology Indicators Report (MOSTI 1994-2004)

## Conclusion

This proposal if approved will offer invaluable insight and understanding into the nature and incidence of innovation in Malaysia. This understanding will be of great value to policy makers in assisting them to assess the current state of innovation in Malaysia as well as formulate policies to engender and accelerate innovation. Schumpeter's dicta are a timely reminder to us that innovation is a central economic activity and it is the most important factor in economic growth.

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