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FROM KNOWLEDGE TO PROSPERITY: ASSESSING THE RELATIONSHIP BETWEEN KNOWLEDGE ECONOMY AND LIVING STANDARDS

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ABSTRACT

Improving the standard of living is the primary objective of all societies, as it reflects the overall quality of life. This research investigates the rationale behind living standards by examining the knowledge economy. The study utilises secondary data from world development indicators for selected economies, covering 2000 to 2023. Appendix (A) contains the catalogue of nations chosen for this study. The independent variables comprise knowledge capital, Education, and technology (represented by High-technology exports). Additional variables include health, Foreign direct investment (FDI), life expectancy, gross capital formation, labour force participation and inflation. To address the research objective, a model investigates the influence of knowledge capital variables on per capita income, which indicates living standards.The study employs a log-log model, with variables transformed using natural logarithms. The model was evaluated using panel-corrected standard error to address the limitations of ordinary least squares (OLS) and account for potential non-spherical errors, heteroskedasticity, and correlation. The findings indicate that the explanatory variables have a positive influence on the standard of living.

INTRODUCTION

The growing significance of knowledge as the pillar of up-to-date economies has been mainly acknowledged over the last decades. The production, distribution and employment of knowledge have been critical in enhancing economic development and public welfare. The appliance of knowledge is now considered the key source of expansion in the globalised economy. The expression Knowledge Economy reveals the enlarged implication of knowledge. A knowledge-based economy refers to the economy where administrations, entrepreneurs and general masses obtain, generate, distribute and use knowledge more competently and productively for the broader outlook of socio-economic development.

From this perspective, science and technology are crucial factors in creating knowledge. Universities, and especially research organisations, play a primary function in creating and transmitting scientific knowledge. There are certain close ties between science, technology and economic growth; innovation is vastly essential for economic development and competitiveness, there is improved magnitude of education and long term learning and more investment is driven for intangibles such as R&D, and education, which sometimes get greater in volume than of investments in fixed capital. Differences in nationwide or regional income levels are often elucidated by variations in total factor productivity(Hall & Jones, 1999; Prescott, 1998) (Hall and Jones, 1999; Prescott, 1997). It is broadly held that technological advancement plays a fundamental part for productivity gains and economic growth. New growth theory, e.g. emphasizes that knowledge generation of firms and other agent contributes to long-run growth because of the presence of industry-wide

knowledge spillovers (Grossman & Helpman, 1991; Romer, 1986) (Romer, 1990; Grossman and Helpman, 1991).

Increased weight of knowledge brings up the greater prospective for economies to reinforce their economic and social development by generating more efficient ways for production of goods and services and to distribute them more efficiently and at lower costs to a larger number of people. However, at the same time danger of a 'knowledge divide is being also raised between advanced developed economies, who are coming up with for the most part of this knowledge, and developing countries, many of which are failing to compete with the emerging, advanced scientific knowledge for the reason of their inadequate awareness, poor economic induced political eras, incompetent economic policies and weak institutions. According to (UNESCO, 2005), The knowledge division is the result of differences in living standards among those who can discover, produce, manage, practice, and spread information and knowledge, and persons who are behind in this phenomenon.

The evolution of knowledge capital is leading to greater increased international competition, which (advanced knowledge) is minimizing the natural resource advantage and low labor cost advantage of most developing economies.

To elucidate certain essential phenomenon in economics, starting from the wealth and poverty of nations to the trend of global trade, economists frequently depends upon large, residual yield differences. That is, there is some vital factor of production which is different from the role of that of physical capital. This is knowledge capital differences that can play an extended function in the global economy and may facilitate in explaining many of stylized facts. Cross-country difference emerges all the way through the quality and quantity of labor (skilled). Quality relies on the ability of skilled workers to gain and aggregate sophisticated knowledge. Quantity depends on workers preference to acquire higher education (JONES, 2009)(Jones, 2009).

Hence, during the last few decades, the study of the factors that enhance and mould the pattern of economic growth has become the major area for researches in modern economics. On the theoretical front, certain models were developed that postulated sustained economic growth can take place in the absence of exogenous growth in the productivity. On the empirical side, there has been an intense research on variables that correlate with growth performance. Macroeconomists have diverted their intention from the study of mere business cycle to the study of growth phenomenon. The present study intends to come up with the empirical findings to see that if the variables that account for knowledge capital correlate with standard of living, because general public welfare cannot be seen only by a higher growth level, rather than finding the relationship between growth and knowledge capital. Secondly, the interest would be to see the reduced level of inequalities as a by-product of knowledge capital.

Knowledge capital creation leads to higher income growth, and it leads to lower poverty level. But does knowledge capital lead to better standard of living? This is the matter, which we would examine in this study, because mere increase in growth does not mean that every individual of the economy is getting better off. In addition the study intends to find that whether inclusive growth results due to creation of knowledge capital? Whether there is a trickle down effect of high income growth and economic benefits as a result of investment in knowledge capital, or disparity are increasing among the people?

Further questions which this particular study would probe in detail include the impact of high tech exports, spending on public education, and Research and development expenditure on income growth, standard of living and income inequalities.

The main objectives of this study are:

a) To study the impact of knowledge capital on country's standard of living

b) To examine the trickle down effect of knowledge capital.

The hypothesis of the study is that there is a significant relationship between knowledge capital and country's standard of living.

Human capital theories explain that the impartment of knowledge and abilities in the human resource results in the human resource development and the enhanced human resource skills results in the increased productivity and earning of the mass. Moreover, upgraded human capital can have an effect of reducing multidimensional poverty. This study would describe how significant increase in human capital spending can lead to improved

standard of living, and how does it effects the pattern of inclusive growth and inequalities.

The rest of the study is organized as section two deals with the literature review, section three contains description of the variables to be used along with their data source. It also discusses the model and econometric technique. section four explains for theoretical framework. section five contains econometric results and their interpretation. Conclusion of the study is discussed in section six.

Data for the variables accounting for knowledge capital is not sufficiently available for larger time period and cross sections. Hence, those countries are included for which sufficient data was available for greater number of years. The study includes 17 cross sections covering the time period from 2000 to 2014.

LITERATURE REVIEW

This section gives an overview of the past literature related to knowledge capital:

Most economists would decide that having a less twisted distribution of national income is desirable for a highly uneven economy provided that average incomes in the two are the same. A frequently articulated opinion is that education can play a vital role in plummeting income inequality. Schultheiß et al. (2024)Schultz (1963) proposes that enhancing human capital as one method to decrease income disparity and greater than before funding for public education might be one tactic to achieve this. (Baba et al., (2009)Fields (1980) presents the counter argument that the gradation of income inequality did not reduce even as various economies spent more and more resources on public education. As a final point, (Ram, (1989)Ram (1989) examines preceding theoretical papers and determines that there are not robust provisions that growing education inside the population depresses income inequality. One should not be astonished that education cannot clarify much of differences in income inequality between different economies.

Adams (1990)Adams (1990) studies that the formation of an enhanced knowledge pool at the universities, through public expenditure on R&D (in the shape of funded published research articles), has a positive influence on the development of productivity in the manufacturing industry in the USA and in turn the overall per capita income, but the trade-off is that the time lags involved in this case may be more than a few decades long (15 to 30 years).

In recent times, Nadiri (1993)Nadiri (1993) examines the outcome of R&D investment on per capita growth, chiefly at the firm and industry levels in developed countries such as USA, UK, France and Germany. Coe et al., (1997)Coe, Helpman, Elhanan and Hofster (1997) investigate the possible technological spillovers during trade between developed and developing countries and its effect on the total factor productivity of the developing countries. The study investigates how a rise in the expenditure of R&D in developed countries impacts the group of developing countries. For this purpose the data of 77 developing economies is used of the same time period. The higher secondary school enrolment rate is used as a measure of human capital. The results revealed that there is significant technological spillovers from developed to developing economies. They came up with the result that increase in R&D expenditure of developed world by 1% will increase the production in the developing countries by 0.06%.

