High tech Engineers: The Engines for Economic Growth.

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Abstract

Technological transformation which has taken the shape of technological revolution can be of great help in the economic development of emerging economies. Engineers have always played an important role in the economic growth of a country. High tech engineers add measurable greater value to the economy giving them an edge. The global market is consistently growing through a technological boom in areas like nanotechnology, logistics, high performing computing and biotechnology. This has brought in a shift in the requirement and availability of engineers especially in the emerging economies. A functional relationship between the numbers of high tech engineers and the GDP of a nation is proposed. We study the rate of the GDP growth as a function of change in the rate of change of high tech engineers. The study is carried out for developing as well as developed economies.

Keywords: Engineering Education, Globalization, Economic Growth, Technological Revolution.

Sub Theme: ***Economics***

Number of words: 140

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Technological Revolution of the twentieth century has seen more innovations than the sum of all the earlier centuries and engineers sit at the epicenter of this revolution. Their creativity, dedication and entrepreneurial spirit has created and accumulated wealth that has resulted in improving the quality of life in most of the societies. It is an established fact that scientific knowledge of engineering combined with creative and innovative production processes is a precondition for economic growth since this combination results in improving the quality and productivity of the industrial processes thereby improving profitability.

Engineers have been rightly called ‘engines’ of growth. From being an ordinary tinker to high tech, engineers have successfully gone through metamorphosis of their profession, innovation and invention being their hallmark. Innovations and inventions are considered to be major players in the economic growth of a nation.

In this paper we attempt to show the functional relationship between the numbers of high tech engineers and the GDP of a nation taking USA as a case study. We understand the constraints of the study since economic growth cannot be attributed to any one factor, it being a complex phenomenon in which several variables play important role. In this study we attempt to establish the contribution of two independent variables, patents and R&D expenditure in the rate of the GDP growth which is the dependent variable. Patent statistics has been accepted as a reliable indicator of innovative activities and the development of new technologies. R&D expenditure is closely related to patent though we do acknowledge that every R&D activity may not result in a patent. It is also accepted that due to globalization, R&D activity may take place in one location while patent can be registered in another country.

1. Introduction

We begin the paper by defining high tech engineers. High tech engineers are the ones who are well versed in the cutting edge technology, the most advanced technology available. The standard criterion for classifying high tech sectors is of the intensity of usage of technology. Since the 60's, OECD (Organization for Economic Cooperation and Development) is engaged in an ongoing a research program, that studies the role of technology innovation within the economic growth process. Under this program, OECD classifies products and services based on the ratio between R&D expenditure to value added and this quotient is referred to as "technology-intensity." This has been accepted as world standard classification system. Gallini (2002) shows patents as instruments of innovation. McAleer and Slottje (2003) differentiate between total patents applications and successful patents applications calling it patent success ratio (PSR). They prove that growth in PSR had a stronger association

with growth in real GDP. However, Sinha (2007) found long term relationship between real GDP and the number of patents for Japan but no evidence of cointegration and causality for South Korea. In this study we introduce expenditure on R&D as a second independent variable. We then empirically study the relationship between patents and economic growth as well the relationship between R&D and economic growth.

Economic growth trajectory of China and India are prime examples of the contribution of high tech industries to the national income. China's hi-tech industry has scored world-acclaimed achievements. It now boasts the second largest hi-tech industry and second largest hi-tech export in the world. In 2006, the total revenue of hi-tech industry exceeded 5.3 trillion yuan, with its added-value contributing 8 percent of GDP growth. India that was once equated with poverty only, is today called a "technology-fueled economic miracle". India's continuous growth in its GDP is attributed to its growth of high technology industries like Information technology, Biotechnology and pharmaceutical industries. It is a major recipient of western countries R&D outsourcing deals. India has also come up with the world's first cheapest car called Nano, designed and manufactured by an Indian automobile company called TATA Motors. It has drawn unprecedented attention from the global auto industry, adding to India's growing reputation for offering innovation and quality at low costs.

The paper is organized as follows. Section 2 discusses the objectives of the study. In Section 3 we discuss the data, the methodology used and its empirical results. Section 4 deals with conclusions.

2. Objective of the study:

The purpose of this paper is to empirically test the relationship between patents (representing inventions and innovations and hence high tech engineering), R&D expenditure and growth in GDP of USA. The process of patenting products is not standardized universally. Hence we use US data from 1963 to 2007. For this study we consider patents to be a consequence of research activities undertaken by high tech engineers. In this study we empirically test the relationship between two independent variables: patent and expenditure on R&D and growth in GDP using GRETL software to develop and estimates econometric model. The study assumes that patents are generated by high tech engineers. Literature review reveals that the relationship between the two independent variables and GDP in the same study has not been done earlier. The uniqueness of the study lies in using two independent variables and their causal relationship with one dependent variable.

