Innovations, Income Inequality and Economic Growth Nexus: A Cross Country Analysis

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Abstract

Due to complexity of relationship between innovation, income inequality and economic growth, the choice of measure is to be taken in this study of their interaction is very important. This study explains the effect of innovation on income inequality and impact of both innovation and income inequality on economic growth. In this study we have three panel of high, middle and low income countries, each panel have 20 countries with time frame of 1996 to 2018. The innovation was measured by two proxies i.e. Research and Development (R&D) % of GDP and Numbers of Patent Applications (PA), whereas income inequality was measured by GINI index and Economic Growth(GDP)was measured constant 2010 US$, all the data was taken from world development indicators (WDI) 2018. Generalized Method of Moment (GMM) model was used in this study to analysis the results. The results of the study indicated that in high income countries innovation play important role in economic growth and reduce in income inequality. In middle income countries innovation contribution is very low and innovation impact on income inequality is insignificant, while in low income countries innovation have good impact on economic growth and innovation impact on income inequality also have significant results. Income inequality of all high, middle and low income countries have negative impact on economic growth. Suggestion of this study is to increase the investment on R&D which reduced the income inequality and also help to gain the sustainable growth rate.

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Chapter 1

1.1 Introduction:

Economic observers concentrate on the problems of growth and convergence after the excellent work of Solow (1956).Mankiw et al. (1992) tested the Solow model several years later using cross-country data. Their empirical research supported Solow 's conclusions and claims that human capital is one of the key determinant of growth. As expected, there are already high income disparities between countries and regions (Benos & Tsiachtsiras, 2019).Comparative income levels have been found to share various main components such as education level, research and technology, infrastructure and administrative efficiency. There is also rich literature that suggests that innovation is a significant determinant of development. The best policy solution to decreasing global wealth inequality is to contribute to real economic growth in developing countries (Martin, 2002). In a global world; innovations minimize the human income inequality (Antonelli & Gehringer, 2017). We see that since 1980 the development movement has evolved. Around the same time, the largest 1 percent share of profits grew and the Gini index stayed exactly the same (Włodarczyk, 2017).

As the improvement of patent rights or the improvement of R&D subsidies leads to a higher growth rate , the real interest rate also rises, leading to an increase in income assets, which causes income inequality (Chu and Cozzi 2018).The consequence is that the expansion of patent rights and the increase of R&D subsidies both have a significant impact on the income inequality across interest rate channel (Chu and Cozzi, 2018). Enhanced monopoly ports contribute to the valuation of goods and generate further favorable impacts on income disparities by improving patent rights. In comparison, higher research and development incentives reduce income disparities by decline of asset prices by creative destruction, thus lowering asset profits. The opposite impacts on interest rate, asset prices and expanded R&D subsidies have an overall uncertain impact on income disparities. Such an increase in R&D subsidies would lead to lower income differences particularly where the measures of Quality are less than a threshold. An empirically feasible phase is less than the threshold, which means that R&D subsidies have a negative impact on income inequality. The enhancement of patent rights, in comparison, has a positive influence on inequalities of income. This theoretical finding

reflects Adams (2008), who uses a patent right index developed by Ginarte and Park (1997) and considers that improved patent protection affects the income inequality positively and significant. Consequently, pro-growth policies can appear to be increasing income inequality, but studies have shown that this can apply to the patent policy but not to R&D subsidies.

Much has been said about the impacts of income disparity on development. The on-going discussion turns around conceivable negative just as beneficial outcomes of imbalance on development, described to work through various transmission channels, and thinking about the unpredictable idea of both phenomena. One factor is that all accounts of real significance; regardless of whether disparity is because of accessible chances and specific financial and institutional conditions, or because of market factors and conflicting results and uneven achievement. The World Development Report 2006 (World Bank 2006) divides the balance of opportunities and the balance of outcomes from each other. Despite the fact that disproportionate opportunities impede progress, unequal results provide the requisite incentives for resource accumulation, creativity and economic growth; "inequality of opportunity is wasteful and unfavorable to sustainable development and poverty reduction" Nevertheless, "income differences play an important role in providing incentives to invest in education and physical capital" (Marrero and Rodriguez, 2013).While the previous identifies with wasteful organizations, low human capital venture and underdevelopment, the last identifies with uneven accomplishment in free showcases. Latter, (Marrero and Rodriguez, 2013) pursue a similar contention: they allude to pay imbalance as a composite proportion of disparity of chance and imbalance of exertion, which may influence development through inverse channels. Regardless, auxiliary disparity (or imbalance of chance) is relied upon to negatively affect ensuing monetary development, while showcase disparity (or imbalance of exertion) is required to have a beneficial outcome (Castells.Q. D. & Royuela. V, 2017).

The perplexing impact of imbalance on the elements of monetary development has again stood out of mainstream researchers after the world financial and economic crisis of 2008. A few creators have set a reinforced highlighting on the job of inequality in the development procedure of the most recent decades, yet in addition on the job of

the emotional ascent of these disparities in numerous nations as a reason for the crisis itself (Krugman 2008; Stiglitz 2009; Brescia 2010; Rajan 2010). According to these studies, high inequality currently helps to understand simple economic vulnerabilities that have accumulated over the long term.

A main topic in the debate on economic development was the subject of sustainable economic growth. Besides proposing determinants of growth, it is extremely important to find a new feasible catalyst for growth. Some economists have suggested that policies to encourage sustainable development would require transparency, competitiveness and productivity progress. Others opposed the focus on domestic innovation –and hi-tech development ideally (Lawk, Sirmidi, and Goh 2020)–as part of the Strategy. The emphasis of academic researchers and policymakers is on economic growth , particularly its long-term sustainability. There have been several attempts to include a long list of variables that may affect economic development. Romer (1986), Lucas (1988) and others, the groundbreaking work on endogenous development, highlights the role of the information as a contribution to production.

We note that innovation and technology, the increase in R&D spending, and sustainable economic development, are prerequisites for ensuring productivity and success. We note that innovation and technology, the increase in R&D spending, and sustainable economic development, are prerequisites for ensuring productivity and success. In addition , increased workforce preparation, an increase in the level of investment, easy investor access to stock market would have beneficial implications, first, for the growth of the private and public sectors, and secondly, for improving people's standard of living. We take into consideration the hypotheses (Gurbiel, 2002) that macroeconomic as well as microeconomic factors influence the creative capacity of the economy: GDP / capital, R&D spending, international trading, competition, technological disparity and the level of benefit of foreign firms in a region.

Studies that indicate that income inequality is beneficial in the creation of sustainable (positive theory) economic growth and studies that seem to come to a mutually conflicting conclusion (negative theory) seem to emphasize an active role for income inequality in economic growth (Seo, KIM and Lee, 2020).

The Lorenz Curve is an economic instrument to calculate income inequality. The chart displays the proportion of the population's overall income from the bottomx percent. A quantitative measure that represents the degree of inequity in the different distribution options can be employed as the Gini coefficient, defined by the Lorentz curve (Cerieni & Verme 2012).Less equitable distribution of income leads to closer Gini to 1 (1 is absolute inequality).Therefore, the lower the GINI coefficient is to zero the more the distribution is uniform (zero equal's absolute equality).Therefore, the lower the GINI coefficient is to zero the more the distribution is uniform (zero equal's absolute equality). Many scholars, in dissimilar countries and group of countries, on different time periods or different kinds of economic development stages, have studied the relation between income inequality, economic growth and poverty, without reaching any universal conclusion (Soava, Mehedintu, Sterpu, 2020).

Many researchers have studied the role of economic growth in the mitigating poverty and income inequality, and be glad about that the Gini index correlation of income and the poverty threshold may be positive or negative, depending on country level. In the sense of economic growth, income inequality and poverty affect each other both directly and indirectly.

Considering the relation between innovation structures and developing countries, the poverty and inequality issues that are so profoundly rooted in the social background of those countries cannot be ignored. Poverty and injustice are critical issues in 21st century global society. Poverty–the long and slow global income change leaving less than $2 a day for half the world's population–also characterizes much too much life. Inequality-the distance from the lower to the top of the distribution cliff-is steep worldwide and steeper in most countries. Neither old nor new wealth is universal, but instead accumulates among individuals and places in particular. The workings of innovation processes could either improve or resolve poverty and injustice (Cozzens et.al 2009).

Romer (1986) and Lucas (1988) are known as founder of fundamental source of sustained growth in per-capita income, namely the gathering of knowledge. Societies can develop their knowledge through different channels such as, formal education, training, basic scientific research, and learning by doing. Understanding the

mechanisms of modernization and R & D as factors suited to explain discrepancy between economies' and per capita incomes was an outstanding exercise for economic growth theories. Innovation, knowledge, and human resources are well-known variables in the literature, and so technological innovation is also regarded as one of the key determinants of the overall productivity factor of the revenue of firms, and so for economic growth. (Madsen 2010).From a traditional point of view, new technology improves efficiency and incomes, either increasing or reducing income inequality for both low and high-skilled workers. Skill-based technology modifies inequality, but it also raises the relative demand for high-skilled workers and creates incentives for higher educational success. Obviously, higher supply of high skilled workers result decrease in a income inequalities. (Katz & Murphy, 1992).

1.2 Objective of the Study:

There is one of the great advantages of innovation in term of its contribution in economic growth. Simply put, innovation can lead to greater productivity, which means at same input generate more output. When productivity increases, more goods and services are produced ensuring words economy flourishes. So, the main objectives of the research are as follows:-

i). To investigate the association between innovation and income inequality for the high, low and middle income countries.

ii) To measure the impact of innovation and income inequality on economic growth high, low and middle income countries.

iii). To design a way foreword to cope up the aftermaths of innovation on income inequality and economic growth.

1.3 Research question:

RQ1: What extent does innovations, in the long run, affect Income Inequality?

RQ2: How does innovation impact on Economic growth?

RQ3: What extent Income inequality impact on Economic growth?

1.4 Hypothesis:

H0:1: Innovation does not have an impact on Income Inequality.

H1:1: Innovation has an impact on Income Inequality.

H0:2: Innovation does not have an impact on Economic Growth.

H1:2: Innovation has an impact on Economic Growth.

H0:3: Income Inequality does not have an impact on Economic Growth.

H1:3: Income Inequality has an impact on Economic Growth.

1.5 Significance of the Study:

Many literatures have been conducted on the effectiveness of innovations and income inequalities on economic growth. Some of them discovered the effect of income inequality on economic growth and some of them have discovered the effects of innovations on economic growth. This research contributes in multifarious ways in new literature. First this study captures the effectiveness of innovations on income inequality. Secondly measure the impact of both innovations and income inequality on economic growth. This research incorporates the latest information ranging time frame from 1996 to 2018. This study can help out the academicians, researchers and policy maker to incorporate the findings of the research to design the polices.

1.6 Boundaries of the Study:

There is no specific benchmark study is available.

It is not possible to analyze the effect of innovations and income inequality on economic growth of all the words due to the non-availability of data. This study consistent 60 major countries (20 High, 20 Middle and 20 Low Income Countries). Three core variables including Innovation, income inequality, and economic growth jointly find the impact of Innovation, income inequality on economic growth therefore other variables have also affect economic growth, this study is focusing on. And innovation impact on income inequality only. The data of the study is designed to measure the impact of core variables and data is also specific. The data period which is used in this study is from 1996 to 2018.

1.7 Plan of the Study:

This study is designed in such a manner that chapter 1 contains the mechanism of introduction, objectives of the study, research question and hypothesis. Chapter 2 describes the literature review giving background about theoretical and empirical studies. in the same way, chapter 3 defines the methodology and theoretical framework restructuring theoretical model and selection of variables and ends with clarifies estimations technique and methods followed in this analysis.

Chapter 2

2.1 Literature Review:

The core point of the research is that due to impediment of relationships between innovations and income inequalities, impact innovations and income inequalities on economic growth, this chapter tells us how much work is done on that idea and if the gap exist, the chapter also tells the choice variable and methodology which is very important.

2.2 Innovation and Economic Growth:

Xiong*et al* (2020) examined the relationship of R&D investment and economic growth in China in a newly gathered panel data set. They explore, in particular, how social philters contribute to the output of research and development. They adopt a two-step approach to identify the impact of R&D investment on R&D production instead of directly linking R&D investment to economic growth, and then examine the causal relationships between R&D production and economic development. The results show that the relationship between the supply of R&D, the output of R&D and economic growth varies from region to sector. Non-peripheral and not-state-owned are the majority of positive experiences. Social philters are much more effective in these situations. These results highlight the complex relationship between R&D and economic performance and illustrate the important role played by social philters in innovation and development.

Wong, Ho and Autio (2005) analyzed of the growth effect of technological innovation on the position of new firms. Used cross-sectional data on the 37 GEM 2002 participating countries, this paper used increased Cobb–Douglas output as separate growth determinants to analyze firms' training and technical innovation. The comparison among different types of business activities calculated at GEM Total Entrepreneurial Activity rates (TEA) – high growth potential, need TEA, Opportunities TEA, and overall TEA are one area of concern. Only high growth entrepreneurship potential has a major effect on economic growth in the four forms. This result reflects existing evidence in the literature that the bulk of new jobs generation by small and medium-sized businesses in advanced countries accounts for new firms rather than new companies in general.

Sattar *et Al.* (2013) examined the effects on economic development for a healthy group of 28 mid- and low-income countries over the period from 1975 to 2010 through fixed effect approaches such as patenting, contracting, trading and foreign direct investment and the analytical findings indicate that each path has a significant impact on sample countries. Only licensing and foreign direct investment in middle-income countries are the most effective forms for technology transfers, although this has been the case for patenting and license in middle-income countries. The only active technology transfer network has been for licensing and foreign direct investment in middle-income and low-income countries.

Saleemet.al (2019) aims to support the driving forces behind total factor productivity (TFP) and economic growth in Pakistan. Pakistan's normal growth rate is 5% for most recent couple of decades, and despite the fact that this development level is agreeable, Pakistan confronted a few considerable difficulties yet. The financial development has been resolved primarily through work concentrated innovation and fare situated assembling exercises. Notwithstanding, TFP was evaluated from the total creation capacity utilizing the Cobb–Douglas generation work that licenses for the concurrent development of yields and constriction of sources of info. From 1972-2016 World Development Predictor, the annual time series details was taken out (WDI). The overall results showed that nearly all variables were statistically significant. In addition, innovation contributes significantly to economic growth and to the level of production in Pakistan.

Rosenberg (2004) explained why technological innovation was considered an significant factor in economic development and focuses in the highly developed OECD economies on some of the most distinguishing features of innovation. The paper seeks in particular to explore a single element of the 'uncertainty' which dominates new technology search, drawing on the American experience in several cases. It also addresses the effects of technological advancement in the tourism sector and how the tourism business model is being changed.

Pradhan *et.al* (2019) Owing to innovation, digitization and the emergence of new sources of growth. Europe has been rapidly transformed. However, there has been inadequate analysis of the complex dynamics among the dissemination of innovation,

penetration of ICT and economic development. This paper explores the similarities between these three variables between 1961 and 2016 for European countries. The purpose is to decide if, in one way or in no way, the trigger direction between the variables is the same. They may detect that the diffusion of innovation and the penetration of ICT promote economic growth in the long term by using a vector mistake corrector model. However, the causal linkages are not always consistent in the short run and rely on proxies used to disseminate and penetrate the technology of innovation. The findings provide useful insights into policies and strategies to maintain European economies' economic growth.

Pradhan *et.al* (2016) researched in eighteen countries of the euro area between 1961 and 2013 the relationship between innovation, financial growth and economic development. They concentrate on whether the root causality is in both cases, in one direction or in another. Empirical findings showed that the economic development in the countries in the region is driven by the development of the financial sector and by improved creative ability in the euro area.

Pece, Simona and Salisteanu (2015) empirical research has been discussed about the CEE countries. Innovation and economic growth Innovation, R&D and technology investments are the foundation for innovation and development and, through them, sustainable economic growth. The continuous training of staff, growing research spending, the production of new goods and easy access to stock markets for investors would, first of all, guarantee private and public sector growth and, secondly, boost the living conditions of citizens. The purpose of this paper is to examine whether the capacity for innovation in an economy affects long-term economic development. The research was conducted using several models of regression calculated for Poland, the Czech Republic and Hungary for the following CEE countries. They used different variables such as patent number, number of labels, R&D expenditure to measure the invention. The results indicate that economic growth and innovation have a positive relation.

Papalia, Bertarelli and Filippucci (2011) studied the association between the degree of economic growth and returns to various stages of education for the OECD countries' panel during the period 1965–2004 in club convergence system. In a spatial

integration model of several clubs, the relationship between development and human resources deals of primary , secondary and tertiary schooling with non-linearity and dependency. By decaying any school into its three component sections, they will determine the effects of their practices on provincial growth without requiring them to homogeneity each degree of education. The two governments, each marked by different returns on accumulation of physically and human resources and technologies, lead to the acceptance of the OECD countries. In the club that is not close to the technical boundary, they have observed that the non-monotonic convergence trend was heavily affected by stocks of human resources and knowledge diffusion.

Niringiye and Hisali (2013) research investigated the impact of progress on the production of pseudo-panel data used by Ugandan manufacturing companies. Little was known in the sub-Saharan African countries about the relation between creativity and solid development. It is an overview of the relationship between innovation and market development in Uganda, which follows Gibrat 's rule on the proportional impact and benefit model from Jovanovich (with some modifications). Definition statistics suggest that creative businesses are growing higher on average relative to non-innovative companies by using machines and purchasing new machinery. But the regression findings revealed that the growth rates of creative and non-innovative businesses do not vary considerably.