Godo and Hayami (2002)Yamauchi and Godo (2001) work on the bidirectional association between economic growth and education. The study used the causality analysis and the data was of time series in nature. The work was conducted for the economy of Japan to see the part of education in augmenting economic growth. It was concluded that education does not discover its way into its dynamic usage automatically and the study termed it as a complex relationship.

Ulku (2004)Ulku (2004) examines the chief hypotheses of the R&D centered growth models that innovation is generated in the R&D segments of the economy and it permits long term durable economic growth, given that there are constant returns to innovation in terms of R&D. The study makes use of different panel data methods and employs patent and R&D figures for twenty OECD and ten Non-OECD countries for the time span 1981–97.Even though the results of the study lend support to endogenous growth models, there is minimal support for constant returns to innovation in terms of R&D, suggesting that innovation does not always culminate in boosting economic growth.

Gyimah-Brempong and Wilson, (2004)Brempong (2004) examine the effect of human health capital on the growth level of the per capita income. The study used the data on OECD and Sub-Saharan African countries. The research expands the traditional neo classical growth model of Solow. The study employs dynamic panel estimator for panel data. The study concludes that there exists a positive and strong relationship between per capita income growth rate and human health investments.
Weinhold and Nair-Reichert, (2009)Laik (2005) examines the influence of a vibrant Intellectual Property Regime IPR in the economic growth of a nation. According to Laik (2005) it enables entrepreneurs to recuperate their novel innovation based expenses. Unquestionably, intellectual property structures must be established so as to bring in more and more economic and intellectual growth. However, the fear that stringent IPR might in fact incite IPR violations in many emerging economies also seems to be a concern which needs to be looked at very carefully. The imbalance between prejudicial competition laws and IPR also take up significance of high degree and hence needs to be predominantly highlighted.
Mogues and Carter (2005)Mogues and Carter (2005) examine that what kind of relation prevails between the growth of the economy and social capital. It is found that those regions of the world have advanced level of social capital; they should realize the advanced growth level in comparison to those economies that are behind in social capital accumulation. Thus, for the growth on both macro and micro grounds, social capital requires special focus.
Gyimah-Brempong et al. (2006)Brempong (2006) prove positive and statistically significant impact of education on per capita GDP growth for the case of African economies. The study use panel data for the period 1960 to 2000. A dynamic panel estimator is used to investigate the impact of higher education on economic growth in African countries. In the analysis, growth elasticity of education human capital was found to be twice as that of the physical capital. They emphasized the need for African countries to use higher education effectively in human capital in growth oriented policies.
Ramos et al. (2009)Ramos, Surinach and Artis (2009) employs yearly data for Gross Domestic Product, stock of capital having productivity, emp and certain indicators for human capital. The data was selected for the fifty Spanish provinces. Time period range was from 1980 to 2008. The study concludes that regional productivity and growth are positively influenced by physical capital. Human capital also shows that it has a vital role to play in upgrading regional productive efficiency and growth: tertiary studies prove to have a substantially positive impact on productivity and similarly secondary studies shows the same positive impact on growth level.
Barro (2000)Barro (2013) confirmed that availability of better education and upgraded health services increased raises the productivity level of labor as a result of which output production also increases. Lifetime earnings of a person are affected in a positive manner by the attainment of higher education level.
According to Allahdadi and Aref (2011) human capital plays a pivotal role in the process of rural development is alleviation of poverty. They study examine the role of human resource development for poverty alleviation in rural areas of Marvdasht, Iran. It is suggested that in knowledge-based economies, a major shift in the way we look at human capital is necessary. Jarreau and Poncet (2012)Jarreau and Poncet (2011) study the influence of export sophistication on the overall performance of the Chinese economy by accounting for domestic distinction within one single economy (China) over the time span of 1997–2009.The study found that regions focusing on the exports of high tech goods consequently grow faster. There was considerable difference in high tech export sophistication at the provincial level. The results reveal that these technological gains are restricted to the normal export undertakings by local firms.(Arshed et al., 2022; Ghulam et al., 2021b, 2021a, 2024; Gul et al., 2022; Huang et al., 2023; Muhammad, 2024; Shabeer, 2022; Shabeer, Ayyubi, et al., 2024; Shabeer, Azra, et al., 2024; Shabeer et al., 2022; Shabeer & Rasul, 2024b, 2024a; Wang et al., 2023; Zain et al., 2024; Zubair et al., 2024)
Abbas (2022)Shahid, Hassan and Chani (2012) shows that that human capital plays a positive role in determining national income. To check the causal relationship between economic development and human capital formation, the study uses Pair-wise Granger Causality test on the time series data ranging from 1972-2009. The

results of the co-integration revealed that the variables are co-integrated. The study concludes that there exists long run stable equilibrium relationship between them. Furthermore, causality test directed the bidirectional causal relationship between economic development and human capital formation.

Khan and Nawaz (2019)Gökmen and Turin (2013) studied the relations among the fore mentionedabovementioned variables variables making use of data of European Union countries for the period 1995 to 2010 and found out that economic freedom level (EFL), human development level(HDL) and foreign direct level (FDI) together have a statistically significant progressive impact on High technology exports (HTX). The study employ panel causality test and find out that that long-run Granger causality exist there running from FDI, HD, and EFL to HTX

3. THEORATICAL FRAMEWORK

(Mankiw et al., 1992)

This section describes how knowledge capital is incorporated in production process historically. It also describes the economic importance of human capital. This section also includes the brief description that how the East Asian economies have attained economic betterment by focusing on knowledge based economy.

3.1 Growth models: Changing Perspectives

In the classical growth theories**,** Smith (1776) propose that population growth is endogenous as it depends on the sustenance offered to accommodate the growing workforce. Investment is also endogenous and is determined by the savings rate, land growth is reliant on occupation of new lands (e.g. colonization) or technological improvement of productiveness of old lands. Technological progress can also raise overall growth level. However, Smith's famous thesis that specialization (the division of labor) tends to improve the growth level is a primary argument. Smith also sees that advancement in machinery and foreign trade are the engines of growth as they smooth the progress of further specialization. Smith's growth model remained the principal model of Classical economics. David Ricardo (1817) adapted it by incorporating diminishing returns to land. Output growth depends on the growth of factor inputs, but unlike other factors of production, land varies in quality but remains fixed in supply. This implies that for the growth process, more land is required for cultivation, but land cannot be created. This has two implications for growth: firstly, increasing landowner's rents over time (due to the limited supply of land) cut into the profits of capitalists from above; secondly, wage goods (from agriculture) will be rising in price over time and this then cuts into profits from below as workers require higher wages. Ricardo, introduced a faster edge to growth than what Smith allowed, but Ricardo's claim at first was that, this decline can be checked by technological up gradation in machinery and the specialization brought by trade. The Malthusian (1798) model argues that if technological change is not occurring and size of the land does not change then the size of the population will be self-equilibrating. He further argues that in the long run accessible resources will be offset by the increase in the size of population. Countries with advanced technological level will have denser populations, but the standard of living is not related to the technological level.

In this particular study, GDP per capita is incorporated as a standard of living measure to see if standard of living is related to the production function that has taken into account the knowledge capital.

In the traditional Solow and Swan (neoclassical) growth models of 1950s, the production of an economy raises in response to more input units of labor and capital. The economies in such a model incline to perform rendering the law of diminishing returns to scale. With these suppositions, the Solow Swan growth model gave certain inferences to the economy e.g. there exists a negative relationship between capital stock and growth rate of the particular economy and it is important for the economy to take advantage of technological progress to gain persistent level of economic growth. This kind of phenomenon underlying in the neoclassical growth theory is not only intrinsic but it also does not explain much in economic term, rather it implies that the technology and its advancement are "exogenous" to the economy. Instead the fact is fairly reverse to that, specifically for the developing countries of the East Asia, where the economies have been growing for more than three decades. This reveals the fact that along with technological advancement (which has proved

to be the primary source in maintaining such high performance in the perspective of economic growth) in these economies, but there surely exist many other elements which are not determined in the Solow Swan growth model.