3. Data and Methodology

We use several sources of data indicated in the Appendix. US patent data has been used in several of the earlier studies (Sinha, McAleer). For the purpose of our study we use US patent data from 1963 to 2007 for U.S.A (See the attached Appendix). All the variables used in the study are obtained from official statistic sites and therefore are assumed to be correct.

We take the logarithms for the real GDP variable, denoted by LNGDP as a dependent variable. The independent variable for patent used in this study is denoted by PATENT. As stated earlier, we assume that patent activities will be generated by high-tech engineers. The other independent variable is R& D expenditure and is denoted by RND.

The empirical model can be expressed as:

$$LNGDP_i = f\ (PATENT_i, RND_i)$$

Where

LNGDP = growth rate of real Gross Domestic Product , (in Billion USD)

PATENT = number of patent applications filed, (in thousands)

RND = R&D expenditures,(in Billion USD)

4. Empirical Results

The result of the study is exhibited in Table 1.

We find that two independent variables PATENT and R&D expenditure make a considerable impact on the GDP growth. The result also suggests that these two independent variables have a slightly stronger effect on economic growth (R^2 = 0.94) and each of the two factors contribute significantly at 1 per cent level to the economic growth (P=0.002 and P=1.83, respectively). The actual and fitted trend between GDP and PATENT, GDP and R&D expenditure are also shows in Figure 1 and 2 to fix with our model.

Table 1 : OLS estimates using the 45 observations between 1963-2007

Dependent variable: LNGDP

Variables	coefficient	std. error	t-ratio	p-value
const	14.6046	0.0458837	318.3	1.13

PATENT	0.00138427	0.000426728	-3.244	0.0023***
RND	0.00638178	0.000558706	11.42	1.83 ***
Adjusted R-squared = 0.94				