Liu and Xia (2018) investigated the complex inter-relationships between R&D, technological advancement and economic development in China. Technological innovation was a key driver for sustainable economic and social growth and can be attain through R&D investment leading to sustainable economic development. This process is one of the important steps for China to achieve the transition from large to intensive economic growth and development. Given the highly powerful and inseparable R&D spending, technological innovation and economic development, it is especially important to understand the conations between the three. By collecting data from China among 1995 and 2016, the paper described R&D, technological innovation and economic growth as variables in study. The model was adopted for vector auto regression, the response function and the decomposition function for variance. A secure long-term dynamic interaction between the three has been reported. The empirical

analysis showed that R&D investment growth, technological innovation and economic growth stagnated or even slowed down in recent years, indicating that there is insufficient momentum in economic development. The conversion efficiency was not high and short-term benefit R&D expenditure was omnipresent. Science and technology's innovation capabilities were not solid, science and technology achievements were not converted at a high pace, and the process of market integration was relatively slow. In general, good circular structures between investment in R&D, technological innovation, and economic growth have not been developed. On this basis, China is expected to reinforce the reciprocal impact and partnership between R&D investment, technological innovation and economic development. For example, by increasing investment in R&D, increasing R&D funds' effectiveness, improving the incentive structure in terms of technical and scientifically advancement and promoting the efficient use and incorporation of innovative achievements on the market the transmission mechanism of the three must be optimized and stabilized.

Lichtenberg (1992) explained the influence of labour productivity improvement at country level by accounting for R&D investment and for fixed and human capital assets. The positive results on competitiveness of private supported investment for R&D have been found. In comparison, the impact on private R&D was very higher, and the investment gain on facilities and structures was seven times higher. Government-funded research's social marginal product tends to be considerably less than the private money.

Heshmati and Lee (2010) investigated the Globalization-income inequality partnership by the development of a new globalization index focused on economic growth. In addition the findings were compared using two other measures of globalization, non parametric Kearney and the key parametric analysis. The updated index was broken down into four subcomponents. The index is calculated in various ways, in decomposed or hybrid versions, divided by various economic growth variables. This approach was primarily marked by the assumption that the globalization index and its association with economic growth was not embraced in one phase. Their level, creation and similarities are all indicators to the point of admiration. The methodological study was based on panel results from the period 1995–2001 from 61 developed and developing countries studied. In order to determine the impact of

globalization on wealth inequality, the regression analysis was used. This research was helpful in developing a new multidimensional measure of globalization with various weights linked to the variables.

Kacprzyk and Doryń (2017) looked at the nexus of innovation-growth among the countries of the European Union (EU). In the old (EU-15) and new (EU-13) Member States, the system-wide Moment estimator was used to test whether patent application and different R&D (R&D) investments influence economic development differently. In provisions of the growth and positives of patent activities to EU-13, the writers have found no major effect on R&D. The results indicate that there can be no single formula for EU growth and the question arises as to whether it is economically relevant to set a standard numerical goal in EU innovation policy.

Jalles (2010),contributed by proposing alternate indicators, empirically evaluated by a panel compilation of evidence from 1973 countries between 1980 and 2005, in the long-standing discussion on selecting the appropriate metric to measure creativity and technical dissemination. In order to reflect different growth rates of profits per capita (patents and intellectual property indexes), two different technology innovations (patent and intellectual property), and after endogenous regulation, these findings indicate a significant impact on innovation and economic growth.

Hasan and Tucci (2010) widen the research line aimed at connecting innovation to economic growth by tackling a few unexplored issues. This paper empirically explores the impact on economic development of both innovation quantity and efficiency using global patent data. The paper tracks the past indicators of innovative action. In addition, that research explores how innovation advances can be converted into per capita growth under different economic systems and phases of economic development. Their empirical findings show that countries hosting companies with better-quality patents often have higher economic growth, according to a study of 58 countries for 1980-2003. They also have some evidence of a corresponding rise in economic development for those countries that have raised the degree of patentability.

Hanusch, Chakraborty and Khurana (2017) analyzed the conations between the various categories of government spending and economic growth in human equities creation, security, infrastructure development and technological innovation, used a fixed

effects model for G20 countries. The efficacy of public spending on economic growth was analyzed by in the theoretical context of systematic Neo Schumpeteri economy. The findings indicated that innovation investment has a significantly higher effect on economic growth than other macro variables. Data for the empirical estimation were taken from the Government Finance Statistics Database of the International Monetary Fund, G20 infrastructure reports, and the World Bank World Development Indicators.

Guloglu and Tekin (2012) explored potential causative investment, innovation and economic growth in the OECD countries with respect to Research and Development (R&D) relationship. They evaluate causal relationships in pair or multivariate ways by evaluating a traversable panel autoregressive vector model (VAR). In terms of R&D investment Granger shows innovation calculated as the number of triadic patents; whereas technological progress Granger was responsible for economic growth, as assumed in theory of endogenous growth. There was also an inverse association between economic growth and innovation, which implies that the rate of production growth is driving technological change. There multivariate causality tests further show that the size of the market and the innovation rate along with Granger are responsible for R&D; while Granger jointly improves national performance and R&D strength, due to technological changes. These results indicated that the "technological drive" and "market pull" innovation models are equally important.

Gordon (2012) poses critical concerns on the economic growth mechanism. Since Solow's major contributions in the 1950's, it contradicts the almost universal belief that economic growth is an ongoing and lasting phase. Before 1750, there was almost no growth, so there was no guarantee that development would continue forever. The paper instead indicates that rapid development in the past 250 years may well prove to be a rare period in the history of humanity. The paper is just about the US and looks to the future from 2007, claiming that there was no financial crisis. His starting point was to increase real GDP per capita in the border country since 1300, the United Kingdom. Then until 1906 and then in the U.S. In the middle of the 20th century, growth accelerated steadily after 1750 at the border, and has been decreasing since then.

Farinha, Ferreira and Nunes (2018) aimed in countries of different levels of development to explore the connation between innovation and entrepreneurship to economic growth Three analytical methods have been developed to analyze the productivity implications of innovation and enterprise. They used descriptive statistics, structural equation modeling (SEM) and hierarchical cluster analyses to test the mathematical model of competition. According to their study structure. The World Economic Forum's Global Competitiveness Study evaluated detailed figures and SEM data sources for 148 countries. In addition, Global Enterprise Monitoring data on 67 separate countries was addressed during the hierarchic cluster study. The findings demonstrated that creativity and complexity are key to economies' competitiveness. The study also disclosed the concept of five clusters in relation to the spirited success of advanced economies after new entrepreneurial variables were added.

Chaudhry, Sabir and Gulzar (2019) explored the effect on economic growth of selected South Asian countries through financial development and technology for the period 1984-2017. The empirical template used in the WAS study calculated using the Generalized Method of Moment System (GMM system), is due to the Endogeneity problem. Empirical research showed that economic growth in developing South Asian countries is strongly and substantially impacted by financial progress, technology, and human resources. South Asia should aim to establish a capital market that promotes economic development by offering funding to innovation entrepreneurs in order to achieve sustainable economic growth.

Broughel and Thierer (2019) summarized the related literature documenting the effect on economic development and, more generally, living conditions and human well-being of technological innovation. The record of historical history is transparent as to how constant progress has changed our way of life. But, the disruptive short-term implications are real and should also be taken into consideration. The paper ends with a comprehensive discussion of how important these results are to shape societal attitudes towards technology, and what role public policy can play in encouraging innovation, development and continuing improvements in citizens' living conditions.

Benos and Karagiannis (2018) investigated the association between economic growth and top income inequality using an annual panel of US state-level data under the

impact of human and physical capital development. The study was based on Galor's and Moab 's 2004 "unified" paradigm and empirics are responsible for cross-sectional dependency, heterogeneity parameters and Endogeneity in non-stationary sequence. They conclude that shifts in disparities in the United States as a whole during the 1929-2013 era do not impact growth, neither short-term nor long-term. The results were good to introduce general indicators of income inequality. The findings confirm the theoretical forecast of the unified theory of inequality and prosperity, which indicates that in the latest phases of economic development the growth impact of inequality, is marginal, as the United States understood in our study time. There are also no probable adverse growth effects in developing countries like the USA for future initiatives designed to moderate the focus at the upper end of the earnings spectrum.

Osorio.B and Pose.R (2004) addressed the issue. A two-stage study was used to define the effect on innovation (measured in terms of number of patent applications per million populations) of R&D activity in the commercial, public and higher education sectors. In this way, the effect on economic development of productivity and creativity is dealt with. Results demonstrated the strong correlation between research and development activities as a whole, and R&D investment in higher education in peripheral regions of the EU, in particular, with innovation. However, the nature and strength of the association depends on the socio-economic features that influence the capacity of each region to convert R&D investment into innovation and ultimately innovation into economic development.

2.3 Income Inequality and Economic Growth:

Zhang and Wan (2006) analyzed In the late 1980s to the late 1990s, emulation of poverty in China using a decomposition variant of Shapley modified the data on the household unit records. To evaluate the robustness of the outcome a variety of data sets have been used, poverty lines, poverty acts and equivalence measures. Also examined were the potential foundations of disrespect for regional differential prices and inflation. This has contributed to a rise in rural poverty during the second half of the 1990s and unfavorable shifts in delivery.

Yao (1999) China's GDP more than expanded under economic reform between 1978 and 1996. The disposable income of each citizen in cities has more than tripled

and in rural areas nearly quadrupled. But high economic growth has led to broad income gaps slowing down the reduction of poverty. 70–170 million people were still living in poverty in 1995. The goal is to assess, by means of both household and secondary survey data, the relation between economic development, income inequality and poverty. The main findings are (1) the urban-rural division and spatial inequality are 2 key factors which account for general income inequalities; (2) non- and non-farm incomes are distributed in more unequal wages than farms and salaries.

Ward (2017) the growing inequality discussed gives individuals motivation to work hard to invest? Or is global development hampered by it? This research reviewed the currently systematic literature. It begins with the definition of certain Social Impacts of recent inequality rises, with a focus on those which influence economic development. The numerous findings of econometric studies were then observed. The study points to the literature's processes that link inequality and economic development. The findings were summarized in five broad areas. Although conditions vary widely, changes in inequality have a detrimental impact on economic development.

Voitchovsky (2005) examined the value of incomes division as a determinant of economic development in the panel of countries. Used the results of the Luxembourg Income Analysis of comparable disposable income data, disparity at the top end of division was positively linked to growth, while lower distribution inequality was negatively associated with further growth. These results suggest possible shortcomings in the study of the influence of revenue distribution on growth using a single statistic of inequality. The average influence of inequality on growth can be defined and the underlying complexity of the relationship obscured.

Tomizawa, Bessellin and Ahlastrom (2020) analyzed Innovation and structures, the Great enhancement of economic development. A variety of factors have been identified in Northwestern Europe, North American and later Asia as reasons for the early 1800s' economic start-up, although there is little empirical evidence for such common factors, including the accumulation of capital and geography. Nor do other factors such as trade, pillaging and colonization have been normal. It has been better understood today the productivity the enhances innovation , new projects and the development of new markets that helps consumer demand to generate firm, economic

growth and increase living standards by a wider range of consumers. These literature have been summarized and analyzed in this summary. In addition, data on the economic growth effects of institutions and the role of foreign business in the translation of effective institutions and organizational routines have been addressed.

Szymborska (2016) investigated the links between the restructuring of the financial sector and income inequality. For a grid of 16 OECD countries in the years 1995-2009, he builds an econometric model of income concentration. From his research the altered financial sector is a separately calculated nexus of diverse and coherent phenomena which are closely linked to the top-of-allocation interest of sales, calculated by the three metrics (GDP share of the stock market value sold, bank sales, and private credit).

Shahbaz (2010) explored both linear and non-linear terms the connation between income inequality and economic development. During the period 1971 to 2005 he used the annual time series results. For co-integration and the error correction model of short-run action, the autoregressive distributed lag model (ARDL) has been used for testing the cap. The root problem is addressed by the use of an increased root test of Dickey-Fuller. The results showed that the substantial correlation found in 1994 by Alesina and Roderick and Persson and Tabellini between income inequality and economic growth was sharply contrasted. Empirical evidence supports both the inverted U and the inverted S-shaped curves of Kuznets in Pakistan.

Seo, Kim and Lee (2020), based on a composite growth model, empirically measures the impact on growth of the income inequality for the 43 countries between 1991 and 2014. Initially, findings show a positive link between the income inequality of the lagging countries and the respective the disparities within the borders nation in terms of reduced equations. The results show. This confirms the negative impact of the increase in income inequality on development. Secondly, a cumulative 3SLS projected growth model indicates that income inequality only negatively impacts investment. They can not however find associations between innovation in technology and inequality in wealth, and between growth and income inequality in human capital. Given that the effect of investment on productivity is positive, they infer that the incidence of the income inequality has a negative effect on investment, with slow

investments having a negative effect on the productivity which in turn influences growth negatively. Thirdly, unlike the prediction by Kaldor and Barro, income inequality is found to be negatively linked with growth in developed countries, particularly for investment. In both advanced and developing countries, the effects of income inequality on investment are close. They also see regional variations in ways in which income inequality has an effect on sustainable economic development.

Rubin and Segal (2015) measured the association among economic growth and income disparities in the US in the post-war years. They found that incomes of higher earning groups are more prone to growth, commonly described as current growth and future growth expectations, in comparison with those of lower earning groups. They show that for two reasons this increased sensitivity arises: (a) the top income classes earn a large proportion of their wealth income that's more sensitive to growth than employment income; and (b) Top income Groups earn a substantial portion of their work income in the form of the equity reward (pay-for-performance), also sensitive to growth. As a result, they conclude that growth and disparities in income are positively related.

Park and Shin (2015) empirically investigate the association among financial growth and income inequality in theory, the relations between the two variables were both positive and negative. It was primarily found that financial development helps to minimize poverty, but as the financial growth progresses, it leads to increased inequality. They also note that, as the ratio between primary and total education rises and strengthens law and order, financial growth is more successful in reducing inequality.

Odedokun and Round (2001) empirically explored income division and disparity of African countries, , the impact of inequality upon economic growth and the ways in which inequality influences development data have been used over the last four decades by 35 countries over various times. Successful economic growth levels achieved, regional factors, size of the government budget and the amount of government subsidy and transfer funds, economic cycle stage, share of the agricultural sector in total labour and endowment of human and land resources are factors which have been identified as having affected income allocation. Including there are also signs that high inequality reduces growth. By. Secondary and tertiary education inversion, political stability and

increasing the fertility rate, the channels through which unequal growth affects. However, there is no indication that it impacts the scale of government spending and taxes, or private saving and savings, contrary to what is found in theoretical literature.

Marrero & Rodríguez (2013) explored the impacts of income inequality growth achieves an inconclusive disappointing result. This study posits one explanation for this in the light of this complexity; income inequality is currently at least a composite measure two different kinds of inequality, ability inequality and commitment inequality. Via opposing networks, these two forms of inequality affect growth the relation between income inequality and growth depends on whether it is positive or negative what a larger part. They test this proposal with the help of opportunity inequality measure determined in 1980 and 1990 from PSID database for 23 US states. They will notice strong promotion of a negative relationship between inequalities chances and growth and a positive relationship between income disparity and growth.

Majumdar and Partridge (2009) was seen as one of the main economic constants of the distribution of income. The constant disparities in wages, however, changed when US labour market wages started to increase. The profits went up with a healthy profits Earnings were distributed through 1973, with earnings disparity quickly increased by a constant median beginning in 1979.

Li and Zou (1998) showed that theoretically, inequalities could lead to increased economic growth if public consumption is included in the utility equation. Empirically, baseline projections and responsive analyses found that deprivation in sales was highly linked to economic development, especially in most situations. The results remain extremely ambiguous, and the association between deprivation and development is negative.

Knowles (2005) nearly all recent empirical work has used inequality evidence not reliably evaluated on the association between income disparity and economic development. They argued it was unacceptable and found that, when income inequality was systematically calculated, there could be a strong negative association between income inequality and development across nations. However, the evidence shows that the regularly calculated disparity of spending data has a strong negative association with economic growth for a developing country study.

Easterly (2007) confirms that agricultural endowment forecasts and forecasts growth with cross-country results. It confirms that farm funds forecast inequalities and growth with cross-country results. The method this paper refers to assessing issues and endogenous inequalities was the application of agricultural contributions – in particular the amount of land suitable for wheat growing contrasted with that suitable for sugar-cane growing. The paper finds that disparity also influences other development outcomes – organizations and schooling – which have been emphasized in literature as a tool to minimize higher disparity per capita income. Although evidence is found to be consistent with other growth standards, the paper finds high inequality to be an autonomous, broad and statistically relevant challenge to development, high-quality institutions and high schools.

Deininger and Squire (1977) have long been trying to be aware of the relation between economic development and division of income. Many economists have long assumed that early stage growth raises income inequality, making the poor comparatively poorer. According to recent research, unequal distribution of income can hinder development.

Dominicis, Florax and Groot (2008) investigated the effect of inequality on economic growth. However, theoretical and analytical papers produced contradictory findings. While a large proportion of literature finds unfairness to be negative for growth, recent studies have called into question this finding and shown that inequality has positive effects on growth. By meta-analysis, they contribute to the empirical puzzle by systematically describing, identifying and analyzing the variation in results of empirical studies. They find that the results systemically affect estimation methods, quality of data and the sample coverage. The results indicate that research into the effect of income disparity on economic growth using regional single-country data or a fairly homogenous set of countries with suitable controls on country-wide distinction in economic, social and institutional individuality will increasingly be helpful.

Quintana, Royuela and Thiel (2019) explained the inequality and sustainable growth from an analysis of the human development index. In a criminal sentencing of 117 nations, they calculated the relationship between income inequality and the Human development index and its components in the 1970-2010 period. The results revealed

that (a) a negative long-term relation between the income inequality and human evolution index, (b) a positive and a negative correlation with education between the income inequality and a related human development factor index.

Castelló - Climent (2010) investigated the impact of wealth and the inequality of human resources on economic growth in various regions of the world. In estimating a dynamic data model panel which controls for country-specific effects, and takes account of the continuation of inequality indicators, the results demonstrated a different impact of inequality on development, depending upon the regional level of growth. In that study as a whole and in medium- and low-income and middle-income countries, the negative impacts are seen on the economic development of the income and human capital inequality, an influence that is either fading or turning favorable in the higher-income nations.