Rebelo (1991) postulated the linearity of production function in capital as an only input and there remain constant returns to both the scale as well as to capital. Rebelo extended the form of capital, as it included human capital, stock of knowledge and financial capital along with usual physical capital. Thus, since capital is only the input, an increase in knowledge stock or any other form of capital shall enhance production. More production implies more employment generation and its ultimate impact shall be the higher level of standard of living and reduced level of income inequalities. The growth rate of an economy depends on its savings rate and on the productivity of its technology. The growth rate of a country largely relies on the rate of savings and on the efficiency of its technological progress.

3.2 Growth model: Significance of Knowledge Capital

Addressing the above debate, a new growth theory was presented in the existing economic work, by the Paul Romer (1986), which in common is also referred to "endogenous growth theories". By expanding the notion of capital to incorporate human capital, this certain theory explains that the law of decreasing returns to scale might not remain valid. It shows that, if the firm invests in capital but at the same time, hires well-informed, educated and skillful trained workers, then on one hand the labor would be productive and on other hand it will utilize the capital and technology much more efficiently and effectively. According to Romer, capital shall be seen as representing a combination of traditional physical combination and the result of outcome of investment in Research and Development sector. Thus, capital comprises not only on buildings, machines etc. but also on innovations and new ideas (that are used for production of new products more efficiently). In this process capital will also generate some externalities, thus production function will have a shift and as a consequence of that there will be increasing returns instead of diminishing returns to investments. Romer keeps an eye on Arrow's (1962) influential work on the mantra of learning by doing. Arrow distinguished from case evidence that there was robust indication that understanding and snowballing productivity were related. He contended that an effective tool of upsurge in experience is capital formation, because each additional capital goods produced and put into usage is accomplished by altering the setting in which production occurs, so that learning by doing adopts continuous new incentives. Thus, it is apparent that innovation requires more spending on research and development, by doing so the production and productivity both will be enhanced. By focusing on technology, production of value added high tech exports is to be increased, but primary force is education in innovation, research and development. Therefore, education sector needs special attention in the economy.

Lucas (1988) presented the paper "Mechanics of Economic Development" and developed a model having constant returns to scale. Instead of relying on externalities, as presented by Romer, Lucas introduced the concept of human capital, replacing just the usual physical labor in the production function. With a production function having constant returns to scale, Rebelo's (1991) theory, gave the wider concept of capital that involves both human and physical capital. Lucas developed a production function involving human capital that exhibits constant returns to scale for human capital. Thus, the marginal product of human capital (that exhibits the inducement to spend time to study) remains constant. As opposed to Solow's model where a change in rate of savings creates level effect on the steady state, here it boosts economic growth

Grrenwood (1997) developed a model in which a foremost change in technology can transform into a sustained decline in productivity. According to this model the time lag involved in adopting the new technological changes and adjustment costs in terms of reallocation of resources are the main reasons behind this slow down. Thus, productivity declines in initial phase of any major technological revolution. This can be the reason behind the economic slowdown especially after the adoption of new information technology techniques in America and Europe.

3.3 Importance of Human Capital

Tangible forms of capital are not the only type of capital. In fact, schooling, training course,

expenditures on medical care are also capital. That is because they raise earnings, improve health, or add to a person's good habits over much of his lifetime. Expenditures on education, training, medical care, and so on are regarded as investments in human capital by the economists.

Education has proved to be the most important source for inter-generational knowledge transfer and human capital accumulation. Educational attainment does not only serve as a significant constituent of technological advancement and total factor productivity growth, in fact it also smoothens the process of the adaptation and adoption the of new technology.

The augmented Solow model (Solow, 1988) argues that human capital is the most vital factor for the process of growth. Compared with physical capital, the accumulation of human capital has a decisive role in influencing the future level of total factor productivity for a given economy or economies (Lucas, 1988). The process of education can be considered as an investment in people and educated people are the carrier of human capital (Nelson and Phelps, 1966).

Training is basically the enhancement and continuity of the normal education. Training is also vital to enhance the productivity level and also the performance at the firm level. (Baldwin and Yates, 1999; Fu and Gong, 2008). Education and training enhances the ability to gain, comprehend and deal with foreign information and technology. In this whole process they improves the ability of one to understand and assess the information on new products or processes that are transferred, it reduces the chance of making errors and risk is also minimized.

In the modern era of knowledge economy, production management requires the executives to adapt to the changes occurring in production environment. If the manager has higher education attainment, more rapidly he will be able to recognize and bring in new techniques (Nelson and Phelps, 1966).Thus, education and training boosts innovation process, accelerates knowledge and technological transfer.

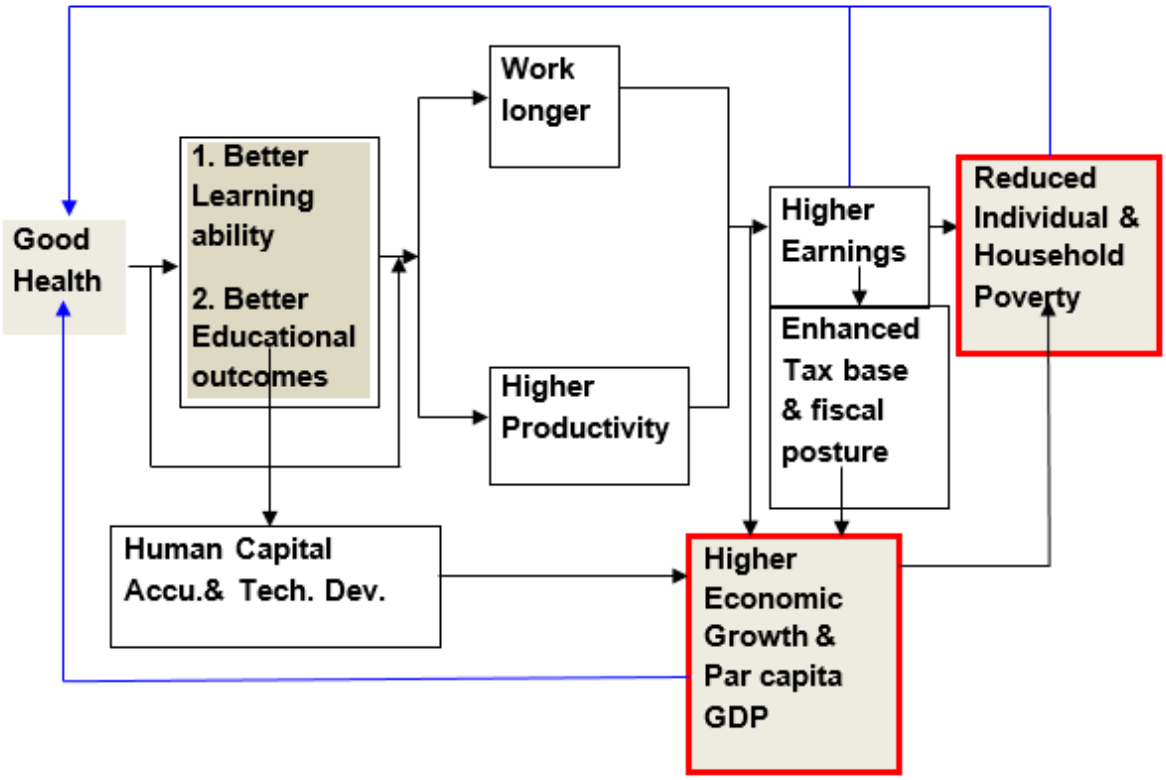
Human capital accumulation has been mainly associated to the educational level. Along with educational attainment, importance of modernization, technological up gradation, research and development is ever increasing. Many researchers have also acknowledged the significance of health, sustenance and nourishment for the development. Mankiw, Romer, and Weil (1992) cite the significance of taking into consideration health and nutrition along with education as a condition for economic growth. Barro and Martin (2004) examine that how economic growth and health are related to each other with the emphasis to find association among health and wealth.