Note: *** = significant level at 1%

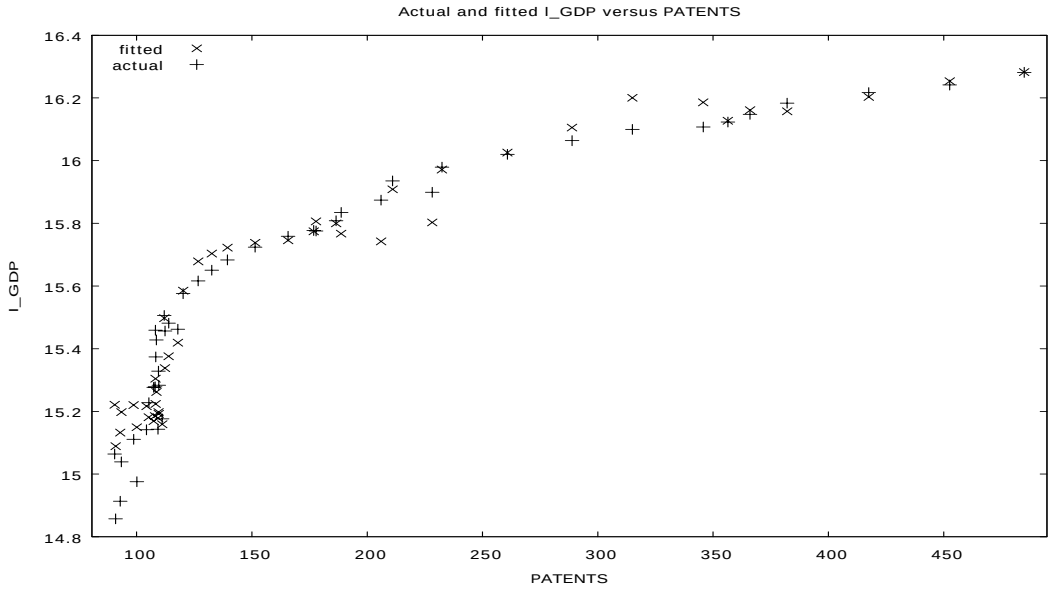

Figure 1: Actual and Fitted LNGDP versus PATENT

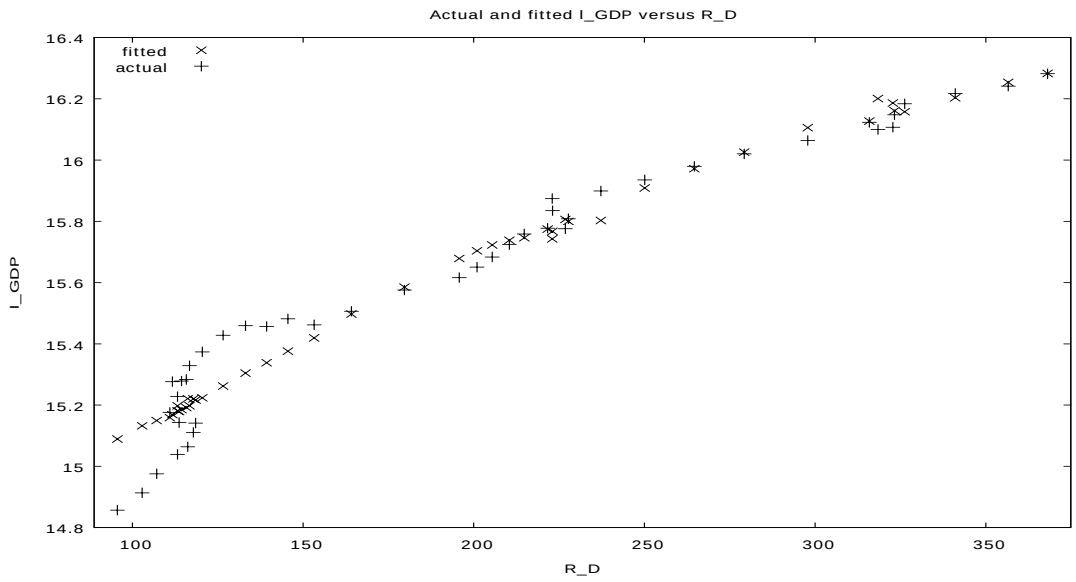

Figure 2: Actual and Fitted LNGDP versus R & D

5. Conclusions:

In this paper we first define high tech tech engineers. Increase in the number of patents signifies engineers becoming high tech. The study further looks at the impact of two independent variables: growth in the number of patents and increase in the expenditure on R&D on the GDP of USA. We found evidence of positive and long term relationship between growth in the number of patents and growth in GDP. We also found two way causality relationship between increase in expenditure on R&D and GDP. Future research can be undertaken to show the relationship between other macroeconomic factors and growth in GDP. Study can also be done to show the relationship between other macroeconomic factors and growth in expenditure on R&D and growth in patents.

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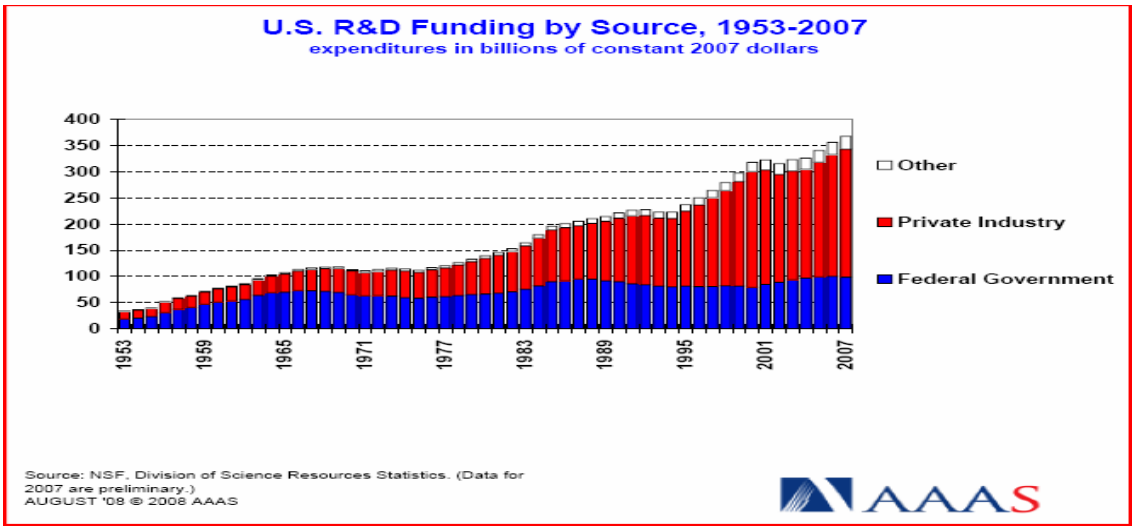
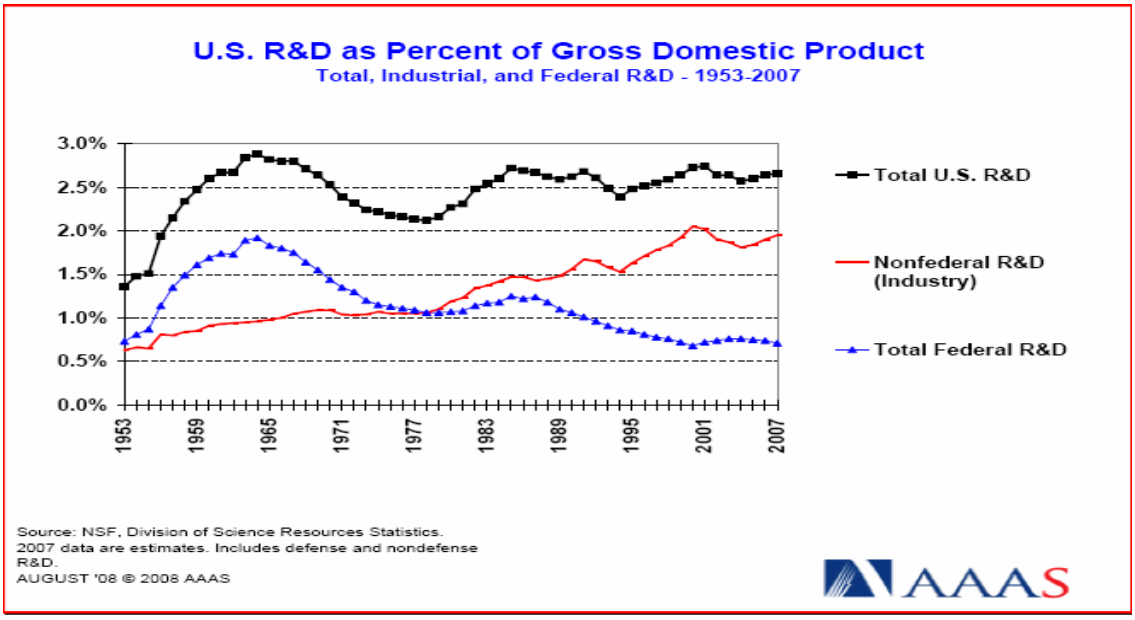
APPENDIX I