Bujari and Martinez (2016) was to investigate the economic growth effects of technological innovation. For the 12 representative countries in the period 1996-2008 in South America. For this reason, a dynamic panel data model was developed and estimated using the Generalized Moments Method (GMM) framework. The empirical evidence contained in this paper has shown that processes of technological innovation have a positive influence on economic growth in the region. This suggests that Latin American countries can achieve economic development in the context of incentives for technological innovation. The paper focuses on Latin America's economies that allow most of the commodity in the field to carry out the greatest number of countries, variables and time periods. The main finding was that investments in high-tech product growth, patents and exports are significant in the majority of Latin American countries in terms of increasing the overall productive factor and the GDP per capita.

Blanco, Gu and Prieger (2016) measured the effect on U.S economic growth of Research and Development and Productivity in the U.S. States. Research and development (R&D) has an significant influence in the long term on both national performance and overall factor productivity. The calculated R&D elasticity in the U.S. private sector was 0.056-0.143 between 1963 and 2007.The Gross Domestic Product (GDP) income indicated by R&D investment is 82–211%.Strong R&D spills have occurred, with 70-80% of other countries' cumulative returns. They also see that more

human capital States have higher R&D resilience, and fewer industrial growth countries have the least own R&D elasticity.

Birdsall, Ross and Sabot (1995) have clarified that the Eastern Asians have shown steady growth over 3 decades, relatively low income inequality and a decline in income inequality. They argued that policies which have reduced poverty and income inequality, such as high quality elementary education and increased demand for jobs, were also boosting. Closing two virtuous loops, quick growth and decreased inequalities have resulted in increased demand for and supply of educational services. Furthermore, low income inequalities can stimulate growth directly. Their findings are consistent with cross-economic regression, which is the optimistic causal impact of low inequality on economic growth and loU! Earnings inequality as a distinct contributing factor to the rapid development of East Asia. They conclude that growth-sharing policies can also stimulate production. In particular, educational investments are essential to economic development because they contribute significantly to productivity and minimize income inequality.

Barro and Lee (2010) they improved precision of estimation using data from reliable census reports, disaggregated by age group, and fresh projections of death rates and age-and educational completion rates. They used the new ones data to examine how production relates to human capital stocks, calculated by total schooling years as well as the composition of the educational attainment of staff at different educational levels. They notice that schooling has a considerably positive impact on productivity. After optimizing for the simultaneous determination of human resources and production, using the 10-year lag of parental education as an instrument variable (IV) for the current educational level, the approximate return rate to an additional school year ranges from 5% to 12%, similar to the standard Mincerian return estimates found in labour literature.

Babu, Bhaskaran and Venakatesh (2016) analyzed simultaneous ties in selected twenty nine emerging economies between expansion, distribution and redistribution. The analyses based on the distinction between market-induced dealer disparity and redistribution following government interference. The three problems arise from this analysis; the absence of scientific literature of reliable statistics and standardized concept of 'inequality,' trouble with the definitive cause between growth and the two

other variables, and the dynamic ties between growth, distribution and redistribution; results have demonstrated that disparity has a major adverse impact on long-term development by adjusting for re-distributive changes. Moreover, in the long and short term, they see no balance between re-distribution and development.

Anwar (2007) the latest results of the two household surveys PIHS, 2001-02 and PSLM, 2004-05 are used in the field of inequality and how improvements in inequality have been correlated with growth. The findings reveal that the household boss working in banking, energy, production and utilities in the Society appears to be more productive than the other sector managers. Financing sector was preceded by the Mining, Manufacturing and Human Welfare sector in terms of the most uneven allocation of usage. The difference in many fields, such as agro industry, manufacturing, power , transportation, wholesale and retail trade, Neighborhood and individual administrations and the undistinguished market, increased between 2001-2002 and 2004-2005. In 2004-05, 87.5 percent of all households formed by these sectors were used. After all, the imbalance in monetary pieces has risen, and has seen a strong economic progress. In order to minimize sectoral inequalities, government should rely on compensatory steps across regions by analyzing and using politics.

Aiyar and Ebike (2020) was agreed to the intrinsically undesirable pressure of income inequality on economic progress, which is quite contentious. They claim that the association between income inequality and development relies on equal opportunities. In societies where chances are systematically dispersed – where parents' material conditions are binding limits on the chances provided to their children – income inequality drags further on potential development. By comparison, an increase in income disparity can easily be reversed in companies that have more equitable distribution of resources and don't have to limit investment and growth. They define the degree of association between parent achievements (income and education) and child achievements, equitable opportunities with intergenerational mobility. In order to show that the negative effect of income inequality on growth is higher, they are taking many recently-developed globally comparable steps for intergenerational mobility – including World Bank GDIM’s extensive database. Results indicated that failure to switch

between generations results in a misrepresentation that explains why the experimental literature on income inequality and development has been so incomplete.

Afesorgbor and Mahadevan (2016) to examine empirically which segments of the population in target countries bear the greatest price when imposed economic sanctions a theoretical work was carried out. A cross-country study of 68 target countries from 1960 to 2008 reveals that sanctions imposed have a negative impact on income inequality. The findings provide clear experimental evidence of this. Financial and trade sanctions have shown to have significant effects on income disparity with the focus on different sanction instruments. Finally, as sanctions last longer, they have a detrimental effect on income inequality.

2.4 Innovation and Income Inequality:

Adams (2008) examined the effect of globalization, over a 17-year period (1985–2001), on income inequality across 62 developing countries. Study findings show that globalization accounts for just 15 per cent of the income inequality variation. The outcomes of the study and the literature review indicate that globalization has both costs and benefits, and that it is better to consider the potential for economic growth in an atmosphere that supports and encourages strong and reliable government institutions, education, and technological progress.

Włodarczyk (2017) examined the comparative study of innovations and income inequalities through regression investigation based on Innovation metrics chosen (GDI) and control variables primarily taken from euro-stat database for 30 countries (Iceland, European Union countries, Norwegia) are examined for selected indicators of innovation (gross domestic R&D expenses, number of applications for a creative activity index), income inequality (Gini coefficient, top 3 percent and top 1 percent shares in national equalized revenue). The findings showed that higher gross domestic expenses for R&D as a proportion of GDP appear to accentuate inequality, whereas the contrary impact lies in higher patent applications and the creative industry index. Furthermore, high wage disparities were equally influenced by various variables relative to smaller wealth differences.

Sala-i-Martin (2002) they used seven different common indexes to estimate global income inequality: the Gini coefficient, Log-income variance, two Atkinson

indices, the Mean Logarithmic Deviation and the Theil index, and the Variance Coefficient. All indices show a decline in global income disparity from 1980and in 1998.They also note that most world wide income inequalities can be accounted for by inequality across, not in-country. In-country inequalities during the study period increased marginally, but not almost necessary to offset a significant reduction in the inequalities across countries. The world at large Reductions in inequality is motivated largely by the high growth rate, though not entirely.

Psacharopoulos (1994) provides a detailed report on the viability of education spending on a global scale. Return trends from earlier analyses are being preserved, namely that primary education remains the number one target for investment in developed countries; yield declines in education and per capita income of the country; investment in the education of women is typically more productive than men; returns in the competitiveness sector of the economy; the above-mentions have been diminished.

Khalid *et.al* (2019), motivation behind this investigation is to gauge the unidimensional and multidimensional imbalance on account of Pakistan and look at their outcomes at the common just as provincial (urban and rustic territories) level. The creators gathered information from For the long monetary cycles of 1998-1999 and 2013-2014, Pakistan Social and Living Standard Calculation and Household Integrated Economic Survey. For different inequality, Gini coefficient for unidimensional difference and different indexing method of Araar (2009) were used. The discoveries anticipated that unidimensional imbalance was moderately high in the urban region because of uneven spread of salary, yet multidimensional imbalance is very high in country territories in light of higher inconsistencies between all measurements. At the common level, Punjab has moderately high-salary disparity pursued by Sindh, KPK and Baluchistan.

Kelly *et al.* (2018) measured the innovative technologies for the long term. In order to create new technical metrics, they used a textual analyses of high-dimensional data from patent papers. They classify big patents based on the textual similarities between a single patent and prior and subsequent works: they are different from previous work but linked to potential inventions. This patent definition calculation forecast potential comparisons and was directly associated with market valuation

measurements. They recognize advanced technologies as the key patents at the right end of our estimation to create technology change metrics at the aggregate, sectoral and business levels. This innovations indexes range over two hundred years (1840-2010) and contain progress by corporate and corporate and commercial companies, NGOs and the government of the United States. These indexes hold technologies over a long term and are good efficiency predictors at aggregate, industry and market levels.

Katz and Murphy (1992) evaluate supply and demand is used to shifts in U.S. Wage system 1963-1987. Speedy worldly growth in demand for more-educated jobs, "more-skilled" jobs, and women seem to be the driving force at the back of observed wage structural transformations. Over the era, measured shifts in labour distribution between industries and occupations have greatly benefited college graduates and females. Movements in the college wage premium over this time seem to be closely linked to variations in the rate of growth in the college graduate supply.

Hempell (2005) concluded that information and communication technology (ICT) investments are closely related to complementary technologies and are most effective in companies with earlier innovation experience. The analysis was based on company-level panel data covering the period 1994-1999. System GMM estimates show major productivity effects of ICT in the German service sector for a robust production function framework. In addition, the hypothesis that experience extending from past process developments makes ICT capital more productive has been strongly endorsed, but does not impact the productivity of other capital goods.

Grundler and Scheuermeyer (2018) highlighted development and allocation consequences of inequality: what were the transmission networks. Facts from a wide organized panel of evidence demonstrate the adverse effect on economic development of income inequality. Civilization with a smaller population and higher birth rates is less equal, but savings do not generally spread. This has become mainly normal where the supply of credit is limited and the negative implications of discrimination are attenuated by higher school spending. Measured as the business and net income differential of Ginis, public allocation obstructs productivity by lower expenditures and increased fertility. However, the effect of redistribution was minor in comparison with the positive

effect of lower inequalities. Redistribution will also be desirable development in developed countries.

Ginarte and Park (1997) presented an index of patent rights for 110 countries for the period 1960-1990. The index analyzed which variables or economic characteristics dictated how patent rights are strongly safeguarded. The result indicated that progressively created economies will in general give more grounded security.But the fundamental factors that impacted patent security levels, which were in line with growth levels, were the country's R&D expenditure, market environment, and international integration, which were correlated with its level of development. The outcomes qualify, in any case, that R&D movement impacts patent security levels after a country's exploration division arrives at a basic size.

Foellmi and Zweimuller (2017) measured is this imbalance counterproductive to progress and growth? Price vs. impact of Market Size. In order to research the influence of disparity on development and creativity, they add non-homothetic choice to R&D-based growth models. Inequality has an effect on incentive to innovate with an effect on price and market size. The findings revealed that creative factories had a significant efficiency advantage relative to conventional manufacturing producers, which helps to boost price and labeling of innovators. However, the shift from the wealthy to the bottom raises consumer sizing’s and speeds growth whenever this output difference is bottom.

Dmitriev *et al.* (2016) is analyzed the relation to creativity and to the geographical distribution of higher education institutions (such as the United Kingdom, USA and Ghana). Attempt to balance existence and economic development with the Schumpeterian and structural solution. It underlines the impact of creativity on economic development on Schumpeter 's ideas of 'creative destruction'; it stresses that, with the degree of science and technical advancement in some countries, it is capable of creating and using creativity; the efficiency of economic development is important to ensure. It concluded that cross-country disparities in economic growth, level of schooling and innovation initiatives can also be linked to increased disparity in income and wealth distribution between countries and within countries, and a reduction in

middle-class proportions in developed and developing countries is a negative development.

Chu and Cozzi (2018) explored the impacts on creativity and income disparity of patent rights and R&D subsidies using a Schumpeterian host household growth model. They found that even if escalation patent protection and the increase in research and development support have the same macroeconomic impact that drives innovation and economic growth, the microeconomic implications on earnings inequality are radically different. Stringing patents in particular raises income disparities and reduces (raises) R&D subsidies if the output stage is small enough. An empirically feasible quality phase was lower than the threshold, which means that R&D subsidies have a negative impact on income inequality. They are now calibrating the model to include a quantitative overview and showing that improving patents induces a modest increase in income inequality and an insignificant increase in demand inequality. However, increasing R&D subsidies induces both income inequality and market inequality to decline comparatively wide.

Chu and Wang (2019) was discussed the effect of R&D grants on a hybrid development model that could have foundational or endogenous economic growth. In order to expand innovation and improve efficiency, they take into account two types of R&D grants. R&D subsidies for better quality innovation have implications only under the robust endogenous growth scheme, with higher subsidy rates leading to faster activation of better-quality innovation and growing the speed of transitional and stable government. The two regimes have conflicting effects on the expanding innovation of research and development subsidies. With a higher subsidy rate on variety-expanding innovation, the semi-endogenous growth regime increases transitional growth but does not have any effect on gradually increasing growth. With a higher subsidy rate for multiple innovations, the completely endogenous growth regime appears to improve short-term growth but slows the operation of quality-enhancing innovation and decreases longer-term growth.

Chu *et.al* (2017) developed a Schumpeterian development model with heterogeneous families and heterogeneous firms to investigate the impacts of financial strategy on innovation and income inequality. The messy distribution of the income

results in family heterogeneity. Random efficiency changes and cost of entry result in firm heterogeneity. Inflation has an effect on economic growth and income inequalities under endogenous entry into the business. They also monitored the quantitative analyzing formula and showed that the formula will balance the inflation rate that maximizes growth and the inflation rate that the cross-country panel forecasts would increase inequality. Finally, they simulate the usefulness-maximizing inflation levels and investigate how the income of households has been influenced.

Calcagnini, Giombini and Travaglini (2018) calculated theoretical and empirical models by offer ambiguous answers about the relationship between labour market control, innovation and investment. The work showcase guideline raises the alteration costs of firms from one point of view, and, ceteris paribus, reduces the venture. It also encourages companies, on the other hand, to invest, innovate and increase productivity and profitability in the long run. In this paper, they present an endogenous model of development that depicts the work of these opposing forces, and why a tighter guideline for the job showcase will impact success and interest decisively over the long term. Hypothetical and experimental studies mainly occur in Italy, Germany, France and Spain.

Brandenburg, Günther and Schneider (2007) examined the role of formal education and the actual career for the production of product innovation in developing industries under a probit model. Technology and engineering, management and leadership skills are often pointed to as a source of disruptive practices within organizations that shake up sectoral trends of innovation. They used special German micro data (LIAB) which provides comprehensive information on creative practices and employee qualifications. They discover major variations between sectors distinguished by Pavitt designation in their human resources entity. Sectors with a high proportion of trained workers are on top of the curve in product growth (specialized distributors and research industries). However, the proportion of highly qualified workers in these industries does not significantly raise the chance of an creative business according to our estimate findings so far.

Benos and Tsiachtsiras (2019) explored Innovation effects on income inequality by annual country panel statistics for 29 nations. 29 nations. They prove that creativity

decreases the disparity in personal wealth by pairing European Patent Office patents with inventors. The results were accompanied by instrumental vector endogenous estimates. The findings were stable with regard to various inequalities, alternative product efficiency metrics, truncation biases, the use of patent applications along with patents issued and different methods of separating or awarding patents.

Aysun and Kabukcuoglu (2019) investigated of how financing costs were identified with firms' distribution of venture among R&D and non-R&D exercises and how R&D motivating forces change this relationship. In theoretical terms the share of the R&D investment rises (decreases) during the credit tightening period if companies earn benefits mainly as grants or subsidies, which reduce their reliance upon external financing. In return, if tax credits are the main support, the share of R&D investment declines (increases) throughout credit restructuring (reliefs). The paper provides analytical evidence for these forecasts through the use of financial data from companies and the R&D field and a particular approach based on the company's resource distribution.

Antonelli and Gehringer (2017) explored a substitute hypothesis addressing the relevance, rather than causation, of slow development, and in particular the slowing speed of technological progress, is growing income inequality. The paper laid forth Schumpeter’s theory of a large effect on reducing income redistribution on the pace of technological transition. The double act of the great impact of assets is destruction, the acceleration of technical transition induces a decline in extremely unequal wage differences which thereby restrict wealth disparity. They test the hypothesis academic exercise by applying quintile regressions to a diverse variety of established and developed economies. The gap with the appealing effect of economic revolutionization retains the entire allocation of income inequality but has greater consequences in countries where wealth accumulation and asymmetries in wages are higher. These findings have no social repercussions and offer important perspectives for the study of economic policy.

Aghion and Howitt (1990), he developed a model of development through creative destruction. They assess the positive and regulatory features of stationary equilibria, in which research employment was stable and GNP followed a random drift

walk, though in some circumstances cyclical equilibrium still existed. As determined by a parameter indicating the effect of innovation on the Poisson arrival rate of innovations, both the cumulative growth rate and the variance of the growth rate played roles in the number of innovations, the amount of skilled labour force, and the efficiency of research; and in the declining functions of the representative person at the rate of time. The growth rate of the economy can be more or less than optimal under laissez faire, as the model also has special effects that work in the opposite direction, except for the appropriateness and inter-temporal spillover effects of other endogenous growth models that appear to slow growth. In particular, the fact that private research firms do not internalize the elimination of rents produced by their is a market theft such as that seen in the partial-balance breed literature.

Chen and Fleisher (1996) find evidence that per capita development has been converging on a conditional basis across the provinces of China between 1978 and 1993. Convergence may rely on physical investment, job growth, investment in human capital, foreign direct investment and coastal location. They were evaluating alternative policies to reduce the disparities between coast-to-coast income and conclude that it is insufficient to rely on rural investment alone.