Persistent growth hang on the level of human capital accumulation and it is increased as an outcome of better learning, improved physical state, and updates education and training process. Without a minimum required education and health environment, labour force remains incompetent to maintain persistent growth level. Identifying the significance of health, theories of economic growth are made more comprehensive by incorporating this aspect in form of human capital input. There is a direct relation amongst growth and health as good health increases human capital level, which enhances the education performance level, as a result labour productivity increases (because of reduced incapability, weakness, and absenteeism due to illness) and these all factors boost up growth phenomenon. Workers with good health are often exposed lesser to diseases and as a consequence, productivity rises.

For the developing economies, investment in health sector is one of the different means to gain higher level of labour efficiency and higher growth level. Martin (2005) explains the Health-Poverty trap (poor countries usually are not healthy, and they are not healthy because of their poorness), that in the less developed economies, it is not possible to generate economic development, exclusive of sorting out the vital health problems of these economies and similarly it is impossible for a economy to develop the health sector starved of raising the economic growth level. Thus, the mutual association between economic growth and health is evident.

In general, the relationship (while incorporating the poverty dimension) is presented in the figure 3.1 below:

Figure 3.1: The Human Capital, Standard of Living and Income Inequalities Relationship



3.4 East Asian Miracle: Lesson to learn from

From literature, it is concluded that knowledge formed by innovation and technical up gradation is the determinant of growth and development in long run. Modern knowledge economy is driven by the rapid development of human capital by generating dynamic educational and training sectors. Along with it is also essential that the advanced level of the required basis for highly competent human resources must be established via scientific techniques and technical innovation.

The basic task in an emerging economy based on knowledge is to bind knowledge for advancement and economic development by generating competent education sector and capable and dynamic human resources, excellent information and communication technology setup (ICT).

Technology and the scientific knowledge is the basis for knowledge-based economic growth and development. Different views on growth model (both exogenous and endogenous), all have recognized the dominant role of scientific progress and its significance, knowledge, in persistent growth phenomenon and higher per capita income level.

Japan, afterward the Second World War got excessive achievements in attracting large number of investors and this amount of foreign direct investment raised growth level. Japan's strategies transformed the Japanese economy into a knowledge-based economy in 1970s and 1980s (era of high growth rate). The efforts made by the Japan remained successful as it progressively became second largest economy of the world following the United States. Following the identical phenomenon, the governments of Malaysia, NIES and China have significantly succeeded in founding a knowledge-based economy by inviting significantly high foreign direct investment level.

Krugman (1994) argument that the growth of East Asian economies would undergo diminishing returns because of inadequate technological advancement remained inaccurate as the East

Asian economies continue to develop by offering new technologies, scientific techniques and efficient ways of production by adopting, adapting and innovating. While knowledge flow from advanced economies have remained the chief cause of new notions for the economies based on knowledge capital of East Asia, nonetheless the main mediums for knowledge run to East Asia are global trade, execution of intangible knowledge and foreign direct investment.

The East Asian countries tend to show considerable progresses in capability development by enhancing the expenditure for research and development sector and producing larger number of R&D people. This attempt of capacity building is fuelled by the improvement in institutional structure, decreasing microeconomic instability and augmenting general human capital standing in the region of East Asia. In this regard, the institutions for research have played a significant role in evolving the innovative ability in these countries.

The economies of the East Asia comprehended the importance of innovation and technological expansion as they moved toward the frontier of knowledge, where they have smaller number of chances of integrating and adapting exogenous technologies. They have put extensive efforts for creating innovative goods and services and methods to sustain competitive advantage with the other industrialized and advanced economies of the world.

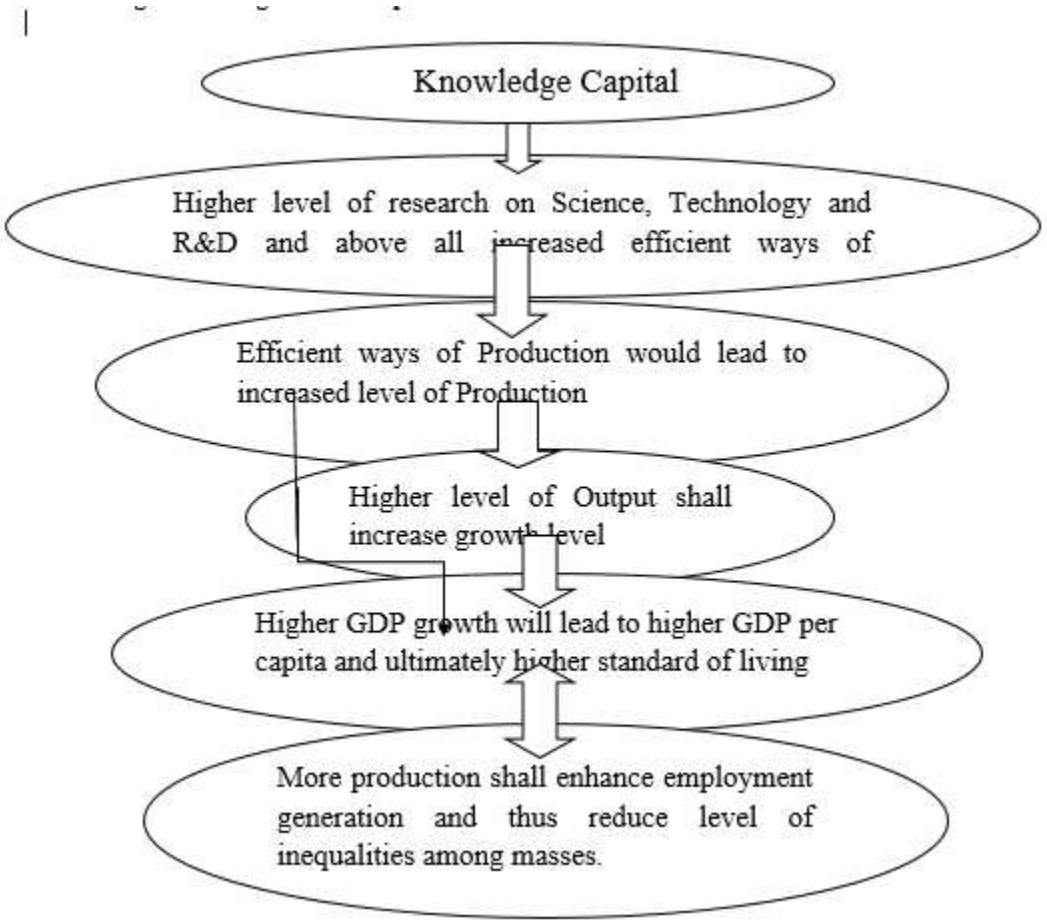
There is an important link between the innovative inputs (such as expenditure on research and development) and innovative products (such as patents). Along with R&D expenditure, openness to foreign knowledge contributes towards the innovation of the said economies. As the infrastructure for innovation in the East Asian economies has been developing, patent applications in most of the economies increases. From table 3.1 below, it is seen that from 2000, there is a persistent increase in number of patent applications in all of the East Asian economies. This tendency is more common in China Japan, Singapore, Korea, Hong Kong and Taiwan.