Trends for R&D Funding and GDP: Case for U.S.





APPENDIX II Annual data on U.S. Patents and R&D expenditures

YEARS	PATENTS	R_D	GDP
1963	90.9	95.63	2,833,963
1964	92.9	102.86	2,998,593
1965	100.1	107.11	3,191,104
1966	93.4	113.21	3,399,126
1967	90.5	116.24	3,484,631
1968	98.7	117.88	3,652,698
1969	104.3	118.52	3,765,397
1970	109.3	113.68	3,771,876
1971	111.1	110.97	3,898,613
1972	105.3	113.24	4,104,966
1973	109.6	115.82	4,341,456
1974	108	114.4	4,319,565
1975	107.4	111.71	4,311,220
1976	109.5	116.73	4,540,937
1977	108.3	120.49	4,750,529
1978	108.6	126.58	5,014,999
1979	108.2	133.13	5,173,444
1980	112.3	139.32	5,161,664
1981	113.9	145.56	5,291,739
1982	117.9	153.25	5,189,250
1983	112	164.17	5,423,777
1984	120.2	179.71	5,813,609

1985	126.7	195.77	6,053,732
1986	132.6	200.97	6,263,619
1987	139.4	205.42	6,475,076
1988	151.4	210.45	6,742,687
1989	165.7	214.81	6,981,436
1990	176.8	221.65	7,112,492
1991	177.8	226.82	7,100,516
1992	186.5	227.73	7,336,614
1993	188.7	223.09	7,532,658
1994	206	222.98	7,835,512
1995	228.2	237.25	8,031,655
1996	211	250.09	8,328,913
1997	232.4	264.62	8,703,528
1998	260.8	279.25	9,066,854
1999	288.8	297.85	9,470,332
2000	315	318.39	9,816,969
2001	345.7	322.77	9,890,694
2002	356.4	315.88	10,048,846
2003	366	323.26	10,301,044
2004	382.1	326.22	10,675,757
2005	417.5	341.06	11,041,846
2006	452.6	356.56	11,311,762
2007	484.9	368.09	11,777,233

Note: Sources of Data:

YEAR = 1963-2007 44 observations.

PATENTS = Number of patent applications filed, in thousands

Source: Statistical Abstract of the U.S., various years.

R_D = R&D expenditures, billions of 2007 dollars obtained as the ratio of expenditure on current dollars divided by the GDP price deflator.

Source for R&D expenditures, 1995 Statistical Abstract of the U.S.

GDP = Real Gross Domestic Product in billions of 2000 dollars,

A full report on the estimates of the R&D Satellite Account is available online at http://www.bea.gov/newsreleases/general/rd/2007/pdf/rdreport07.pdf