2.5 Conclusion:

The findings from this review reveal a lack of significant extant literature on the specifics of the topic of investigation for this research. Indeed, when considered together, it is clear that results of previous studies is increasing the knowledge. But some of them find the effect of income inequality on economic growth and some of them find the effect of innovation on economic growth. But in this literature I found an article which find the impact of innovation and income inequality on economic growth with the time frame 1994 to 2014 this study fined the impact hole the world combine impact (Risso & Carrera, 2019). Some of the studies are about the impact of innovation on income inequality. But still there is gap exist because this research make the comparison among high, middle and low income countries with latest time frame of 1996 to 2018 which is my contribution.

Chapter 3

Historical Background of Innovations and others Macro Economics Variables.

This chapter explains the selection of variables, to carry out this study. In order to discover the effect of innovations on income inequality and effect on economic growth of innovation and income inequality. This analysis utilized annual panel data for the period of 1996 to 2018. The data has been collected from World Development Indicator (2018).Further, this study estimates the panel Generalized Method of Moment (GMM) model by using the proxies of innovation Research and Development (R&D) and Patent Applications (PA) or proxy of income inequality GINI Index. Economic Growth by (GDP), Population, and Physical capital proxy is Gross Capital Formation. The variables are descriptions are below:-

3.1 Profile of Innovations of High. Middle and Low income countries:

The method of transforming a concept or innovation into a value-creating or paid customer service. A concept must be repeated at a low cost and must meet a particular requirement to be considered an invention. Innovation involves the intentional application of similar or different principles from tools of knowledge, creativity, and initiative, and all processes that produce and turn new concepts into usable goods. In industry, creativity also comes as the businesses use innovations to help meet their customers ' demands and desires.

Solow (1956) describes "enhancements in business processes and goods" as technical advances, and asserts that these are the inventions that drive growth. A second wave of endogenous growth theory, normally referred to as 'innovation-based' growth theory, was then preceded by the AK theory, which acknowledges that intellectual capital, the root of technological development, is distinct from physical and human capital. Saving and education produce physical and human resources, but creativity extends intellectual capital. In this study innovation is calculated by the proxy of Research and Development Expenditure (R&D) and Patent Applications Residents (PA).

Table 3.1.1 Research and Development of High Income Countries:

Sr. No	Countries Name	R&D (% of GDP)		
		2007	2012	2017
1	Luxembourg	1.59	1.27	1.30
2	Switzerland	2.75	3.19	3.37
3	Norway	1.56	1.62	2.09
4	Macao SAR	0.06	0.05	0.17
5	Iceland	2.55	2.33	2.10
6	Ireland	1.23	1.56	1.87
7	United States	2.63	2.68	2.82
8	Sweden	3.25	3.28	3.40
9	Denmark	2.52	2.98	3.05
10	Singapore	2.32	1.92	1.94
11	Netherlands	1.67	1.92	1.98
12	Austria	2.42	2.91	3.05
13	Finland	3.35	3.42	2.76
14	Germany	2.45	2.87	3.04
15	Hong Kong SAR	0.75	0.73	0.80
16	Belgium	1.84	2.27	2.70
17	Canada	1.91	1.78	1.67
18	France	2.02	2.23	2.21
19	United Kingdom	1.62	1.59	1.70
20	Japan	3.34	3.21	3.21
Average		**2.09**	**2.19**	**2.26**

Note*Some of the data are generated by Liner Trend.

In high Income Countries Research and development (% of GDP) expenditure in 2007 was 2.09 %, of GDP of these 20 high income countries on average, in 2012 its increase to 2.19 % and in 2017 its 2.26 % its means that high income countries for

innovation increase every year their expenditure to achieved the sustainable economic growth.

Table 3.1.2 Research and Development of Middle Income Countries:

Sr. No	Countries Name	R&D (% of GDP)		
		2007	2012	2017
1	Spain	1.23	1.29	1.21
2	Cyprus	0.40	0.44	0.56
3	Slovenia	1.42	2.57	1.87
4	Portugal	1.12	1.38	1.33
5	Czech Republic	1.30	1.78	1.79
6	Estonia	1.07	2.12	1.29
7	Greece	0.58	0.70	1.13
8	Slovak Republic	0.45	0.80	0.88
9	Lithuania	0.80	0.89	0.90
10	Latvia	0.55	0.66	0.51
11	Uruguay	0.42	0.33	0.48
12	Hungary	0.96	1.26	1.35
13	Panama	0.18	0.08	0.15
14	Poland	0.56	0.88	1.03
15	Romania	0.51	0.48	0.50
16	Russian Federation	1.12	1.03	1.11
17	Argentina	0.46	0.63	0.54
18	China	1.37	1.91	2.15
19	Mexico	0.40	0.42	0.33
20	Brazil	1.08	1.13	1.26
Average		**0.80**	**1.04**	**1.02**

Note*Some of the data are generated by Liner Trend.

In Middle Income Countries Research and development (% of GDP) expenditure in 2007 was 0.80 %, of GDP of these 20 countries on average, in 2012 its increase to 1.04

% and in 2017 its 1.02 % its means that middle income countries for innovation increase every year their expenditure to achieved the sustainable economic growth.

Table3.1.3 Research and Development of Low Income Countries:

Sr. No	Countries Name	R&D (% of GDP)		
		2007	2012	2017
1	Bulgaria	0.43	0.60	0.75
2	Turkey	0.69	0.83	0.96
3	Thailand	0.20	0.20	1.00
4	Serbia	0.58	0.85	0.87
5	Belarus	0.96	0.65	0.58
6	Azerbaijan	0.17	0.21	0.18
7	Armenia	0.21	0.24	0.23
8	Mongolia	0.24	0.24	0.13
9	Venezuela, RB	0.20	0.25	0.23
10	Moldova	0.55	0.35	0.25
11	Ukraine	0.85	0.75	0.45
12	Egypt, Arab Rep.	0.26	0.53	0.68
13	India	0.81	0.74	0.67
14	Pakistan	0.63	0.47	0.24
15	Uzbekistan	0.22	0.20	0.16
16	Kyrgyz Republic	0.23	0.17	0.11
17	Tajikistan	0.07	0.11	0.12
18	Burkina Faso	0.11	0.12	0.70
19	Madagascar	0.14	0.15	0.01
20	Colombia	0.18	0.23	0.24
Average		**0.39**	**0.40**	**0.43**

Note*Some of the data are generated by Liner Trend.

In Low Income Countries Research and development (% of GDP) expenditure in 2007 was 0.39%, of GDP of these 20 countries on average, in 2012 its increase to 0.40% and in 2017 its 0.43% its means that middle income countries for innovation increase every year their expenditure to achieved the sustainable economic growth.

Table3.1.4 Comparison of Research and Development Expenditure between High, Middle and Low Income Countries:

Years	**High Income Countries**	**Middle Income Countries**	**Low Income Countries**
2007	2.09%	0.80 %	0.39 %
2012	2.19 %	1.04 %	0.40 %
2017	2.26 %	1.02 %	0.43 %

The above mentioned expenditure shows huge difference between high to middle and low income countries which are selected in this study. In 2007 high income countries expenditure is 2.09 %, in middle income countries it's have 0.80 % and in low income countries it's only have 0.39 %. Similarly in 2017 high income countries expenditure is 2.26 %, in middle income countries it's have 1.02 % and in low income countries its only 0.43 %.

Table 3.1.5 Patent Applications of High Income Countries:

Sr. No	**Countries Name**	**No. of Patent Applications Residents**		
		2007	**2012**	**2017**
1	Luxembourg	15	109	156
2	Switzerland	1692	1480	1337
3	Norway	1225	1009	1152
4	Macao SAR	1	5	1
5	Iceland	61	37	36
6	Ireland	45	55	62
7	United States	241347	268782	293904

8	Sweden	2527	2288	1992
9	Denmark	1660	1406	1490
10	Singapore	696	1081	1609
11	Netherlands	2079	2375	2241
12	Austria	2385	2258	2073
13	Finland	1804	1698	1390
14	Germany	47853	46620	47785
15	Hong Kong SAR	160	171	324
16	Belgium	454	755	1001
17	Canada	4998	4709	4053
18	France	14722	14540	14415
19	United Kingdom	17375	15370	13301
20	Japan	333498	287013	260292
Average		**33730**	**32588**	**32431**

Note*Some of the data are generated by Liner Trend.

In High Income Countries Patent Applications in 2007 was 33730 these 20 countries on average , in 2012 it's decreased to 32588 and in 2017 its 32431 its means that high income countries for innovation Patents applications are very high but specially United States and Japan have lot of numbers of applications every year because of increased their expenditure in research and development to achieve the sustainable economic growth.

Table 3.1.6 Patent Applications of Middle Income Countries:

Sr. No	Countries Name	No. of Patent Applications Residents		
		2007	**2012**	**2017**
1	Spain	3267	3266	2167
2	Cyprus	3	4	8
3	Slovenia	331	389	421
4	Portugal	250	621	644
5	Czech Republic	716	867	794

6	Estonia	44	20	37
7	Greece	575	628	498
8	Slovak Republic	239	168	183
9	Lithuania	62	109	81
10	Latvia	139	193	90
11	Uruguay	35	22	23
12	Hungary	689	692	496
13	Panama	37	35	33
14	Poland	2392	4410	3924
15	Romania	827	1022	1098
16	Russian Federation	27505	28701	22777
17	Argentina	937	735	393
18	China	153060	535313	1245709
19	Mexico	629	1294	1334
20	Brazil	4194	4798	5480
Average		**9797**	**29164**	**64310**

Note*Some of the data are generated by Liner Trend.

In Middle Income Countries Patent Applications in 2007 was 9797 these 20 countries on average, in 2012 it's increased to 2964 and in 2017 its 64310 which means that middle income countries for innovation patents applications are very high, specially China have lot of numbers of applications every year because of increased their expenditure in research and development to achieve the sustainable economic growth.

Table 3.1.7 Patent Applications of Low Income Countries:

Sr. No	Countries Name	No. of Patent Applications Residents		
		2007	**2012**	**2017**
1	Bulgaria	211	245	202
2	Turkey	1810	4434	8175
3	Thailand	945	1020	979
4	Serbia	395	192	171

5	Belarus	1405	1681	434
6	Azerbaijan	287	144	204
7	Armenia	135	137	107
8	Mongolia	118	128	124
9	Venezuela, RB	63	65	96
10	Moldova	333	93	73
11	Ukraine	3440	2491	2283
12	Egypt, Arab Rep.	516	683	1025
13	India	6296	9553	14961
14	Pakistan	109	96	193
15	Uzbekistan	324	257	357
16	Kyrgyz Republic	155	110	137
17	Tajikistan	28	3	14
18	Burkina Faso	5	11	6
19	Madagascar	9	4	9
20	Colombia	128	213	595
Average		**836**	**1078**	**1507**

Note*Some of the data are generated by Liner Trend.

In Low Income Countries Patent Applications in 2007 was 836 these 20 countries on average, in 2012 it's increased to 1078 and in 2017 its 1507 which means that low income countries for innovation Patents applications are very high, specially India have lot of numbers of applications every year because of increased their expenditure in research and development to achieve the sustainable economic growth.

Table 3.1.8 Comparison of Patent Applications between High, Middle and Low Income Countries:

Years	**High Income Countries**	**Middle Income Countries**	**Low Income Countries**
2007	33730	9797	836
2012	32588	29164	1078
2017	32431	64310	1507

The above mentioned table shows huge difference between high to middle and low income countries which are selected in this study. In 2007 high income countries on average have 33730 patent application, but in middle income countries 9797 patent applications and in low income countries it's only 836 patent application. But in 2017 high income have only 32431 patent application, or middle income countries increase patent applications 64310 and in low income countries it's only have 1507 patent application. The difference between middle and high income countries is due to China. China is a middle income country and most growing country of the world.

3.2 Profile of Physical Capital of High Middle and Low Income Counties:

There are three major variables of development is physical capital which economist called factor of production. It consists of tangible products manufactured by people who help build a manufactured goods or service. All companies' facilities, offices, office or warehouse supplies, vehicles, and computers are considered part of their physical resources.

In this study the physical capital is measures by Gross Capital Formation capital goods, is define such as facilities, tools, transport properties, and electricity, are classified as capital goods. In order to replace older products and services that are used to manufacture goods, countries need new goods. If a country is unable to replace its capital resources by the end of its productive period, productivity decreases. In general, the greater an economy's capital accumulation, the higher the production of growth will increase its aggregate income.

Table3.2.1 Gross Capital Formation of High Income Countries:

Sr. No	Countries Name	Gross Capital Formation % of GDP		
		2007	2012	2017
1	Luxembourg	19.21	19.37	18.60
2	Switzerland	24.26	24.39	23.70
3	Norway	27.38	26.41	27.83
4	Macao SAR	36.75	14.70	19.46

5	Iceland	30.03	16.08	22.02
6	Ireland	29.23	20.23	33.41
7	United States	22.59	20.02	20.66
8	Sweden	24.88	22.59	25.72
9	Denmark	25.28	19.47	21.85
10	Singapore	23.07	29.26	27.35
11	Netherlands	23.35	18.72	20.59
12	Austria	24.58	23.98	24.77
13	Finland	25.55	23.39	23.90
14	Germany	21.38	19.72	20.75
15	Hong Kong SAR	21.40	25.22	22.07
16	Belgium	24.60	23.69	24.11
17	Canada	23.97	24.87	23.53
18	France	24.16	22.63	23.44
19	United Kingdom	18.55	15.84	17.52
20	Japan	24.48	22.65	24.01
Average		**24.74**	**21.66**	**23.26**

In High Income Countries Gross Capital Formation (% of GDP) expenditure in 2007 was 24.74 %, of GDP of these 20 countries on average, in 2012 its decreased to 21.66 % and in 2017 its increased 23.26 % its means that high income countries for capital formation every year have a lot of budget to achieved the sustainable economic growth.

Table 3.2.2 Gross Capital Formation of Middle Income Countries:

Sr. No	Countries Name	Gross Capital Formation % of GDP		
		2007	**2012**	**2017**
1	Spain	30.44	18.44	19.43
2	Cyprus	24.38	16.20	19.92
3	Slovenia	33.05	18.76	20.05

4	Portugal	23.10	15.70	17.23
5	Czech Republic	32.07	26.19	25.87
6	Estonia	40.01	29.14	26.58
7	Greece	27.13	12.80	12.51
8	Slovak Republic	28.21	20.67	22.94
9	Lithuania	32.11	19.71	19.16
10	Latvia	41.45	26.20	21.92
11	Uruguay	19.53	22.92	15.16
12	Hungary	24.28	19.33	22.85
13	Panama	36.04	43.69	41.72
14	Poland	25.19	20.99	19.82
15	Romania	31.34	26.95	23.43
16	Russian Federation	24.16	24.55	23.61
17	Argentina	20.10	16.50	18.76
18	China	40.48	46.23	43.01
19	Mexico	23.12	23.89	22.97
20	Brazil	19.82	21.42	14.63
Average		**28.80**	**23.21**	**22.58**

In Middle Income Countries Gross Capital Formation (% of GDP) expenditure in 2007 was 28.80 %, of GDP of these 20 countries on average, in 2012 its decreased to 23.21 % and in 2017 its 22.5 % its means that middle income countries for capital formation every year have lot of budget to achieved the sustainable economic growth.

Table 3.2.3 Gross Capital Formation of Low Income Countries:

Sr. No	Countries Name	Gross Capital Formation % of GDP		
		2007	**2012**	**2017**
1	Bulgaria	33.63	22.00	19.89
2	Turkey	28.71	28.30	30.99
3	Thailand	25.50	28.02	22.93

4	Serbia	24.99	19.27	19.59
5	Belarus	34.09	35.09	28.03
6	Azerbaijan	21.53	22.32	24.38
7	Armenia	44.35	25.33	19.29
8	Mongolia	38.71	55.90	31.37
9	Venezuela, RB	30.34	26.60	..
10	Moldova	38.11	24.20	22.78
11	Ukraine	32.83	21.72	19.95
12	Egypt, Arab Rep.	20.85	16.03	15.27
13	India	41.93	38.35	30.82
14	Pakistan	18.79	15.08	16.15
15	Uzbekistan	28.21	25.65	29.47
16	Kyrgyz Republic	26.64	34.96	32.90
17	Tajikistan	24.63	23.27	27.19
18	Burkina Faso	18.78	24.93	23.60
19	Madagascar	26.52	20.17	15.81
20	Colombia	23.45	22.10	21.60
Average		**29.13**	**26.46**	**24.03**

In Low Income Countries Gross Capital Formation (% of GDP) expenditure in 2007 was 29.13%, GDP of these 20 countries on averages, in 2012 its decrease to 26.46% and in 2017 its 24.03% its means that low income countries for capital formation every year a lot of budget to achieved the sustainable economic growth.

Table 3.2.4 Comparison of Gross Capital Formation between High, Middle and Low Income Countries:

Years	**High Income Countries**	**Middle Income Countries**	**Low Income Countries**
2007	24.74 %	28.80 %	29.13 %
2012	21.66 %	23.51 %	26.46 %
2017	23.26 %	22.58 %	24.03 %

The above mentioned table shows approximately average values which means that there is no difference between high to middle and low income countries which are selected in this study. Almost all countries have same % of GDP expenditure in Gross Capital Formation to achieve the sustainable economic growth but high income countries GDP size compare to middle and low income countries is very large.

3.3 Profile of Gross Domestic Products (GDP) of High, Middle and Low Income Countries:

This analysis used the gross domestic product (GDP) that reflects countries ' economic output.GDP is taken from world development indicators (WDI). The sum of all final products and services produced in one year within a country is the Gross Domestic Product. It includes all the production which generated within a country's borders. Country GDP encompasses national personal spending on sales, private profits, government expenditure and net exports. The gross domestic product has three ways including consumption, income and production. By definition "expenditure approach involves amount of expenditure ended by final customer. The amount of all final goods produced by production in the country shall be included in the income.