Table 3.1 Number of patent applications in the East Asian economies

Country	2000	2001	2002	2003	2004	2005	2006	2007
China	51,906	63,450	80,232	105,317	130,384	173,327	210,501	245,161
Hong Kong	8,295	8,914	9,130	9,102	10,005	11,763	13,790	13,766
Indonesia	3,889	3,922	3,837	3,300	3,667	4,303	4,606	N/A
Japan	419,543	440,248	421,805	413,093	423,081	427,078	408,674	396,291
Korea	102,010	104,612	106,136	118,651	140,115	160,921	166,189	172,469
Malaysia	6,227	5,934	4,937	5,062	5,442	6,286	4,800	N/A
Philippines	3,636	2,605	854	1,873	2,696	2,351	3,265	N/A
Singapore	8,236	8,656	8,199	7,906	8,585	8,605	9,163	9,951
Taiwan	61,231	67,860	61,402	65,742	72,082	79,442	80,988	81,834
Thailand	5,049	5,332	4,489	5,131	5,373	6,340	6,248	1,388

Source of Table 3.1: World Intellectual Property Organization and the WIPO Patent Report, 2008 Edition.

Figure 3.2 Diagrammatic representation for Theoretical Framework



4. DATA AND METHODOLOGY

This section of the study discusses the nature and source of the data, description of the dependent, independent and controlled variables used in the study. Model and econometric technique used for empirical findings is also discussed in this section.

4.1 Source and nature of data

The data is secondary in nature and selected from world development indicators for the time period from 2000 to 2014 of all those economies for which data is available. The list of the selected countries is given in appendix (A).

4.2 Description of variables

The detail of the variables used in the model is described as under:

4.2.1 Dependent Variables

The dependent variables used in the study are:

GDP Per Capita:

This is used as a proxy variable for standard of living and is a dependent variable in this study. GDP per capita is obtained if gross domestic product is divided by total population.

4.2.2 Knowledge Capital

The description of the independent variables used in the study is given below:

- **Research and Development Expenditure as % of GDP:**

  Research and Development expenditures used as an independent variable for 'Knowledge Capital. R&D expenditure are both current and capital

expenditures; including both public and private sector on innovative work that is done methodically for enhancing knowledge and to use knowledge for the new applications. R&D covers primary research, secondary research, and tentative development.

- **Spending on education, total as % of GDP:**
It is used as an independent variable. Public expenditure on education as % of GDP is the total public expenditure (current and capital) on education expressed as a percentage of the Gross Domestic Product (GDP) in a given year. Public expenditure on education includes government spending on educational institutions (both public and private), education administration, and transfers/subsidies for private entities (students/households and other private entities).

- **High-technology exports:**
It is used as an independent variable**.** High-tech exports are the products with the advanced intensity of Research and development; such as computers, medicine products, scientific instruments, and electrical appliances.

4.2.3 Controlled Variables

The following are the controlled variables, used in the study:

- **Health expenditure as % of total GDP:**
It includes the provision of protective and remedial health services, family planning projects, nourishment, and accidental aid and rescue. However, expenditure for water and sanitation is not included in it. This variable is used as controlled variable in both the models.

- **Foreign direct investment:**
Foreign direct investment is defined as the net inflows of investment, to obtain a long-term management interest in an enterprise, working in a country other than that of the investor. It is actually the aggregate of equity capital, long-term capital, reinvestment of earnings, and short-term capital as shown in the balance of payments. This variable depicts net inflows in the reporting economy from foreign investors. Net inflows are defined as new investment inflows minus disinvestment.

- **Life expectancy:**
Life expectancy at birth indicates the number of years a new-born child would live if established pattern of death at the time of its birth stays the same all through its life.

- **Gross Capital Formation (% of GDP):**
Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress."

- **Labor force participation rate, total (% of total population ages 15-64):**
Labor force participation rate is the proportion of the population ages 15-64 that is economically active: all people who supply labor for the production of goods and services during a specified period.

- **Inflation, consumer prices (annual %):**
Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.

4.3 The Model

In this study, to capture the objectives two separate models would be estimated. Firstly we would examine the impact of knowledge capital variables on per capote income that is used to measure standard of living. Secondly we would capture the relationship between knowledge capital and income inequality. The model specification is explained below as model I and model II. In model, Independent variable is Per capita income whereas in model II, dependent variable is Ginni Index.
The variables used, in both models of the study are transformed by taking natural logarithms. Thus, models will become log-log model.

After estimating a log-log model the coefficients can be used to determine the impact of explanatory variables (X) on explained variable (Y). The coefficients in a log-log model represent the elasticity of the dependent variable with respect to independent variable. To be more precise, the coefficient is the expected percent change in X variable for a percent change in Y variable.

4.3.1 Model I:

The study incorporates knowledge capital in the classical production function to see the impact of knowledge capital on output. Here output is in per capita terms.

$$\frac{Y}{L} = f(K.C, K, L)$$ ---------- **(4.1)**

K.C represents knowledge capital. K represents capital where as L shows labor. Based on above equation in this study we will estimate the following econometric model:

$$(Y/L)_{it} = \beta_0 + \beta_1(K.C)_{it} + \beta_2(C.V)_{it} + \mu_{it}$$ ---------- **(4.2)**

The variables have i and t subscripts for i = 1, 2… N cross sections and t = 1, 2,…,t time periods. C.V shows the controlled variables used in the study. The parameter β_0 is the intercept term, whereas β_1 and β_2 are the slope coefficients. Here the expected signs for independent variables are positive i.e. $\beta_1 > 0, \beta_2 > 0$

For this model equation is as under:

$$lnGDPPerCapita_{it} = \beta_1 + \beta_2 lnEduExp_{2it} + \beta_3 lnR\&DExp_{3it} + \beta_4 lnGrossCapitalformation_{4it} + \beta_5\, lnHightechExports_{5it} + \beta_6\, lnLabor\ force\ participation_{6it} + \beta_7\, lnForeign\ Diect\ Investment_{7it} + \beta_7\, Inflation + \mu_{it}$$ ---------- **(4.3)**

Where ln represents the natural logarithm. The above equation can be interpreted as; one percent change in explanatory variables will change the standard of living (per capita income) by one percent in same direction. The following table shows the expected signs of the independent variables being used in the model:

Table 4.1: Expected signs for standard of living model

Variable	Expected Sign	Variable	Expected Sign
Education Expenditure	Positive	Research & Development Expenditure	Positive
Gross Capital Formation	Positive	High Technological Exports	Positive
Labor Force Participation Rate	Positive	Foreign Direct Investment	Positive
Inflation	Positive		

4.3.2 Model II:

We use knowledge capital in the function as independent variable to see the impact of knowledge capital on inequalities.

$$\boldsymbol{G.I = f(K.C, K, L)}$$ ---------- **(4.4)**

G.I represents Ginni index. Based on above equation in this study we will estimate the following econometric model:

$$\boldsymbol{ln(G.I)_{it} = \beta_0 + \beta_1 ln(K.C)_{it} + \beta_2 ln(C.V)_{it} + \mu_{it}}$$ ---------- **(4.5)**

The variables have i and t subscripts for i = 1, 2… N cross sections and t = 1, 2…. t time periods. The parameter β_0 is the intercept term. Where as β_1 and β_2 are the slope coefficients. Here the expected signs for slope coefficients are negative i.e. $\beta_1 < 0$ and $\beta_2 < 0$.

In this model the following set of two equations will be estimated:

$$lnGinniIndex_{it} = \beta_1 + \beta_2 lnEduExp_{2it} + \beta_3 lnR\&DExp_{3it} + \beta_4 lnHealthExp_{4it} + +\beta_5\, lnLife\ expectancy_{5it} + \beta_6 lnGDP\ per\ capita *_{6it} + \mu_{it}$$ ---------- (4.6)

$$lnGDPPerCapita *_{it} = \beta_1 + \beta_2 lnEduExp_{2it} + \beta_3 lnR\&DExp_{3it} + \beta_4 lnGrossCapitalformation_{4it} + \beta_5\, lnLife\ Expectancy_{5it} + \beta_6\, lnHealthExp_{6it} + \beta_7\, lnForeign\ Diect\ Investment_{7it} + \mu_{it}$$ ---------- (4.7)

The above equation shows that Gini index depends upon spending on education, research and development expenditure, life expectancy and Gdp per capita. Whereas the spending on education, research and development expenditure, gross capital formation, life expectancy, health expenditure and foreign direct investment are used to capture the endogeniety of Gdp per capita.

Ln represents the natural logarithm in above equations. The equation 4.6 can be interpreted as; one percent change in independent variables will change the income disparities (Ginni index) by one percent in opposite direction.The expected signs of the independent variables being used in the model are given below in the table:

Table 4.2: Expected signs for income inequalities model

Variable	Expected Sign	Variable	Expected Sign
Education Expenditure	Negative	Research & Development Expenditure	Negative
Health Expenditure	Negative	GDP per capita	Negative
Life Expectancy	Negative		

4.4 Methodology

The econometric technique to be used in the study is discussed below:

4.4.1 Pooled OLS model

It is simplest approach where time and space of pooled data is not considered in fact it is assumed that only homogeneity exists and estimates the equations by using the ordinary least square technique. In general it is written as:

$$Y_{it=}\beta_1+\beta_2 X_{2it} + \beta_3 X_{3it} + \mu_{it}$$

After estimating the desired equation, main concern is the diagnostic tests for the presence of multicollinearity, hetroskedsticity and autocorrelation. If VIF<5, value of Breusch- Pagon test and Walt test is closer to zero then the presence of said problems exist and the results can be misleading and distorted.

4.4.2 Panel Fixed Effect

Because of the biasness of the results of pooled OLS, the fixed effect technique is used to account for individuality of each cross-sectional unit where slope coefficient is assumed to be constant but the intercept varies across the individuals. In fixed effect technique each individual's intercept is time invariant. Its general equation would be as:

$$Y_{it=}\beta_{1i}+\beta_2 X_{2it} + \beta_3 X_{3it} + \mu_{it}$$

Subscript$i$on intercept term shows that intercept of cross sections may be different. This heterogeneity can be due to "other factors". Thus FEM assumes that the slope coefficients of the explanatory variables do not differ across individual countries or over time period. In fixed effect technique intercept varies actually by virtue of dummy variable technique. Therefore the above equation is written as

$$Y_{it=}\alpha_1 +\alpha_2 D_{2i}+\alpha_3 D_{3i}+ \alpha_4 D_{4i}+\beta_2 X_{2it} + \beta_3 X_{3it} + \mu_{it}$$

Here dummies are being used to estimate the fixed effects it is therefore known as least-squares dummy variable model.

4.4.2.1 Problem of Hetroskedasticity and Autocorrelation

Having applied the above stated technique, the diagnostic tests should be should conducted. For hetroskedasticity modified Wald test, where as to detect the presence of autocorrelation Wooldridge test is tested

. The presence of hetroskedasticity and autocorrelation will make the results biased and inconsistent.

DISCUSSION

4.4.3 Panel Corrected Standard Error (PCSE)

To overcome above issue, the study will estimate the model by using panel corrected standard error. Beck and Katz (2006) suggest that estimating linear models of TSCS data by ordinary least squares (OLS) and proposed a sandwich type estimator of the covariance matrix of the estimated parameters, which they called panel-corrected standard errors (PCSE) that is robust to the possibility of non-spherical errors. The panel corrected standard error estimate is robust not only

to unit heteroskedacity, but it also robust against possible contemporaneous correlation across the unit that is common in panel data. They show that in more realistically sized data-sets the previous procedures the standard errors are under-estimated. The reason for is, that the number of parameters to be estimated in the error-covariance matrix are large and number of observations used to estimate them are relatively smaller. As a result, it over-fits the data, or more precisely it over-fits the pattern of the error term.

They show that the efficiency gains from contemporaneous correlation correction are normally small in comparison to standard error bias, which is relatively large. Consequently, they propose to estimate standard errors according to a robust method which tends to incorporate contemporaneous correlation information into the coefficient variance-covariance matrix without adjusting the coefficient estimate. Thus, this procedure controls for serial correlation in simpler way prior to the final estimation and relies on robust standard errors, in other words Panel corrected standard errors (PCSE) possess small sample properties in comparison to alternatives

4.4.4 Two-Stage Least Squares / IV Regression

4.4.4.1 Why there is a need for IV Regression?

Three important threats to internal validity are:

- Omitted variable bias from a variable that is correlated with X but is unobserved (so cannot be included in the regression) and for which there are inadequate control variables;
- Simultaneous causality bias (X causes Y, Y causes X)
- Errors-in-variables bias (X is measured with error)

All three problems result in $E(u|X) \neq 0$. Instrumental variables regression can eliminate bias when $E(u|X) \neq 0$ by using an instrumental variable (IV), Z.

Consider the following equation:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + u_{it}$$

IV regression breaks X into two parts: a part that might be correlated with u, and a part that is not. By isolating the part that is not correlated with u, it is possible to estimate β_1.This is done using an ***instrumental variable***, Z_{it}, which is correlated with X_{it} but uncorrelated with u_{it}.

4.4.4.2 Two Conditions for a Valid Instrument

For an instrumental variable (an "instrument") Z to be valid, it must satisfy two conditions:

1- Instrument relevance; Cov (z,x)≠0
2- Instrument exogeneity; Cov (z,Ɛ)=0

4.4.4.3 How two stage least squares (TSLS) works?

As the name suggests, there are two distinct stages in two-stage least squares. In the first stage, TSLS finds the portions of the endogenous and exogenous variables that can be attributed to the instruments. This stage involves estimating an OLS regression of each variable in the model on the set of instruments. The second stage is a regression of the original equation, with all of the variables replaced by the fitted values from the first-stage regressions. The coefficients of this regression are the TSLS estimates. TSLS woks in a following way:

Isolate the part of X that is uncorrelated with u by regressing X on Z using OLS:

$$X_{it} = \pi_0 + \pi_1 Z_{it} + \nu_{it} \quad \text{---------- (1)}$$

Because Z_i is uncorrelated with u_i, $\pi_0 + \pi_1 Z_i$ is uncorrelated with u_i. Compute the predicted values of X_{it} , X_{it} * where

$$X_{it} *= \pi_0 * + \pi_1 * Z_{it}$$

Replace X_{it} by X_{it} * in the regression of interest: regress Y on X* using OLS:

$$Y_{it} = \beta_0 + \beta_1 X_{it} *+ \mathcal{E}_{it} \quad \text{---------- (2)}$$

Because X_{it} * is uncorrelated with u_{it}, the first least squares assumption holds for regression (2). (This requires n to be large so that π_0 and π_1 are precisely estimated.) Thus, in large samples, β_1 can be estimated by OLS using regression (2)**.** The resulting estimator is called the *Two Stage Least Squares (TSLS)* estimator,

Model for income inequality is estimated by using this technique. In this model instrumented variable used is GDP per capita which on first stage depends upon life expectancy, health expenditure, gross capital formation, foreign direct investment, research and development expenditure and public spending on education. In the second stage GDP per capita is used along with other variables (expenditure on health, life expectancy, research

and development expenditure and public spending on education) to see having impact on Gini index.