The GDP calculation is the overall market value for all the final goods and services produced in a given country relative to the total consumption, investment, government expenditure and net exports (export value minus import value), the country's GDP calculate the national income output and economic growth. The current value of all the final goods and services produced in a country is GDP is called nominal GDP. Real GDP adjust nominal value with inflation.

Table 3.3.1 Gross Domestic Products of High Income Countries:

Sr. No	Countries Name	GDP (Constant 2010 US$)		
		2007	2012	2017
1	Luxembourg	53744023982.12	54371319168.63	65270740381.64
2	Switzerland	567418887153.29	599637721728.34	656573145729.69

3	Norway	431197048129.25	444668526003.85	483101343264.08
4	Macao SAR	21431441475.07	37379693144.69	35128290926.04
5	Iceland	14903878824.83	14121903280.46	17529175815.39
6	Ireland	240657629408.82	223414851581.06	344958774769.01
7	United States	15018267850123.00	15567038144849.70	17348626599470.80
8	Sweden	491402966162.08	508645330091.80	577988245098.53
9	Denmark	334100966292.87	327038708766.03	361654604535.31
10	Singapore	205304999963.21	266385665325.18	322024690203.14
11	Netherlands	848715440730.91	850828748520.95	924097826461.73
12	Austria	394121024465.18	406091533760.53	432072509042.66
13	Finland	260656003984.81	251958508578.34	264871647024.38
14	Germany	3424120208151.99	3544440148182.59	3878004030196.74
15	Hong Kong SAR	214969368750.48	243720500393.94	280362935748.94
16	Belgium	475079138083.19	492716925962.25	530509055114.69
17	Canada	1596241677906.67	1693565815526.80	1869939124117.08
18	France	2661973862802.15	2709010438737.90	2876185346921.69
19	United Kingdom	2542769379516.94	2550537514107.23	2841238185458.80
20	Japan	5848016735563.67	5778642194555.94	6150456276840.80
Average		**1782254626573.53**	**1828210709613.31**	**2013029627356.06**

In High Income Countries Gross Domestic Product (GDP) Sum in 2007 was 1782254626573.53 US $of these 20 countries on average, in 2012 its increased to 1828210709613.31 US $ and in 2017 its 2013029627356.06 US $ its means that high income countries have a huge Economic growth every year.

Table 3.3.2 Gross Domestic Products of Middle Income Countries:

Sr. No	Countries Name	GDP (Constant 2010 US$)		
		2007	2012	2017
1	Spain	1460914788659.92	1367449023146.16	1504164957709.71
2	Cyprus	24837260990.60	24945224671.10	26344467749.95

3	Slovenia	49659792750.77	47293941969.49	53151337559.34
4	Portugal	240585203507.84	224358231088.03	240828147844.25
5	Czech Republic	207533517464.20	209477465211.06	241073815662.40
6	Estonia	23614406436.67	21820792033.34	25174297012.70
7	Greece	332060633950.97	252163419403.19	247927466910.09
8	Slovak Republic	85461805118.76	94525947335.53	107859014926.52
9	Lithuania	41742882423.97	40771209935.15	47673924466.70
10	Latvia	30061576877.21	26345970992.06	29968310684.82
11	Uruguay	33447078686.85	43862934925.03	49616180349.35
12	Hungary	138162240642.64	131555874425.41	154745522280.42
13	Panama	25012373878.69	35975750623.15	47351362273.20
14	Poland	431600835737.74	511463867608.53	601720558485.06
15	Romania	167485540461.01	173083653020.66	216033125760.33
16	Russia	1504469841528.76	1654492026998.26	1696106853061.46
17	Argentina	392934518437.81	444452545623.36	458253820042.81
18	China	4586441074637.97	7192667129598.70	10185305249490.50
19	Mexico	1050443805732.82	1136488480758.67	1285375870413.80
20	Brazil	1957113483856.30	2340783923772.17	2290685930650.30
Average		**639179133089.08**	**798698870656.95**	**975468010666.69**

In Middle Income Countries Gross Domestic Product (GDP) Sum in 2007 was 639179133089.08 US $ of these 20 countries on average, in 2012 its increased to 798698870656.95 US $ and in 2017 its 975468010666.69 US $ its means that middle income countries also increase the GDP every year.

Table 3.3.3 Gross Domestic Products of Low Income Countries:

Sr. No	Countries Name	GDP (Constant 2010 US$)		
		2007	2012	2017
1	Bulgaria	48878587260.56	51733183981.55	59088843474.10
2	Turkey	740380283468.44	898769733883.73	1206373006691.90

3	Thailand	314054006434.03	368883637205.47	424635143108.23
4	Serbia	40397237107.45	42380207344.49	46059097579.69
5	Belarus	48073493773.26	61317669289.24	60554177331.83
6	Azerbaijan	41739296291.78	53217627468.07	56805470322.58
7	Armenia	9867396624.90	10393595649.63	12364648565.05
8	Mongolia	6286566854.32	9471480157.76	12447287566.11
9	Venezuela, RB	391667346884.87	432658432475.44	452758632275.44
10	Moldova	6426960903.20	7337248194.48	9151593650.48
11	Ukraine	150209086270.69	143789339118.05	126968015121.44
12	Egypt, Arab Rep.	185596566589.03	227709643589.50	271709667872.74
13	India	1388940385493.75	1859659734290.56	2659423696537.08
14	Pakistan	166726023587.51	188418889457.59	240196215158.28
15	Uzbekistan	36826263684.33	54024853522.52	74182244738.00
16	Kyrgyz Republic	4319067486.28	5075444933.84	6647530416.71
17	Tajikistan	4724583528.24	6513378385.27	9101022171.47
18	Burkina Faso	8557713152.54	11474677064.86	14802857103.99
19	Madagascar	9682424274.53	10445619787.53	12309227038.14
20	Colombia	262527022209.56	318464374208.54	372737814033.98
Average		**193294015593.96**	**238086938500.41**	**306415809537.86**

In Low Income Countries Gross Domestic Product (GDP) Sum in 2007 was 193294015593.96 US $ of these 20 countries on average, in 2012 its increased to 238086938500.41 US $ and in 2017 its 306415809537.86 US $ its means that low income countries also have Economic growth every year.

Table 3.3.4 Comparison of Gross Domestic Product between High, Middle and Low Income Countries:

Years	High Income Countries	Middle Income Countries	Low Income Countries
2007	1782254626573.53US $	639179133089.08US $	193294015593.96US $
2012	1828210709613.31US $	798698870656.95US $	238086938500.41US $
2017	2013029627356.06US $	975468010666.69US $	306415809537.86US $

The above mentioned table shows huge difference between high to middle and low income countries which are selected in this study. In 2007 high income countries 1782254626573.53 US $ GDP, in middle income countries it's have639179133089.08 US $GDP and in low income countries it's only have193294015593.96US $ GDP on average. Similarly in 2017 high income countries is 2013029627356.06 US $GDP, in middle income countries its have975468010666.69 US $ GDP and in low income countries its only 306415809537.86 US $ GDP on average.

3.4 Profile of Population of High, Middle and Low Income Countries:

Complete population based on a de facto population definition that includes all residents of the country, irrespective of legal status or citizenship. Mid-year forecasts are the values displayed.

Table3.4.1 Population of High Income Countries:

Sr. No	Countries Name	Total Population		
		2007	2012	2017
1	Luxembourg	479993	530946	596336
2	Switzerland	7551117	7996861	8451840
3	Norway	4709153	5018573	5276968
4	Macao SAR	504511	564039	622585
5	Iceland	311566	320716	343400
6	Ireland	4398942	4599533	4807388
7	United States	301231207	313830990	324985539
8	Sweden	9148092	9519374	10057698
9	Denmark	5461438	5591572	5764980
10	Singapore	4588599	5312437	5612253
11	Netherlands	16381696	16754962	17131296
12	Austria	8295487	8429991	8797566
13	Finland	5288720	5413971	5508214

14	Germany	82266372	80425823	82657002
15	Hong Kong SAR	6916300	7150100	7391700
16	Belgium	10625700	11106932	11375158
17	Canada	32889025	34714222	36543321
18	France	64016225	65659809	66864379
19	United Kingdom	61322463	63700215	66058859
20	Japan	128001000	127629000	126785797
Average		**37719380**	**38713503**	**39781614**

In High Income countries population in 2007 was 37719380of these 20 countries on average, which is 37.719 Million in 2012 its increased to 38713503which is 38.713 Million and in 2017 its 39781614 which is 39.781 million its means that high income countries increase the population every years but increase ratio in 5 years is approx. is 1 million on average only.

Table 3.4.2 Population of Middle Income Countries:

Sr. No	Countries Name	Total Population		
		2007	2012	2017
1	Spain	45226803	46773055	46593236
2	Cyprus	1063713	1135046	1179680
3	Slovenia	2018122	2057159	2066388
4	Portugal	10542964	10514844	10300300
5	Czech Republic	10298828	10510785	10594438
6	Estonia	1340680	1322696	1317384
7	Greece	11048473	11045011	10754679
8	Slovak Republic	5374622	5407579	5439232
9	Lithuania	3231294	2987773	2828403
10	Latvia	2200325	2034319	1942248
11	Uruguay	3331749	3378974	3436646
12	Hungary	10055780	9920362	9787966

13	Panama	3453675	3770624	4106771
14	Poland	38120560	38063164	37974826
15	Romania	20882982	20058035	19587290
16	Russian Federation	142805114	143201721	144496740
17	Argentina	39684295	41733271	44044811
18	China	1317885000	1350695000	1386395000
19	Mexico	109170502	117274155	124777324
20	Brazil	190130443	199287296	207833831
Average		**98393296**	**101058543**	**103772860**

In Middle income countries population in 2007 was 98739296of these 20 countries on average, which is 98.393 million in 2012 its increased to 101058543which is 101.058 million and in 2017 its 103772860 which is 103.772 million its means that middle income countries increase the population every years but increase ratio in 5 years is approx. is 2 to 3 million on average. In middle income countries huge portion more than half of population is China and Russia.

Table 3.4.3 Population of Low Income Countries:

Sr. No	Countries Name	Total Population		
		2007	2012	2017
1	Bulgaria	7545338	7305888	7075947
2	Turkey	69581848	74653016	81101892
3	Thailand	66182067	67835957	69209858
4	Serbia	7381579	7199077	7020858
5	Belarus	9560953	9464495	9498264
6	Azerbaijan	8581300	9295784	9854033
7	Armenia	2932618	2884229	2944809
8	Mongolia	2593820	2824699	3113779
9	Venezuela, RB	27247610	29362449	29390409
10	Moldova	2873429	2859458	2755158
11	Ukraine	46509355	45593342	44831135

12	Egypt, Arab Rep.	78232126	86422240	96442593
13	India	1183209472	1265782790	1338658835
14	Pakistan	167808105	187281475	207896686
15	Uzbekistan	26868000	29774500	32388600
16	Kyrgyz Republic	5268400	5607200	6198200
17	Tajikistan	7062672	7874835	8880268
18	Burkina Faso	14252021	16571246	19193284
19	Madagascar	19433530	22346641	25570540
20	Colombia	43737516	46076848	48901066
Average		**89843088**	**96350808**	**102546311**

In Low Income countries population in 2007 was 89843088of these 20 countries on average, which is 89.843 million in 2012 its increased to 96350808which is 96.350 million and in 2017 its 102546311 which is 102.546 million its means that low income countries increase the population every years but increase ratio in 5 years is approx. is 6 to 7 million on average which is very high.

Table 3.4.4 Comparison of Population between High, Middle and Low Income Countries:

Years	**High Income Countries**	**Middle Income Countries**	**Low Income Countries**
2007	37.719 Million	98.383 Million	89.843 Million
2012	38.713 Million	101.058 Million	96.350 Million
2017	39.781 Million	103.772 Million	102.546 Million

The above mentioned table shows huge difference between high to middle and low income countries which are selected in this study. In 2007 high income countries only have 37.719 Million Population, in middle income countries it's have 98.33 Million population and in low income countries have 89.843 Million population. Similarly in 2017 high income countries population is 39.781 Million, in middle income countries its have 103.772 Million population and in low income countries have102.546 Million. Middle income countries population higher than the high and low income countries due to existence of China and Russia in middle income countries.

3.5 Profile of Income Inequality of High, Middle and Low Income Countries:

Revenue inequality is how unequal revenue is distributed through a population. The lower the distribution of taxes, the greater the disparity of wealth. Unequal income is also followed by the distribution of unequal wealth. Populations could be divided in different ways in order to demonstrate various levels and types of income discrimination, such as income inequality by sex or race. Various methods may be used, such as the Gini coefficient, to evaluate the degree of income inequality in a population.

The Gini index is measured to the extent that a perfectly equal distribution differs between the distribution of incomes (or in some cases, consumption expenses) between individuals or families within the economy and deviates from a perfectly equal distribution. A Lorenz curve tracks the average percentages of gross income earned, starting with the poorest individual or family, against the approximate number of beneficiaries. The area between the Lorenz curve and the hypothetical absolute equality line is determined by the Gini index, expressed as a percentage of the maximum area under the line. A Gini index of 0 thus represents perfect equality, while an index of 100 suggests perfect inequality.

Table 3.5.1 GINI Index of High Income Countries:

Sr. No	Countries Name	GINI Index		
		2007	2012	2017
1	Luxembourg	31.1	34.3	34.9
2	Switzerland	34.3	31.6	32.7
3	Norway	27.1	25.7	27
4	Macao SAR	..	..	..
5	Iceland	29.5	26.8	24.2
6	Ireland	31.9	33.2	34.1
7	United States	41	..	..
8	Sweden	27.1	27.6	28.8
9	Denmark	26.2	27.8	28.7
10	Singapore	..	..	..
11	Netherlands	29.6	27.6	28.5
12	Austria	30.6	30.5	29.7

13	Finland	28.3	27.1	27.4
14	Germany	31.3	29.7	27.6
15	Hong Kong SAR	..	..	..
16	Belgium	29.2	27.5	27.4
17	Canada	33.8	28.7	27.7
18	France	32.4	33.1	31.6
19	United Kingdom	35.7	32.3	31.5
20	Japan	3.34	3.21	3.21
Average		**29.56**	**27.92**	**27.81**

Note*Some of the value is generated by Liner Trend.

In High Income countries Gini Index in 2007 was 29.56 %of these 20 countries on average, which is decreased in 2012 to 29.92 %and in 2017 its 27.81 % which means that in high income countries income inequality decreased every year which have positive impact to economic growth.

Table 3.5.2 GINI Index of Middle Income Countries:

Sr. No	Countries Name	GINI Index		
		2007	**2012**	**2017**
1	Spain	34.1	35.4	34.7
2	Cyprus	31.1	34.3	31.4
3	Slovenia	24.4	25.6	24.2
4	Portugal	36.8	36	33.8
5	Czech Republic	26	26.1	24.9
6	Estonia	31.2	32.9	30.4
7	Greece	34	36.3	34.4
8	Slovak Republic	24.7	26.1	28.4
9	Lithuania	34.8	35.1	37.3
10	Latvia	37.5	35.2	35.6
11	Uruguay	46.4	39.9	39.5
12	Hungary	27.9	30.8	30.6
13	Panama	52.7	51.7	49.9
14	Poland	34	33	29.7

15	Romania	37.5	36.5	36
16	Russian Federation	42.3	40.7	37.2
17	Argentina	46.6	41.4	41.2
18	China	46.7	42.2	31.2
19	Mexico	46.8	48.7	44.1
20	Brazil	54.9	53.5	53.3
Average		**37.52**	**37.07**	**35.39**

Note*Some of the value is generated by Liner Trend.

In Middle Income Countries Gini Index in 2007 was 37.52 %of these 20 countries, which is increased in 2012 to 37.07 %and in 2017 its decreased 35.39 %which means that in middle income countries income inequality decreased every year which have positive impact to economic growth.

Table 3.5.3 GINI Index of Low Income Countries:

Sr.No	Countries Name	GINI Index		
		2007	**2012**	**2017**
1	Bulgaria	36.1	36	40.4
2	Turkey	38.4	40.2	41.4
3	Thailand	39.8	39.3	36.5
4	Serbia	40.4	39.9	36.2
5	Belarus	29.6	26.5	25.4
6	Azerbaijan	26.6	25.3	31.4
7	Armenia	31.2	29.6	33.6
8	Mongolia	35.8	33.8	31.5
9	Venezuela, RB	49.9	50.39	50.89
10	Moldova	34.4	29.2	25.9
11	Ukraine	27	24.7	26
12	Egypt, Arab Rep.	31.2	28.3	31.5
13	India	34.8	35.2	34.1
14	Pakistan	31.6	30.8	31.4

15	Uzbekistan	35.6	34.5	32.7
16	Kyrgyz Republic	33.9	27.4	27.3
17	Tajikistan	32.2	31.5	34.1
18	Burkina Faso	41.8	37.4	34.1
19	Madagascar	41.2	42.6	39.5
20	Colombia	51.29	52.7	49.7
Average		**36.14**	**34.76**	**34.68**

Note*Some of the value is generated by Liner Trend.

In Low Income Countries Gini Index in 2007 was 36.14 %of these 20 countries on average, which is decreased in 2012 to 34.76 %and in 2017 its decreased 34.68 %which means that in low income countries income inequality decreased every year which have positive impact to economic growth but the decreasing rate is very low.

Tale 3.5.4 Comparison of Population between High, Middle and Low Income Countries:

Years	**High Income Countries**	**Middle Income Countries**	**Low Income Countries**
2007	29.56 %	37.52 %	36.17 %
2012	27.92 %	37.07 %	34.76 %
2017	27.81 %	35.39 %	34.68 %

The above mentioned table shows huge difference between high to middle and low income countries while in low and middle income there is not much difference in high income countries in 2007 Gini Index average of selected countries is 29.56 %, in middle income countries it's have 37.52 % and in low income countries it's have 36.17 %. Similarly in 2017 high income countries income inequality is 27.81 % and in middle income countries its have 35.39 % and in low income countries 34.68 %. Income inequality has worst effect on economic growth.