RESULTS AND INTERPERTATION

Econometric results are described for both the models as under:

5.1 Model (1) for standard of living

This model has employed Panel corrected standard error (PCSEs) technique. Before explaining the results of PCSEs other tested techniques are briefly discussed below:

5.1.1 Pooled OLS

The tabulated result for pooled ordinary least square, are given in the table 5.1 (see appendix). All the coefficients are statistically significant. As the value of R^2 shows 82.17% of the model is being explained by the independent variables. The model shows the positive relationship between variables used for knowledge capital and standard of living. But there is a need to conduct the diagnostic test to see if there is any problem of hetroskedasticity in pooled OLS model. The Breusch-Pagon test in the table 5.2 (given in the appendix) shows that there is no problem of hetroskedasticity. The P-value indicates that null hypothesis (that variances are constant) is not rejected. On testing multicollinearity (table 5.2 in appendix) it is found that there is no problem of multicollinearity as VIF is less than 5. But joint F test tells that there is a need to run fixed effect model (see table 5.3 given in appendix).

5.1.2Fixed effect regression model

The outcome for the fixed effect regression model is given in table 5.4 (see appendix).The fixed effect regression model has most of the coefficients for the independent variables (e.g. education spending, gross capital formation, labor force participation, inflation) are negative whereas expectedly they must have a positive sign. However research and development expenditure and high tech exports shows a positive relationship with GDP per capita. R-Square is 59%. Education spending and R&D expenditure are statistically insignificant.

5.1.2.1 Cross-sectional dependence test is run to determine is there any cross sectional dependence. Pr in the table 5.5 (in appendix) confirms that cross sections are independent. Hence the fixed effect assumption that individual specific effect is correlated with independent variables is not fulfilled.

5.1.2.2 Diagnostic tests

The tests mentioned below are conducted to deduct the presence of heteroskedasticity and autocorrelation to see the consistency of fixed effect model. Results are given in the table 5.6 of the appendix.

5.1.2.2.1 Modified Wald test checks the group-wise heteroskedasticity in fixed effect regression model. It is concluded from P-value that there is a problem of heteroskedasticity in this particular model.

5.1.2.2.2 Wooldridge test is used for detecting the problem of autocorrelation in the panel data. This test confirms the presence of serial correlation as its null hypothesis that there is no first order autocorrelation is rejected.

Because of the presence of heteroskedasticity and autocorrelation, fixed effect model is no more consistent and results can be biased. Therefore, Panel corrected standard error are used to estimate the model I.

5.1.3 Panel Corrected Standard Errors (PCSE)

The results of panel corrected standard errors reveal that all the coefficients are significant at 1% significance level. The outcome (in the table 5.7) shows that an increase of 1% in public spending on education will increase GDP per capita by 0.79%, if research and development expenditure is increased by 1% an increase of 0.703% will occur in GDP per capita. If the exports of high technological exports are increased by 1% we shall have the increment of GDP per capita by 0.775%.

The controlled variables of the study; gross capital formation raises per capita by 0.6336% and foreign direct investment raises per capita income by 0.2117% if it is increased by 1%. However labor force participation rate and inflation reduces standard of living.

Table 5.7 shows that all the variables of knowledge capital are statistically significant having the expected signs. Hence, the alternative hypothesis is accepted that there is a significant relationship between knowledge capital and standard of living.

Table 5.7 Panel corrected standard errors

Independent Variables	Coefficients	Z-statistic	Standard Errors	P-value
LEdu	0.7926***	4.54	0.1747	0.000
LRD	0.7036***	10.82	0.6505	0.000
LHTE	0.7744***	2.85	0.2720	0.004
LGCF	0.6336***	4.03	0.1573	0.000
LLFP	-1.3034***	-5.19	0.2511	0.000
LP	.-0.6126***	-9.53	0.6428	0.000
LFDI	0.2117***	6.12	0.3462	0.000
Constant	4.5012***	3.12	1.4432	0.002
R-Square	0.8217	Wald Chi Square	1085.75	

*** shows that coefficient is significant at 1%

The reason that coefficient of education spending is higher than that of R&D is that the provision of education forms the basis of knowledge capital and primary focus of every government is to increase this base of knowledge capital creation, where as R&D expenditure forms the tip of knowledge capital and usually is very refined and specialized. The expected benefits of R&D are not expected in short run and that is why some governments prefer to divert their resources from spending on R&D to education sector. Labor force participation rate holds a negative relationship with GDP per capita. This can be due to the reason that most of the economies in the study are developing where large number of labor is unemployed. Because of this higher unemployment level labor force participation rate, does not cause GDP per capita to rise in fact the resultant of this unemployment level is negative impact of labor force participation on the GDP per capita.

CONCLUSIONS

The study intends to find, that how the knowledge capital is related with standard of living of the mass The focus of the study is to see the pattern of change in standard of living of people as a result of change in knowledge capital and to check that if standard of living is increasing or decreasing, then income disparity increases or decreases?

The study finds out that exports of high technological goods raise the standard of living. High tech exports ensure higher revenue or profit as compare to low tech products. Greater returns increase the production, and employment opportunities are offered. High tech exports demand more skilled labor and the scientific expertise, whose wage rate shall be greater than the un-skilled laborer. High tech exports increase the research and scientific activities as higher level of wage rate for skilled labor provides the incentive to people to work out more in science and technological oriented learning. The prospects of future higher returns invest more and more in research and development.

Also the studyfind out that public expenditure on education is significant in our model of standard of living and there is a direct link between this variable and the standard of living, because in long run it is education expenditure that enhances the productivity level and life time income stream level. Higher public education spending ensures the higher level of education and higher level of education increases the productivity level and wage rate is determined by the productivity of the laborer.

Research and development (R&D) expenditure also has a significant and direct relationship with standard of living. R&D through innovation offers new sophisticated products into the market and this introduction of novel products in the market tends to attract new customers which increase the consumption of these new sophisticated products. A firm gets the exclusive right to produce newly innovated product that raises its profit margin. The quest for higher profits translates into higher expenditure on research and development, so that the growth cycle of the firm continues.

In the present study Goss capital formation, controlled variable also affects GDP per capita in a positive manner. More capital formation raises the production activities and ultimately GDP per capita. Foreign direct investment has a positive significant impact on GDP per capita. More investment in to the country raises the business activities and production level of the country. Increased level of production generates employment opportunities. Labour force participation rate and inflation rate has shown negative impact on standard of living. Negative impact of labor force participation rate, point towards the unskilled and incompetent labor force which cannot transform working hours in higher standard of living.

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APPENDIX

A- List of the selected economies:

1- Croatia	2- Estonia	
3- Poland	4- Slovenia	5- Hungary
6- Bulgaria	7-Malaysia	8- Mexico
9- Romania	10- Russia	11- Turkey
12- China	13- Guatemala	14- South Africa
15- Thailand	16- Madagascar	17- Pakistan

B- Table of the outcomes:

Table 5.1 Pooled OLS

Independent Variables	Coefficients	T-statistic	Standard Errors	P-value
LEdu	0.7926	3.69	0.2150	0.000
LRD	0.7036	8.12	0.8664	0.000
LHTE	0.7744	2.14	0.3621	0.034
LGCF	0.6336	2.47	0.2567	0.015
LLFP	-1.3034	-3.36	0.3881	0.001
LP	-.6126	-7.94	0.7717	0.000
LFDI	.2117	4.48	0.4726	0.000
Constant	4.5012	2.35	1.9180	0.020
R-Square	0.8217	F(7,157)		103.36

Table 5.2 Breusch-Pagon test

Chi-Square	0.88
Probability	0.3483

Table 5.3 Fixed effects regression model

Independent Variables	Coefficients	T-statistic	Standard Errors	P-value
LEdu	-0.1391	-0.84	0.1663	0.404
LRD	0.9295	0.74	0.1257	0.461
LHTE	0.4964	10.27	0.4832	0.000
LGCF	-.3840	-2.23	0.1725	0.028
LLFP	-.2671	-0.26	1.020	0.794
LP	-.2825	-5.07	0.5568	0.000
LFDI	0.2407	7.07	0.3403	0.000
Constant	-4.7932	-1.14	4.1961	0.255
R-Square	0.5911	F test		146.60