Chapter 4

METHODOLOGY

This chapter explains how evaluate the effect of innovations and income equality on economic growth and also measure the effect of innovation on income inequality. This chapter also explain what are the diagnostic test are use to achieve the objective and what are the consequences of these diagnostic test.

4.1 Theoretical Foundation Inequality and Economic Growth:

There are two key by which income inequality can stimulate growth: incentives and savings.

Incentives impact development directly: agents in an environment where contributions are rewarded work harder and reach a high production level. Once the system of rewards and punishment creates inequality, there will be a correlation between inequality and development. However, the interplay of such constraints with incentives may lead to a causal negative relationship between inequality and growth when additional restrictions, such as the imperfect credit markets and political economy limitations, are implemented into the model.

In the Solow model, higher saving rates decide higher stable state income levels or higher growth rates in endogenous model growth. It has been taken as the conventional wisdom that inequality contributes to higher savings. However, a positive, negative, or neutral correlation between inequality and savings is supported by several

theoretical arguments. Recent econometric evidence indicates that unequal income has no big impact on savings, possibly due to the mechanism's compensatory effects in various directions. (Mendes, 2013)

Alesina and Rodrik (1994) or Persson and Tabellini (1994) are suggesting models that can damage development through inequality. As in the Solow model, growth is triggered by the buildup of physical, human capital and technological resources (innovations). According to the statement of "incentives," taxation decreases the net return of factors such as capital and skilled labour. If high taxes affect growth, the accumulation rate of these factors decreases.

People differ from each other in their faculty. Alesina and Rodrik (1994) Capitalists and educated middle class have their own "accumulative factor" [capital, skilled workers and technology] while "the poor" have untrained jobs, which is helpful in production but doesn't "accumulate." People with more skills accumulate more capital, Persson and Tabellini (1994) said people differs by their ability to gain skills and to accumulate productive capital. In order to unify the exhibition, call those with (more) productive capital or more capacity. (Mendes, 2013).

4.2 Theoretical Foundation of Innovation and Economic Growth:-

Solow 's Growth model was presented as endogenous growth theory, the first paper entitled 'A contribution to Theory of Economic Development' (1956),. It describes "improvements in market processes or goods" as technical improvements and asserts they become the driving factors for economic development. Since the AK Theory, a second wave of endogenous growth theory, commonly referred to as the 'innovation-based' growth theory, followed, acknowledging the distinction between intellectual capital and physical and humane capital, the root of technical development. Savings and education have accrued physical and human resources, but intellectual capital is generated by creativity (Howit, 2010).

The theory of endogenous growth implies that economic growth is mostly the product of endogenous rather than external factors. The theory of endogenous growth notes that human capital investment, innovation and knowledge contribute significantly impact on economic growth (Romer 1987, 1990).

4.3 Dynamics of the Model:

This study has two models the dependent variable in 1st model is GDP and in 2nd model is GINI. Where the 1stmodel has six independent variables are R &D, Pop, GINI, Patents Application (PA) and Physical Capital (K) in 2nd model independent variable is R &D and G. In order to understand the estimate, the dynamic among the variables. First, consider the classical production function of Cobb-Douglas:

$$\mathbf{Y=Ak^{\alpha}L^{\beta}(1)}$$

Implying that production (Y) while (K) is physical capital (k), Labor (L) and the level of technology (A). Theories of economic growth link the level of technology to the application of patents (PA) and expenditure in research and development (R&D). In this context, we believe that the technology is defined by a combination between R&D and patent applications (PA), production is substituted with gross domestic product (GDP), labour is substituted with (Pop) (Chaudhry, Sabir & Gulzar, 2019) and physical capital (K) is expressed as follows:

$$\mathbf{GDP_{i,t} = \{(R\&D_{i,t})\ (PA_{i,t})\}^{\alpha}\ (K_{i,t})^{\beta}(Pop_{i,t})^{\gamma}\ \mu_{i,t}} \qquad \mathbf{(2)}$$

If we taking logarithms we obtain the following dynamic expression:

$$\mathbf{\ln(GDP_{i,t}) = \alpha_0 + \alpha_1 \ln(R\&D_{i,t}) + \alpha_2 \ln(PA)_{i,t} + \alpha_3 \ln(K)_{i,t} + \alpha_4 \ln(Pop)_{i,t} \mu_{i,t} (3)}$$

We transformed this model to add income distribution variable (GINI) in this model to achieve the objective:

4.3.1 Model-1:

$$\mathbf{\ln(GDP_{i,t}) = \alpha_0 + \alpha_1 \ln(R\&D)_{i,t} + \alpha_2 \ln(PA)_{i,t} + \alpha_3 \ln(K)_{i,t} + \alpha_4 \ln(GINI)_{i,t} + \alpha_5 \ln(Pop)_{i,t} + \mu_{i,t} \qquad (4)}$$

Where $\alpha_0$is the intercept of the model, α_1 is the elasticity of the research and development, $\alpha_2$is the elasticity of patents application, α_3**is** elasticity of physical capital, $\alpha_4$is the elasticity of income distribution, and $\alpha_5$is the elasticity of population.

4.3.2 Model-2:

To estimate the association between innovation (R &D) and income inequality (GINI):

$$\mathbf{GINI_{i,t} = \gamma_0 + \gamma_1 (R\&D)_{i,t} + \varepsilon_{i,t}} \qquad \mathbf{(4)}$$

While $\gamma_0$is the intercept of the model and $\gamma_1$the elasticity of the research and development (R&D).

4.4 Definitions of the Variables:

4.4.1 Innovation: -Is measures with two proxies, which represent innovation, One is spending in R&D, as calculated as a GDP proportion by the contingent investment on research and growth. They involve both capital and existing investment in the four major sectors: business, government, higher education and non-profit private sector. Research and development encompasses theoretical research, applied study and experimental development. (Lichtenberg, 1992, Osorio and Pose, 2004 Wloderczyk, 2107 and Risso& Carrera, 2019) and Worldwide patent applications submitted by the Treaties of Patent Cooperation or by a specific Patent Office are patent applications. (Jalles, 2010, Osorio and Pose, 2004, Antonelli & Gehringer, 2017 and Wloderczyk, 2107). The data has been collected from World Development indicator (2019)

4.4.2 Economic Growth: -Is measured by Gross domestic product (GDP), the GDP calculation is the overall market value for all the final goods and services produced in a given country relative to the total consumption, investment, government expenditure and net exports (export value minus import value), the country's GDP calculate the national income output and economic growth.The current value of all the final goods and services produced in a country is GDP is called nominal GDP.Real GDP adjust nominal value with inflation. (Osorio and Pose, 2004 Wloderczyk, 2107 and Risso & Carrera, 2019). The data has been collected from World Development indicator (2019).

4.4.3 Income Inequality: - Is measured by Gini index which is measures, the Gini index is measured to the extent that a perfectly equal distribution differs between the distribution of incomes (or in some cases, consumption expenses) between individuals or families within the economy and deviates from a perfectly equal distribution. The average percentages of gross income earned against the approximate number of beneficiaries starting with the poorest individual or household are tracked in the Lorenz curve. The area between the Lorenz curve and the hypothetical absolute equality line is determined by the Gini index, expressed as a percentage of the maximum area under the line. A Gini index of 0 thus represents perfect equality, while an index of 100 represents perfect inequality.(Ward, 2017, Wloderczyk, 2107 &Risso and Carrera, 2019). The data has been collected from World Development indicator (2019).

4.4.4 Physical Capital (K):- is measured by Gross fixed capital formation % of GDP, measuring by (formerly gross domestic investment) consists of spending on adds to

economic capital assets plus net inventory adjustment. Factories, equipment and gear sales include property maintenance (fences, ditches, reservoirs, etc.) and road building, railways and the like, including schools, offices, hospitals, private family residences, commercial and industrial facilities. Inventory inventories include inventory of goods kept by businesses in order to accommodate transient or unpredictable changes in demand or revenue and "the work being done." (Risso and Carrera, 2019).The data has been collected from World Development indicator (2019).

4.4.5 Population: -Complete population based on a de facto population definition that includes all residents of the country, irrespective of legal status or citizenship. Mid-year forecasts are the values displayed. The data has been collected from World Development indicator (2019).

4.5 Data Selection:

This thesis is based on panel data, the econometrics techniques are discuss in this chapter on which panel data is estimated. Data from panels are commonly used because it gives time and scale. There are also benefits over cross-sectional data from the panel data. The sample size of the data can be expanded dramatically and productive outcomes can also be obtained (Baltagi, 1998). In case of panel data, the second advantage is that the omitted variable biased could be less possible. For each cross-sectional observation, panel details can be balanced or unbalanced, the panel would be assumed to be balanced when time is equal. In the case of an unbalanced panel data set, though, the number of observations varies between cross sections.

Penal data also used due to these several reasons (i) Its control the problem of heterogeneity (ii) It offers more insightful details, greater variability, less co-linearity between variables, more independence and more reliability (iii) Panel data models allow us to develop and test complex behavioral models.

This study consist on the 60 high, middle and low income countries where 20 high income countries are Luxembourg, Switzerland, Norway, Macao, Iceland, Ireland, United States, Singapore, , Austria, Finland, Germany, Hong Kong, Belgium, Denmark, Sweden, Netherlands Canada, France, United Kingdom and Japan, 20 middle income countries are, Estonia, Greece, Slovak Republic, Lithuania, Latvia, Uruguay, Hungary, Panama, Poland, Romania, Russia, Argentina, China, Spain, Cyprus, Slovenia, Portugal,

Czech Republic Mexico, and Brazil, and 20 low income countries are Bulgaria, Turkey, Thailand, Serbia, Colombia, Belarus, Azerbaijan, Armenia, Mongolia, Venezuela, Moldova, Ukraine, Egypt, India, Pakistan, Uzbekistan, Kyrgyz Republic, Tajikistan. Burkina Faso, and Madagascar (IMF Outlook October 2018).

The data period is from 1996 to 2018 is used in this study to analyzed the impact of innovation and income inequality on economic growth and innovation impact on income inequality. Sources of the data are World Development Indicator (WDI) 2018.

4.6 Diagnostic Test:

Before going to the main evaluation methodology some diagnostic tests are conducted. Few evaluation experiments are performed before a regression and others are carried out after a regression. In compliance with its order and rationale, all these tests are listed in detail below.

4.6.1 Descriptive Statistics:

Descriptive statistics are reported at the first step of analysis. Descriptive statistics are the field in which knowledge collecting is defined in a quantitative manner. Descriptive statistics are meant to synthesize a survey, rather than to use the data to think from the population that the sample of data is thought to represent. Summary of statistics are starting from reporting numbers of observations of all variables include in sample, then central tendency that include mean, median, mode, minimum and maximum values and then report standard deviation that is used as measure of dispersion.

4.6.2 Correlation Matrix:

After showing descriptive statistics, next step is to check the correlation among variables. Correlation matrix is structured that analysis the problem of degree of association or multi-co-linearity among variables that are used in the same estimation equation. Under condition of perfect multi-co-linearity, the OLS estimator simply does not exist. In order to define the problem of multi-co-linearity the pair wise correlation cofactor extracted from a correlation matrix is helpful. The high value of a correlation coefficient equal to (60%) confirms the multi-co-linearity problem.

4.6.3 Test for Stationary:

Next step is to check stationary of variables because if a data of variable is non-stationary, then all the regression analysis findings are not applicable.

The standard approach is to analyze the stationary data of the time series by examining the presence of unit roots in the time series given. Augmented Dickey Fuller test The ADF test is the most commonly used test for the analysis of the unit root existing in the data proposed by Dickey Fuller Test (1981). Augmented Dickey Fuller test always to be performed before the regression investigation proposed by Dickey and Fuller (1981) to verify the stationary of the variables. In panel data Levin, Lin & Chu (2002) (LLC) and Im, Pesaran & Shin (2003) (IPS) unit root test are used. IPS unit root test shows combined unit root value of variables and LLC unit root test shows specific unit root value of variables.

4.6.3.1 Panel Unit Root Test:

Examining the existence of unit roots in the data series is mandatory. For the stationary exams, they picked Levin, Lin & Chu (2002) (LLC) and Im, Pesaran & Shin (2003) (IPS). The null hypothesis is that the data variable contains a root unit or non-stationary data. Whereas the cumulative unit root value of variables is explained by the IPS unit root test, the LLC unit root test reveals the individual unit root value of variables.

4.6.4 Hausman Specification Test:

After checking stationary, next step is to check the problem of Endogeneity suspected in the variables of decentralization and institutions. This problem may generate biased OLS regression equation. The Endogeneity problem of the variables involved in the estimation analysis is tested using the Husman specification Test. The literature review has demonstrated the variables such as decentralization and political institutions are endogenously determined. Through running two OLS regressions, artificial regression can be used to conduct the Husman test. In the first step, the presumed endogenous problem variable is taken as a dependent variable and is regressed to all other variables and methods. After that, residuals from this equation are obtained and a name is given. In the second step, the original equation is re-estimated as an extra regressor, plus the residuals from the first regression. If the OLS estimates are consistent, then the residual coefficient obtained from the first stage does not vary significantly from zero, but if the

suspected variable is endogenous, it implies a large probability value and suggests that the endogenous problem exists. If the OLS predictions are consistent, which means the residues of the first stage do not vary materially from 0, but if the presumed variable is endogenous, then residual have significant effect on dependent variable which implies that Endogeneity issue exist.

The Hausman Test is also used on a sample to decide which of the Random Effect (REM) and Fixed Effect (FEM) models is better. A fixed effect model takes the individual characteristics into account for each cross-section by allowing for different intercepts for each cross-section. The Random Effect Model assumes that there is a random variance between entities. In other words, the error term of the random effects unit should not be correlated with the independent variable, so that time invariant variables play a function as an explanatory variable.

A null hypothesis rejection means that besides the random effect model, the fixed effect model would be suitable.

4.6.5 Sargan Test:

Sargan test was developed by Sargan J.D to check the validity of instruments. The validity of instruments is used to check the consistency of GMM estimator. If the instruments are exogenous than they are uncorrelated with error term.

4.7 Estimation Technique:

This econometric model of this work develop a over-identified equation having endogenous variables correlating with the error term. The OLS estimation methodology yields inconsistent and biased results in this certain conditions. There may be instrumental variables (IV) technique to deal with the Endogeneity dilemma. The TSLS estimating technique is a particular IV estimator type which covers the Endogeneity problem and over-identified equation but does not provide modified standard error for unidentified form and heterosedasticity autocorrelation. In addition, in the occurrence of the structure of equations, two-stage least square (2SLS) is also not a good technique to deal with the issue of Endogeneity but real-world. Last of all the estimation technique of Generalized Least Square (GLS) still deals with the Endogeneity problem, but has some extra assumptions.

When the issue of Endogeneity in the model is present, the econometric model of the sample is used. The problem of Endogeneity arises when explanatory variables

included are associated with the term model error. Ordinary least square (OLS) estimates provide skewed and inconsistent results in the presence of Endogeneity problem in the model. Arellano and Bond developed the Generalized Moment Method (GMM) technique in 1991.It is hard to find that exogenous model tools are sufficient for the model, so lagged value dependent and independent variables are used as model tools in this analysis. The lagged value of economic growth (GDP), research and development (R&D), patent application (PA), gross capital application (GCF), Gini coefficient's index (GINI) and population, (Pop) are taken as instruments variables in the model.

Generalized Method of Moment (GMM) also abolishes the serial association and heteroscedasticity problematic issues from the model. In order to resolve the endogenous issue, the methodology of instrumental variables is used for the GMM model, that method is used in regression to solve simultaneity bias problems between the independent and dependent variable and the error term.GMM is the advanced technical type of instrumental variables which gives reliable and unbiased estimates even if the model has problems of autocorrelation and heteroscedasticity. In the data of panels heteroscedasticity and Endogeneity problem always exist. For the validity of instrument variables say Z it must meet two conditions.

a. It should be highly associated with endogenous variable X that is

$$\mathbf{Cov\ (X,Z) \neq 0}$$

b. It should not be interconnected with error term

$$\mathbf{Cov\ (Z,\mu) = 0}$$

Generalized method of moment estimation technique give consistent parameters by optimizing the objective purposes that include the moment restrictions. GMM is stronger estimation than two stage least square (2SLS) techniques; three stage least square (3SLS); and Generalized Least Square (GLS) estimation methods. GMM estimation method provide the lower order moment that include Mean, Median and Mode, but higher order moment include Skewness and Kurtosis as well.

So, GMM technique is more appropriate technique to measure the effect of innovations on economic growth and measure the effect of innovation on income inequality or interactive term of both impact of innovation and income inequality on economic growth (Ulku, 2004 & Risso and Carrera, 2019).

4.8 Natures of Variables:

The dependent variables Gross Domestic Product (GDP) in natural log form and data are constant in 2010. The independent variable innovation is measured by Research and Development (R&D) and the data is in % of GDP and also innovation is measured by Patent of Applications (PA) and it's in natural log form. The income disparity is calculated by Gini Index and it's in index form. The Physical capital (K) is measured by Gross Capital Formation and the data is in % of GDP. The Population is also in natural log form.

Chapter 5

Results and Discussion

The purpose of the chapter is to describe the impact of innovation and income inequality on economic growth of high, middle and low income countries and also describe the impact of innovation on income inequality. First this chapter discusses the descriptive statistics of variables, diagnostic test, and estimation technique. Each panel have 20 countries and period of the data from 1996 to 2018. This chapter also includes the interpretation and discussion of all estimation results and their impact of economic growth. Selected countries list is given in appendix.

5.1 Descriptive Statistics:

In this study relationship of economic growth with innovation, income inequality and other macroeconomics is analyzed using two models, model of high-income countries, model of middle income countries and model of low income countries and also find the impact of innovation on income inequality. Descriptive statistics are the field in which knowledge collecting is defined in a quantitative manner. Descriptive statistics are meant to synthesize a survey, rather than to use the data to think from the population that the sample of data is thought to represent. The descriptive statistics for each model is given below.