Table 5.4 Cross-sectional dependence test

Pesaran's test of cross sectional independence	0.561
Pr	0.5747

Table 5.5 Diagnostic tests

Modified Wald test			
Chi square	365.02	Probability	0.0000
Wooldridge test			
F-Statistic	8.891	Probability	0.0093

A- Stata Outcomes

MODEL: Standard of living

Pooled OLS

```
. regress LGDPPC LEdu LRD LHTE LGCF LLFP LP LFDI
```

Source	SS	df	MS	Number of obs =	165
Model	297.874742	7	42.5535346	F(7, 157) =	103.36
Residual	64.6358053	157	.411693027	Prob > F =	0.0000
				R-squared =	0.8217
				Adj R-squared =	0.8137
Total	362.510548	164	2.21043017	Root MSE =	.64163

LGDPPC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LEdu	.7926292	.2150514	3.69	0.000	.3678621	1.217396
LRD	.7036528	.0866453	8.12	0.000	.5325119	.8747936
LHTE	.0774417	.0362178	2.14	0.034	.0059047	.1489786
LGCF	.6336706	.2567588	2.47	0.015	.1265234	1.140818
LLFP	-1.303436	.3881467	-3.36	0.001	-2.0701	-.5367733
LP	-.6126554	.0771747	-7.94	0.000	-.76509	-.4602208
LFDI	.2117823	.0472686	4.48	0.000	.1184178	.3051469
_cons	4.501297	1.918088	2.35	0.020	.7127107	8.289884

i- Pooled OLS

ii- Joint F-Test

```
. test LEdu LRD LHTE LGCF LLFP LP LFDI

 ( 1)  LEdu = 0
 ( 2)  LRD = 0
 ( 3)  LHTE = 0
 ( 4)  LGCF = 0
 ( 5)  LLFP = 0
 ( 6)  LP = 0
 ( 7)  LFDI = 0

       F(  7,   157) =  103.36
            Prob > F =    0.0000
```

iii- Diagnostic tests

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of LGDPPC

         chi2(1)      =     0.88
         Prob > chi2  =   0.3483

. estat ovtest

Ramsey RESET test using powers of the fitted values of LGDPPC
       Ho:  model has no omitted variables
                 F(3, 154) =      1.73
                  Prob > F =      0.1621

. estat vif
```

Variable	VIF	1/VIF
LHTE	3.81	0.262488
LFDI	2.93	0.341721
LEdu	2.07	0.482326
LP	1.50	0.666963
LLFP	1.32	0.755024
LGCF	1.29	0.777857
LRD	1.25	0.801139
Mean VIF	2.02	

iv- Fixed effect

```
. xtreg LGDPPC LEdu LRD LHTE LGCF LLFP LP LFDI, fe

Fixed-effects (within) regression               Number of obs      =       165
Group variable: Country                         Number of groups   =        16

R-sq:  within  = 0.8784                         Obs per group: min =         9
       between = 0.5255                                        avg =      10.3
       overall = 0.5911                                        max =        11

                                                F(7,142)           =    146.60
corr(u_i, Xb)  = -0.5950                        Prob > F           =    0.0000
```

LGDPPC	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LEdu	-.1391563	.1663359	-0.84	0.404	-.467971	.1896583
LRD	.0929527	.1257492	0.74	0.461	-.1556297	.3415352
LHTE	.4964062	.0483203	10.27	0.000	.4008861	.5919263
LGCF	-.384074	.1725235	-2.23	0.028	-.7251203	-.0430276
LLFP	-.2671674	1.020711	-0.26	0.794	-2.284921	1.750586
LP	-.2825587	.0556821	-5.07	0.000	-.3926317	-.1724857
LFDI	.2407787	.0340345	7.07	0.000	.1734989	.3080584
_cons	-4.793235	4.196119	-1.14	0.255	-13.08817	3.501699
sigma_u	1.196759					
sigma_e	.28991971					
rho	.94456622	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(15, 142) =    41.80             Prob > F = 0.0000
. xtcsd, pesaran
```

```
. xtcsd, pesaran


Pesaran's test of cross sectional independence =     0.561, Pr = 0.5747

. xttest3

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (16)  =     365.02
Prob>chi2 =      0.0000


. xtserial LGDPPC LEdu LRD LHTE LGCF LLFP LP LFDI

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      15) =      8.891
           Prob > F =      0.0093
```

v – Panel corrected standard error

```
. xtpcse LGDPPC LEdu LRD LHTE LGCF LLFP LP LFDI

Number of gaps in sample:  6

Linear regression, correlated panels corrected standard errors (PCSEs)

Group variable:   Country                    Number of obs      =       165
Time variable:    Year                       Number of groups   =        16
Panels:           correlated (unbalanced)    Obs per group: min =         9
Autocorrelation:  no autocorrelation                        avg =   10.3125
Sigma computed by casewise selection                        max =        11
Estimated covariances      =       136       R-squared          =    0.8217
Estimated autocorrelations =         0       Wald chi2(7)       =   1085.75
Estimated coefficients     =         8       Prob > chi2        =    0.0000
```

LGDPPC	Panel-corrected Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LEdu	.7926292	.1747719	4.54	0.000	.4500826	1.135176
LRD	.7036528	.0650562	10.82	0.000	.5761449	.8311606
LHTE	.0774417	.0272051	2.85	0.004	.0241206	.1307628
LGCF	.6336706	.1573122	4.03	0.000	.3253444	.9419968
LLFP	-1.303436	.2511347	-5.19	0.000	-1.795651	-.8112216
LP	-.6126554	.0642897	-9.53	0.000	-.7386609	-.4866499
LFDI	.2117823	.0346299	6.12	0.000	.1439089	.2796558
_cons	4.501297	1.443247	3.12	0.002	1.672585	7.33001

v – Panel corrected standard error

```
. xtpcse LGDPPC LEdu LRD LHTE LGCF LLFP LP LFDI

Number of gaps in sample:  6

Linear regression, correlated panels corrected standard errors (PCSEs)

Group variable:    Country                    Number of obs      =       165
Time variable:     Year                       Number of groups   =        16
Panels:            correlated (unbalanced)    Obs per group: min =         9
Autocorrelation:   no autocorrelation                        avg =   10.3125
Sigma computed by casewise selection                         max =        11
Estimated covariances      =       136        R-squared          =    0.8217
Estimated autocorrelations =         0        Wald chi2(7)       =   1085.75
Estimated coefficients     =         8        Prob > chi2        =    0.0000
```

LGDPPC	Panel-corrected Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
LEdu	.7926292	.1747719	4.54	0.000	.4500826	1.135176
LRD	.7036528	.0650562	10.82	0.000	.5761449	.8311606
LHTE	.0774417	.0272051	2.85	0.004	.0241206	.1307628
LGCF	.6336706	.1573122	4.03	0.000	.3253444	.9419968
LLFP	-1.303436	.2511347	-5.19	0.000	-1.795651	-.8112216
LP	-.6126554	.0642897	-9.53	0.000	-.7386609	-.4866499
LFDI	.2117823	.0346299	6.12	0.000	.1439089	.2796558
_cons	4.501297	1.443247	3.12	0.002	1.672585	7.33001

```
. estat firststage

First-stage regression summary statistics
```

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(2,171)	Prob > F
LGDPPC	0.7657	0.7575	0.3683	49.8583	0.0000

```
Minimum eigenvalue statistic = 49.8583

Critical Values                       # of endogenous regressors:    1
Ho: Instruments are weak              # of excluded instruments:     2
```

	5%	10%	20%	30%
2SLS relative bias	(not available)			

	10%	15%	20%	25%
2SLS Size of nominal 5% Wald test	19.93	11.59	8.75	7.25
LIML Size of nominal 5% Wald test	8.68	5.33	4.42	3.92