Table 5.1.1 Descriptive Statistics of High Income Countries:

Variables	Obs.	Mean	Max.	Min.	S.D
GDP	183	1710000000000	17800000000000	8700000000	3270000000000
R&D % of GDP	398	2.275	3.748	1.124	0.670

Patent application	429	32785.50	384201.0	1.000	84321.82
GCF % of GDP	458	22.572	38.169	9.307	3.812
GINI Index	193	30.352	41.5000	24.900	3.286
Population	460	37655143	327000000	268916	68908315

The analysis begins with descriptive statistics of the data. The descriptive statistics in above table of all included variables of high-income countries. Summary of statistics is a numerical account of the key elements of data. It's also summarized sample rather than the population, it explain number of observation. Standard deviation, minimum, and maximum values represent measures of inconsistency while mean is utilized as central tendency measures. The table4.1.1 show the total numbers of observations of all included variables of 20 countries period from 1996 to 2018. On average of GDP of high-income countries is 1.51 trillion US $with maximum 17.8 trillion and minimum 8.7 billion and standard deviation is 3.27 trillion which shows dispersion from the average value. The Government expenditure % of GDP with 460 observations of high income countries have 398 observation with average is 2.088, with maximum 3.913 and minimum 0.044 and S.D is 0.821 dispersion from average value. The patent application have 429 observations in high income countries on average value is 32785, with maximum 384201, while minimum value is 1 and the S.D 84321.82 dispersion from the average value.

The Gross capital formation % of GDP have 458 observations, the GCF in high income countries have on average value 22.572, maximum value is 38.169, minimum value is 9.307 and S.D value is 3.812, dispersion from the average value. The GINI coefficients index have 193 observation, income inequality in high income countries on average is 30.352, maximum value is 41.5, minimum value is 34.9 and S.D value is 3.286 which is dispersion form the average value. The population have 460 observation with average value is 37655143, maximum value is 327000000, minimum value is 268916 and dispersion from average value is 68908315.

Table 5.1.2 Descriptive Statistics of Middle Income Countries:

Variables	**Obs.**	**Mean**	**Max.**	**Min.**	**S.D**
GDP	460	64200000	10800000000000	11100000000	1340000000000

		0000			
R&D % of GDP	416	0.846	2.580	0.062	0.472
Patent application	409	19868.50	1245709	2.0000	117439.6
GCF % of GDP	458	24.550	47.818	10.217	7.132
GINI Index	278	38.787	59.900	27.700	9.270
Population	460	98161745	1390000000	873423	284000000

The descriptive statistics in above table of all included variables of middle income countries. Summary statistics are a numerical description of main data elements in the sample. Standard deviation, minimum, and maximum values denote measures of variability while mean is utilized as central tendency measures. The table 5.1.2 show the total numbers of observations of all included variables of 20 countries period from 1996 to 2018. On average of GDP with 460 observations of middle income countries value is 0.642 trillion US $ with maximum 10.8 trillion and minimum 11.1 billion and standard deviation is 1.37 trillion which shows dispersion from the average value. The Government expenditure % of GDP of middle income countries have 416 observation with average value is 0.846, with maximum 2.580 and minimum 0.0620 and S.D is 0.472 dispersion from average value. The patent application have 409 observations in middle income countries on average value is 19868, with maximum 1245709, while minimum value is 2 and the S.D value is 117439 dispersion from the average value.

The Gross capital formation % of GDP have 458 observations, the GCF in middle income countries have on average value 24.550, maximum value is 47.818, minimum value is 10.217 and S.D value is 7.132, dispersion from the average value. The GINI coefficients index have 278 observation, income inequality in middle income countries on average is 38.787, maximum value is 59.9, minimum value is 27.7 and S.D value 9.270 is which is dispersion form the average value. The population have 460 observation with average value is 98161745, maximum value is 1390000000, minimum value is 873423 and dispersion from average value is 284000000.

Table 5.1.3 Descriptive Statistics of Low Income Countries:

Variables	**Obs.**	**Mean**	**Max.**	**Min.**	**S.D**

GDP	460	196000000000	2850000000000	2150000000	383000000000
R&D % of GDP	374	0.399	1.192	0.014	0.265
Patent application	388	949.448	14961	1.000	2013.491
GCF % of GDP	454	24.377	58.150	0.272	7.580
GINI Index	218	38.853	58.700	24.000	8.168
Population	460	89767627	1350000000	2316568	254000000

The descriptive statistics in above table of all included variables of low income countries Summary statistics are a numerical description of main data elements in the sample. Standard deviation, minimum, and maximum values denote measures of variability while mean is utilized as central tendency measures. The table show the total numbers of observations of all included variables of 20 countries period from 1996 to 2018. On average of GDP with 460 observations of low income countries is the average value of GDP 196 billion US $ with maximum 2.85 trillion and minimum 2.15 billion and standard deviation is 383 billion which shows dispersion from the average value. The Government expenditure % of GDP of low income countries have 374 observation with average value is 0.399, with maximum 1.192 and minimum 0.014 and S.D is 0.265 dispersion from average value. The patent application have 388 observations in low income countries on average value is 949.448, with maximum 14961, while minimum value is 1 and the S.D value is 2013.491 dispersion from the average value.

The Gross capital formation % of GDP have 454 observations, the GCF in low income countries have on average value 24.377, maximum value is 58.150, minimum value is 0.272 and S.D value is 7.580, dispersion from the average value. The GINI coefficients index have 218 observation, income inequality in low income countries on average value is 38.853, maximum value is 58.7, minimum value is 24 and S.D value 8.168 which is dispersion form the average value. The population have 460 observation with average value is 8976727, maximum value is 1350000000, minimum value is 2316568 and dispersion from average value is 254000000.

5.2 Empirical Results of Panel Unit Root Test:

In this stage firstly check the stationary of the variables which are used in the study, it is necessary to determine the existences of stationary of the data to check the presences of the stationary we used unit root test. Liven, Lin and Chu (2002) (LLC) and Im, Pesaran and Shin (2003) (IPS) are used for this purpose because LLC explain the common unit root result and IPS explain the individual unit root results. If LLC and IPS both have significant at same time which means data is stationary at individual level of cross section and common level. Some variables are stationary at level while some variables are stationary at first difference. The findings were nevertheless recorded at the table for both cases. According to the variables involved in this analysis, the following hypotheses were created.

H_0: The variable is non stationary.

H_1: The variable is stationary.

Table 5.2.1 Penal Unit Root (Levin, Lin & Chu and Im, Pesaran& Shin) Test of High Income Countries:

	Level		First Difference		
	Common Unit Root	Individual Unit Root	Common Unit Root	Individual Unit Root	
Variables	**LLC**	**IPS**	**LLC**	**IPS**	**Decision**
Ln GDP	-2.971	-1.408	-11.810	-7.6073	I(1)
	0.001	0.079	0.000	0.000	
R&D	-2.093	-1.198	-9.660	-9.040	I(1)
	0.018	0.115	0.000	0.000	
Ln PA	-4.149	-3.229	-10.900	-8.985	I(O)
	0.000	0.000	0.000	0.000	
GCF	-2.827	-3.373	-10.917	-11.326	I(O)
	0.002	0.000	0.000	0.000	
GINI	-6.450	-2.692	-16.795	-6.822	I(O)
	0.000	0.003	0.000	0.000	
Ln Pop	3.828	1.932	2.326	-2.702	I(1)
	0.999	0.973	0.009	0.003	

The results of Levin, Lin & Chu (LLC) and Im, Pesaran & Shin (IPS) indicates GDP, R&D, and Pop of high income countries is stationary at first difference because the probability value of these variable at level is greater than 0.05 while Pa, GCF and GINI of high income countries is stationary at level because these variables probability value is less the 0.05

Table 5.2.2 Penal Unit Root (Levin, Lin & Chu and Im, Pesaran& Shin) Test of middle income countries:

	Level		First Difference		
	Common Unit Root	Individual Unit Root	Common Unit Root	Individual Unit Root	
Variables	**LLC**	**IPS**	**LLC**	**IPS**	**Decision**
Ln GDP	-1.680	-0.105	-6.776	-3.99395	I(1)
	0.004	0.458	0.000	0.000	
R&D	-2.817	-1.070	-12.554	-11.209	I(1)
	0.002	0.142	0.000	0.000	
Ln PA	-0.890	0.224	-13.197	-8.886	I(1)
	0.186	0.588	0.000	0.000	
GCF	-1.522	-2.938	-10.639	-9.821	I(1)
	0.063	0.001	0.000	0.000	
GINI	-7.828	-2.893	-11.855	-4.881	I(O)
	0.000	0.001	0.000	0.000	
Ln Pop	3.652	1.638	-2.379	-3.760	I(1)
	0.999	0.949	0.032	0.000	

The results of Levin, Lin & Chu (LLC) and Im, Pesaran& Shin (IPS) indicates GDP, R&D, Pa, GCF, and Popof middle income countries is stationary at first difference because the probability value of these variable at level is greater than 0.05 while GINI of middle income countries is stationary at level because these variables probability value is less the 0.05.

Table 5.2.3 Penal Unit Root (Levin, Lin & Chu and Im, Pesaran& Shin) Test of Low income countries:

	Level		First Difference		
	Common Unit Root	Individual Unit Root	Common Unit Root	Individual Unit Root	
Variables	**LLC**	**IPS**	**LLC**	**IPS**	**Decision**
Ln GDP	-1.872	-2.600	-8.269	-7.525	I(0)
	0.030	0.004	0.000	0.000	
R&D	-2.667	-0.719	-36.249	-10.002	I(1)
	0.003	0.236	0.000	0.000	
Ln PA	-3.648	-2.497	-12.091	-10.270	I(0)
	0.000	0.006	0.000	0.000	
GCF	-0.630	-1.504	-11.061	-8.985	I(1)
	0.264	0.066	0.000	0.000	
GINI	-959.110	-98.963	-11.850	-4.852	I(O)
	0.000	0.000	0.000	0.000	
Ln Pop	-7.075	-2.574	-2.535	-3.533	I(0)
	0.000	0.005	0.005	0.000	

The results of Levin, Lin & Chu (LLC) and Im, Pesaran& Shin (IPS) indicates R&D and GCF of low income countries is stationary at first difference because the probability value of these variable at level is greater than 0.05 while GDP, Pa, GINI, and Pop of low income countries is stationary at level because these variables probability value is less the 0.05.

5.3 Hausman Test Results:

Hausman (1978) test is used to check Endogeneity problem in the model and it's also used for model selection among fixed effect model (FEM) and random effect model (REM). The Hausman test results for high middle- and low-income countries model are shown below in the tables of innovation and income equality impact on economic growth and find the impact of innovation on income inequality as shown in equation 1 and 2.

Hypothesis:

H0: Random Effect Model is better than Fixed Effect Model.

H1: Fixed Effect Model is better than Random Effect Model.

Table 5.3.1 Hausman Test Results of High Income Countries of 1st Model:

Test Summery	Chi-Sq Statistics	Chi-Sq d.f	Prob.
Cross Section Random	71.454*	5	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test result for high income countries shown above in the table reject the null hypothesis and accept the alternative hypothesis which fixed effect model is better than the random model.

Table 5.3.2 Hausman Test Results of Middle Income Countries of 1st Model:

Test Summery	Chi-Sq Statistics	Chi-Sq d.f	Prob.
Cross Section Random	29.003*	5	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test result for middle income countries shown above in the table reject the null hypothesis and accept the alternative hypothesis which fixed effect model is better than the random model.

Table 5.3.3 HausmanTest Results of Low Income Countries of 1st Model:

Test Summery	Chi-Sq Statistics	Chi-Sqd.f	Prob.
Cross Section Random	86.781*	5	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test result for low income countries shown above in the table reject the null hypothesis and accept the alternative hypothesis which fixed effect model is better than the random model.

Table 5.3.4Hausman Test Results of High Income Countries of 2nd Model:

Test Summery	Chi-Sq Statistics	Chi-Sq d.f	Prob.
Cross Section Random	9.243*	2	0.009

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test result for high income countries shown above in the table reject the null hypothesis and accept the alternative hypothesis which means that fixed effect model is better than the random model.

Table 5.3.5Hausman Test Results of Middle Income Countries of 2nd Model:

Test Summery	Chi-Sq Statistics	Chi-Sq d.f	Prob.
Cross Section Random	9.898*	2	0.007

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test result for middle income countries shown above in the table reject the null hypothesis and accept the alternative hypothesis which means that fixed effect model is better than the random model.

Table 5.3.6HausmanTest Results of Low Income Countries of 2nd Model:

Test Summery	Chi-Sq Statistics	Chi-Sq d.f	Prob.
Cross Section Random	1.532	2	0.464

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test result for low income countries shown above in the table accept the null hypothesis and reject the alternative hypothesis which means that random effect model is better than the fixed model.

5.4 Endogeneity Test Results:

Hausman (1978) test is used to check Endogeneity problem in the model of all models of high income, middle income and low income countries. First make independent variable as dependent variable and regress the regression and make residual series than regress that residual series on original dependent variable, if the probability value of residual of the variable which means that Endogeneity exists between that independent variable and dependent variable. Endogeneity is check with dependent variable GDP and GINI with its independent variable which shows in equation1 and 2.

Hypothesis:

H0: There is no Endogeneity between variables.

H1: There is Endogeneity between variables.

Table 5.4.1 EndogeneityResult with GDP for High Income Countries:

Sr. No.	Variables	Coefficients	T Statistics	Probability
01	Residual of (R&D)	-0.122	-4.101*	0.000
02	Residual(Ln PA)	0.070	2.251*	0.025
03	Residual (GCF)	0.004	0.860	0.390
04	Residual (GINI)	0.010	1.750	0.081
05	Residual (Ln Pop)	0.814	23.098*	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test results for high income countries model above in the table reject the null hypothesis and accept the alternative hypothesis of R&D, Pa and Pop because the probability value is less than 0.05 which indicates that the Endogeneity exist between them, while GCF and GINI does not have Endogeneity problem because the probability value of these variables are higher than the 0.05.

Table 5.4.2 Endogeneity Result with GDP for Middle Income Countries:

Sr. No.	Variables	Coefficients	T Statistics	Probability
01	Residual of (R&D)	0.122	1.750	0.081
02	Residual(Ln PA)	-0.076	-2.345*	0.019
03	Residual (GCF)	-0.004	-1.042	0.298
04	Residual (GINI)	0.001	0.218	0.827
05	Residual (Ln Pop)	1.097	29.747*	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test results for middle income countries model above in the table reject the null hypothesis and accept the alternative hypothesis of Pa and Pop because the probability value is less than 0.05 which indicates that the Endogeneity exist between them, while R&D, GCF and GINI does not have Endogeneity problem because the probability value of these variables are higher than the 0.05.

Table 5.4.3 Endogeneity Result with GDP for Low Income Countries:

Sr. No.	Variables	Coefficients	T Statistics	Probability
01	Residual of (R&D)	0.440	1.722	0.086
02	Residual (Ln PA)	-0.039	-0.552	0.582
03	Residual (GCF)	-0.006	0.978	0.329
04	Residual (GINI)	0.038	4.342*	0.000
05	Residual (Ln Pop)	1.130	33.989*	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test results for low income countries model above in the table reject the null hypothesis and accept the alternative hypothesis of GINI and Ln Pop because the probability value is less than 0.05 which indicates that the Endogeneity exist between them, while R&D, Ln PA and GCF does not have Endogeneity problem because the probability value of these variables are higher than the 0.05.

Table 5.4.4Endogeneity Result with GINI for High Income Countries for 2nd Model:

Sr. No.	Variables	Coefficients	T Statistics	Probability
01	Residual of (R&D)	-1.043	-3.637	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test results for high income countries model above in the table reject the null hypothesis and accept the alternative hypothesis of R&D because the probability value is less than 0.05 which indicates that the Endogeneity exist between them.

Table 5.4.5Endogeneity Result with GINI for Middle Income Countries of 2nd Model:

Sr. No.	Variables	Coefficients	T Statistics	Probability

01	Residual of (R&D)	-0.956	-5.153	0.000

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test results for middle income countries model above in the table reject the null hypothesis and accept the alternative hypothesis of R&D because the probability value is less than 0.05 which indicates that the Endogeneity exist between them.

Table 5.4.6Endogeneity Result with GINI for Low Income Countries of 2nd Model:

Sr. No.	Variables	Coefficients	T Statistics	Probability
01	Residual of (R&D)	0.414	2.212	0.028

Note: * denotes the rejection of null hypothesis at 5 present level of significance.

The Hausman test results for low income countries model above in the table reject the null hypothesis and accept the alternative hypothesis of R&D because the probability value is less than 0.05 which indicates that the Endogeneity exist between them.

5.5 Correlation Matrix Results:

Correlation matrix is constructed to check the problem of degree of association or multi-co-linearity among variables that are used in the same estimation equation. Under condition of perfect multi-co-linearity, the OLS estimator simply does not exist. In order to define the problem of multi-co-linearity the pair wise correlation cofactor extracted from a correlation matrix is helpful. The high value of a correlation coefficient equal to (60%) confirms the multi-co-linearity problem.

Table 5.5.1 Correlation Matrix for High Income Countries of 1st Model:

	Ln GDP	R&D	Ln PA	GCF	GINI	Ln Pop
Ln GDP	1					
	…….					
R&D	0.056	1				
	0.444	…….				
Ln PA	0.949	0.229	1			
	0.000*	0.001*	…….			
GCF	-0.140	0.113	-0.126	1		
	0.057	0.125	0.088	…….		

GINI	0.481	-0.269	0.438	-0.175	1	
	0.000*	0.000*	0.000*	0.017*	…….	
Ln Pop	0.988	0.100	0.957	-0.145	0.466	1
	0.000*	0.174	0.000*	0.050	0.000*	…….

Note: * denotes the 5 present level of significance.

The results of correlation matrix high income countries shows that R&D have insignificant correlation with GDP but PA have significant and positive correlation with GDP because the probability value is 0.000, whereas GCF insignificant correlation with GDP but GINI Coefficient and Pop have significant and positive correlation with GDP because the probability value is 0.00. PA and GINI have correlation with R&D because these variables have probability less than 0.05, PA have positive and GINI have negative correlation with R&D on the other hand GCF and Pop have insignificant correlation with R&D of high income countries.

GINI and Pop have significant and positive correlation with PA because the probability value is 0.000. While GCF have insignificant correlation with PA. GINI have significant negative correlation with GCF because the probability value is 0.012 which is less than 0.05. Pop have insignificant correlation with GCF. But Pop have positive significant correlation with GINI because the probability value is 0.000.

Table 5.5.2 Correlation Matrix for Middle Income Countries of 1st Model:

	Ln GDP	**R&D**	**Ln PA**	**GCF**	**GINI**	**Ln Pop**
Ln GDP	1					
	…….					
R&D	0.235	1				
	0.000*	…….				
Ln PA	0.874	0.388	1			
	0.000*	0.000*	…….			
GCF	0.023	0.230	0.172	1		
	0.715	0.000*	0.006*	…….		
GINI	0.447	-0.312	0.181	-0.200	1	
	0.000*	0.000*	0.004*	0.001*	…….	

Ln Pop	0.963	0.152	0.879	0.082	0.532	1
	0.000*	0.017*	0.000*	0.198	0.000*	…….

Note: * denotes the 5 present level of significance.

The results of correlation matrix shows that R&D, PA GINI and Pop have significant and positive correlation with GDP, but GCF have insignificant correlation with GDP of middle income countries. PA, GCF and Pop have significant and Positive correlation with R&D, while GINI have significant negative correlation with R&D of middle income countries.

GINI, Pop and GCF have significant and positive correlation with PA. On the other hand GINI have significant negative correlation with GCF because the probability is less than 0.05 but Pop have insignificant correlation with GCF. While Pop have positive significant correlation with GINI of middle income countries.

Table 5.5.3 Correlation Matrix for Low Income Countries of 1st Model:

	Ln GDP	**R&D**	**Ln PA**	**GCF**	**GINI**	**Ln Pop**
Ln GDP	1					
	…….					
R&D	0.417	1				
	0.000*	…….				
Ln PA	0.601	0.737	1			
	0.000*	0.000*	…….			
GCF	0.054	0.006	0.172	1		
	0.470	0.932	0.006*	…….		
GINI	0.421	-0.253	0.181	-0.200	1	
	0.000*	0.000*	0.004*	0.001*	…….	
Ln Pop	0.877	0.284	0.879	0.082	0.532	1
	0.000*	0.000*	0.000*	0.198	0.000*	…….

Note: * denotes the 5 present level of significance.

The results of correlation matrix shows that R&D, PA GINI and Pop have significant and positive correlation with GDP, but GCF have insignificant correlation with GDP of low income countries. PA, and Pop have significant and Positive correlation

with R&D, while GINI have significant negative correlation with R&D of low income countries and GCF have insignificant correlation with R&D of low income countries.

Whereas GINI, Ln Pop and GCF have significant and positive correlation with PA. On the other hand GINI have significant negative correlation with GCF because the probability is less than 0.05, but Pop have insignificant correlation with GCF of low income countries. While Pop have positive significant correlation with GINI of low income countries.

Table 5.5.4 Correlation Matrix for High Income Countries of 2nd Model:

	GINI	R&D	G
Ln GDP	1		
	…….		
R&D	-0.636	1	
	0.000*	…….	1

Note: * denotes the 5 present level of significance.

The results of correlation matrix shows that R&D has significant and negative correlation with GINI.

Table 5.5.5 Correlation Matrix for Middle Income Countries of 2nd Model:

	GINI	R&D	G
Ln GDP	1		
	…….		
R&D	-0.436	1	
	0.000*	…….	1

Note: * denotes the 5 present level of significance.

The results of correlation matrix shows that R&D has significant and negative correlation with GINI. G also have significant but positive correlation with R&D.

Table 5.5.6 Correlation Matrix for Low Income Countries of 2nd Model:

	GINI	R&D	G
Ln GDP	1		
	…….		

R&D	-0.240	1	
	0.000*	…….	1

Note: * denotes the 5 present level of significance.

The results of correlation matrix shows that R&D has significant and negative correlation with GINI.

5.6 GMM Results:

Generalized method of moments (GMM) technique was developed by Arellano and Bond in 1991. Exogenous instruments for model are hard to find that appropriate instruments for the model, so in this study dependent and independent variables lagged value is used as instruments of model. The lagged value of economic growth (GDP), research and development (R&D), patent application (PA), gross capital application (GCF), Gini coefficient's index (GINI) and population, (Pop) are taken as instruments variables in the model.

Generalized Method of Moment (GMM) also abolishes the serial association and heteroscedasticity problematic issues from the model. In order to resolve the endogenous issue, the methodology of instrumental variables is used for the GMM model, that method is used in regression to solve simultaneity bias problems between the independent and dependent variable and the error term.GMM is the advanced technical type of instrumental variables which gives reliable and unbiased estimates even if the model has problems of autocorrelation and heteroscedasticity.

So, GMM technique is more appropriate technique to examine the impact of innovations on economic growth and measure the effect of innovation on income inequality or interactive term of both impact of innovation and income inequality on economic growth.

Table 5.6.1 Empirical findings of Penal Generalized Method of Moments for High Income Countries of 1st Model:

Sr. No.	Variables	Coefficients	Probability
01	Research & Development (R&D)	-0.223	0.000*
02	Log of Patent Application (Ln PA)	0.208	0.000*
03	Gross Capital Formation (GCF)	0.025	0.012*

04	Gini Coefficient Index (GINI)	-0.009	0.295
05	Log of Population (Ln Pop)	0.665	0.000*
06	Constant (C)	14.930	0.000*
	Number of Observations	133	
	Number of Instruments	07	

Note: * denotes the 5 present level of significance.

In this results Fixed effect with white cross-sections are used with the instruments of lnPA(-1), GINI(-1), RD(-1), GCF(-1), lnPOP(-1), lnGDP(-1) lnPA(-2), GINI(-2), RD(-2), GCF(-2), lnPOP(-2) and lnGDP(-2) to find the impact of innovation and income inequality on economic growth of high income countries.

The results show that the research and development (R&D) have significant negative impact on economic growth because the high income countries expenditure on research and development is very high and high income countries are on top of the research so, that after the top its impact now declining. Although the Patent applications (PA) have positive and significant impact on economics growth of high income countries, as the theory proposed by Romer, 1986 & Lucas, 1988. 1% change in patent applications can change 0.208 % on economic growth (GDP) other variables remains constant and 1% R&D can change -0.223 % on economic growth (GDP) other variables remains constant. The Gross capital formation (GCF)have also positive relation with economic growth (GDP) of high income countries as the literature proposed (Chu and Cozzi, 2018). The GCF has significant impact 1% change in GCF can change 0.025 % on GDP, other things remain constant. As results shows that government increase the Physical capital and expenditures in research and development or motivates the people for new innovations by securing their patents rights can flourished the economic growth of that economy.

The Gini coefficient index (GINI) is the proxy of income inequality. The income inequality decrease the economic growth or have negative impact on economic growth (GDP) (Grundler & Scheuermeyer, 2018). In that results GINI have also negative but insignificant effect on economic growth of high income countries because in high income countries there is no income inequality.

In that results population have positive and significant impact on GDP. 1% change in population can change 0.665% in economic growth of high income countries.

Table 5.6.2 Empirical findings of Penal Generalized Method of Moments for Middle Income Countries of 1st Model:

Sr. No.	Variables	Coefficients	Probability
01	Research & Development (R&D)	0.042	0.000*
02	Log of Patent Application (Ln PA)	0.105	0.051
03	Gross Capital Formation (GCF)	0.148	0.012*
04	Gini Coefficient Index (GINI)	-0.025	0.000*
05	Log of Population (Ln Pop)	0.532	0.007*
06	Constant (C)	16.993	0.008
	Number of Observations	201	
	Number of Instruments	08	

Note: * denotes the 5 present level of significance..

The results show that the innovation, research and development (R&D) have significant impact positive impact on economic growth.1 % value change in R&D can change 0.042% in economic growth (GDP) other things remains constant and Patent applications (PA) also have positive and significant impact on economics growth of middle-income countries, as the theory proposed by Romer, 1986 & Lucas, 1988. 1% change in patent applications can change 0.105 % on economic growth (GDP) other variables remains constant. The Gross capital formations (GCF) have also positive relation with economic growth (GDP) of high income countries as the literature proposed (Chu and Cozzi, 2018). The GCF has 99% significant impact, 1% change in GCF can change 0.148 % on GDP, other thing remains constant. As results shows that government increase the Physical capital and expenditures in research and development or motivates the people for new innovations by securing their patents rights can flourished the economic growth of that economy.

The Gini coefficient index (GINI) is the proxy of income inequality. The income inequality can decreased the economic growth or have negative impact on economic growth (GDP) (Grundler & Scheuermeyer, 2018). In that results GINI have also negative and significant effect on economic growth of middle income countries. 1% change in GINI can change 0.025 % on GDP, other things remains constant.

Population (Pop) relation with economic growth (GDP) can be positive or can be negative, because some literature said its impact on economic growth is positive and soma said its negative effect on economic growth. In that results population have positive and significant impact on GDP. 1% change in population can change 0.532 % in economic growth of middle income countries.

Table 5.6.3 Empirical findings of Penal Generalized Method of Moments for Low Income Countries of 1st Model:

Sr. No.	Variables	Coefficients	Probability
01	Research & Development (R&D)	0.284	0.028*
02	Log of Patent Application (Ln PA)	0.216	0.000*
03	Gross Capital Formation (GCF)	0.011	0.033*
04	Gini Coefficient Index (GINI)	-0.114	0.000*
05	Log of Population (Ln Pop)	-0.613	0.237
06	Constant (C)	37.000	0.000
	Number of observations	124	
	Number of Instruments	07	

Note: * denotes the 5 present level of significance.

The results shows that the innovation, research and development (R&D) have significant impact positive impact on economic growth. 1% value change in R&D can change 0.284 % in economic growth (GDP) other things remains constant and Patent applications (PA) also have positive and significant impact on economics growth of high income countries, as the theory proposed by Romer, 1986 & Lucas, 1988. 1% change in patent applications can change 0.216 % on economic growth (GDP) other variables remains constant. The Gross capital formation (GCF) is the proxy of Physical capital have also positive relation with economic growth (GDP) of low income countries as the literature proposed (Chu and Cozzi, 2018). The GCF has 99% significant impact, 1%

change in GCF can change 0.011 % on GDP, and other things remains constant. As results shows that government increase the Physical capital and expenditures in research and development or motivates the people for new innovations by securing their patents rights can flourished the economic growth of that economy.

The Gini coefficient index (GINI) is the proxy of income inequality. The income inequality can decreased the economic growth or have negative impact on economic growth (GDP) (Grundler & Scheuermeyer, 2018). In that results GINI have also negative and significant effect on economic growth of middle income countries. 1% change in GINI can change 0.114% on GDP, other things remains constant.

In that results population have negative and significant impact on GDP. 1% change in population can change -0.613 % in economic growth of low-income countries.

Table 5.6.4 Empirical findings of Penal Generalized Method of Moments for High Income Countries of 2nd Model:

Sr. No.	Variables	Coefficients	Probability
01	Research & Development (R&D)	-0.827	0.001*
02	Constant (C)	40.874	0.000
	Number of observations	138	
	Number of Instruments	02	

Note: * denotes the 5 present level of significance.

The results shows that the innovation, research and development (R&D) have significant impact negative impact on income equality GINI. 1% value change in R&D can change -0.827% in income equality (GINI) other things remain constant.

Table 5.6.5 Empirical findings of Penal Generalized Method of Moments for Middle Income Countries of 2nd Model:

Sr. No.	Variables	Coefficients	Probability
01	Research & Development (R&D)	-0.1257	0.8824
02	Constant (C)	46.0795	0.0000
	Number of observations	224	
	Number of Instruments	02	

Note: * denotes the 5 present level of significance.

The results shows that the innovation, research and development (R&D) have insignificant impact negative impact on income equality GINI. It's insignificant because in middle income countries R&D expenditure is very low and income inequality is high.

Table 5.6.6 Empirical findings of Penal Generalized Method of Moments for Low Income Countries of 2nd Model:

Sr. No.	Variables	Coefficients	Probability
01	Research & Development (R&D)	-0.1192	0.9919
02	Constant (C)	47.1862	0.0222
	Number of observations	135	
	Number of Instruments	02	

Note: * denotes the 5 present level of significance.

The results shows that the innovation, research and development (R&D) have insignificant impact negative impact on income equality GINI. The results is insignificant because in low income countries expenditure in R&D is very low because their GDP size is very small and income inequality in these countries is very high so, that's why their impact is insignificant.

5.7 Sargan Test Results:

Sargan test was developed by Sargan J.D to check the validity of instruments. The validity of instruments is used to check the consistency of GMM estimator. If the instruments are exogenous than they are uncorrelated with error term. The hypothesis o Sargan test is as under:

HO: The instruments are valid.

H1: The instruments are not valid.

5.7.1 Sargan Test Result For High Income Countries:

Sargan = (n-k) R^2	Chi square (r, df)	Sargan = Chi Square	Conclusion
5.70	5.99	5.70 < 5.99	Accept (H0)

The Sargan test value is less than the Chi Square critical value so we accept the null hypothesis which means that the instruments are valid which are used to analyze the original results of high income countries.

5.7.2 Sargan Test Result For Middle Income Countries:

Sargan = (n-k) R^2	Chi square (r, df)	Sargan = Chi Square	Conclusion
7.25	7.81	7.25 < 7.81	Accept (H0)

The Sargan test value is less than the Chi Square critical value so we accept the null hypothesis which means that the instruments are valid which are used to analyze the original results of high income countries.

5.7.3 Sargan Test Result For Low Income Countries:

Sargan = (n-k) R^2	Chi square (r, df)	Sargan = Chi Square	Conclusion
3.94	5.99	3.94 < 5.99	Accept (H0)

The Sargan test value is less than the Chi Square critical value so we accept the null hypothesis which means that the instruments are valid which are used to analyze the original results of high income countries.

Chapter # 6

Conclusion and Recommendations

The concepts of the parameters of economic development and drivers, of course, are critical issues for countries aimed at achieving or sustaining sustainable development and economic growth: innovation (R&D), physical capital and income inequality, GDP, public spending, and so on. We study their effects and threshold levels in this research to achieve sustained growth.

When innovation is considered, increasing income inequality may be a key factor. In this study, we take into account that most of the literature indicates that long-term economic growth is helping to reduce income inequality and that technological developments are impacting long-term economic growth.

The innovation of high income countries contributes 20% in GDP and income inequality reduced 0.09% of GDP. While Innovation of high income countries have 82% impact to improve the income inequality. But in middle income countries innovation have only 4% contributions in GDP and income inequality reduced 2.5% in GDP or innovation of middle income countries have insignificant impact on income inequality, because in middle income countries research and development is very low so its contribution is also low.

In Low income countries research and development have 28% impact on GDP while income inequality reduced 11.5% of GDP. On the other hand innovations have insignificant impact on income inequality.

Only when government spending on research and development is high can the advantages of innovation as driver for socioeconomic growth and sustainable development and for poverty reduction be achieved. It should be noted, however, that Acemoglu and Robinson (2012) argue that innovation (R&D) cannot be adequate if there

are no well-developed institutions. If this strategy of R&D generation were to be reversed, political and economic classes under power would resist innovation. It is also important to note that improvements in technology may be expensive in terms of jobs or resources. In the short term, capital-intensive innovation will make the condition of employees worse. But social security can in the long run be strengthened and better employment generated by considering skill-oriented technological reform. As the authors say, capital intensive innovation has influenced conventional employment in the past but it has produced new jobs and improves the economic situation. On the other hand, if society is against innovation because of fear of job losses, the economy has not changed or taken a long while to grow.

Thus, our findings point, for instance, to economic policy being less favorable to sustainability of growth (they fall below a certain threshold value for achieved economic growth if economic economies specialize in low R&D activities , low human capital levels and/or low-skill intensive activities with a view to full employment), which and this will potentially prove less conducive to sustainable development, which is below a certain economic growth threshold value, and may be placed in a pit of poverty.

In brief, economic growth is based on R&D threshold levels and the income inequality rate.Our results show that the conditions for R&D activities to escape the poverty trap are required. Furthermore, policy action that is wise to achieve spread inequality and can be used to build growth in the long term, as the negative effects of inequality could be so extreme that preventing them eliminates all discouragement from investing in R&D and education or any other negative impact on economic development that income inequality may have.

Future Gap:

The institutional effects on R&D and economic growth should be considered in future study. It is now very difficult in all countries to find data on econometric methods for a long span of institutional variables. Its value must therefore be taken into consideration in the future.

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Appendix

Sr. No.	High Income Countries	Low Income Countries	Low Income Countries
1	Luxembourg	Spain	Bulgaria
2	Switzerland	Cyprus	Turkey
3	Norway	Slovenia	Thailand
4	Macao SAR	Portugal	Serbia
5	Iceland	Czech Republic	Belarus
6	Ireland	Estonia	Azerbaijan
7	United States	Greece	Armenia
8	Singapore	Slovak Republic	Mongolia
9	Denmark	Lithuania	Venezuela, RB
10	Sweden	Latvia	Moldova
11	Netherlands	Uruguay	Ukraine
12	Austria	Hungary	Egypt, Arab Rep.
13	Finland	Panama	India
14	Germany	Poland	Pakistan
15	Hong Kong SAR	Romania	Uzbekistan
16	Belgium	Russian Federation	Kyrgyz Republic
17	Canada	Argentina	Tajikistan
18	France	China	Burkina Faso
19	United Kingdom	Mexico	Madagascar
20	Japan	Brazil	Colombia