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Innovation Policy and Growth - Education, Research & Development, Government Effectiveness and Business Policy

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Abstract

Title: Innovation Policy and Growth - Education, Research & Development, Government Effectiveness and Business Policy Name: Mueid Al Raee Supervisors: Jo Ritzen, Denis de Crombrugghe Year of enrolment: 2013-2014 (Year 1 was Courses and Proposal Development) Expected final date: 2017-2018 (Targeting August/September 2017) Email address: alraee@merit.unu.edu Short abstract: This paper examines the relationship between innovation represented by labour productivity growth in non-traditional sectors and innovation policy for a cross-section of countries. Innovation policy is characterized by investments in tertiary education and research and development as a percentage of Gross Domestic Product (GDP), the freedom in the business environment, as well as the overall government effectiveness. Our results confirm beta-convergence, that is, the economic convergence between richer and poorer countries. We could show a significant positive effect of the interaction between government effectiveness and government expenditures in tertiary education as a percent of GDP on labour productivity growth in non-traditional sectors. Also, a positive relationship between the growth variable and effective research and development expenditures for developing countries was observed. We could not uncover a relationship between other innovation policies and growth. Non-traditional sector labour productivity growth in the oil rich Arabian Gulf countries was observed to be consistently slower than western countries. We were unable to discern the reasons behind this slower growth

and to confirm or reject any dynamics related to the resource curse. Long abstract/Introduction: While discussing education and research and development (R&D) policy in the context of innovation and growth studies there has been a debate whether higher education and R&D expenditures have higher returns for developed countries in comparison to developing countries. An important insight therein is that the question of inefficiencies in the translation of innovation policies to growth is often left unanswered. Consequently, we try to disentangle how innovation policies work keeping in view the interaction with the effectiveness of government. We investigate the factors that contribute to technological stagnation in developed countries and innovation policies that support developing countries in their path towards the frontier. We consider different strategies may be required to sustain innovation in various conditions and also provide a glimpse of the nature of innovation in Arabian Gulf countries, that are characterised by a high share of natural resource rents in the economy. While acknowledging that defining the ideal combination of institutions and policies that are important for innovation is a complex task, we favour a conceptually broad approach to innovation policy. To exploit our framework, we use an indicator that proxies the dependent variable innovation for both developed and developing countries. That is labour productivity growth exclusive of natural resource rents and agricultural value added referred to as labour productivity growth in the following text unless specified otherwise The explanatory variables of innovation policy for education and research and development are constructed by interacting expenditures with the effectiveness of government. Our identification strategy comprises five-year labour productivity growth rates regressed as a function of initial labour productivity, relevant innovation policy variables lagged by five years, control variables and dummy variables. The results confirm the convergence effect between countries that has been widely discussed in the literature (Barro, 1991; Barro, 2012). The importance of the government effectiveness, tertiary education expenditures and R&D expenditures is uncovered in the results in global settings as well as in the case of developed and developing countries. Finally, we glance over the relationship between the state of innovation in the Arabian Gulf countries and its relationship with fluctuating oil prices. Novelty/Originality: We provide novel evidence of the importance of considering the interaction of innovation policies and the environment that they are promulgated. Most importantly we find that the labour productivity growth effects of expenditures in tertiary education and research and development are dependent on the interaction with sound governance. Results: There is significant and positive relationship between the interaction of government effectiveness with government expenditure in tertiary education as a percent of GDP and labour productivity excluding natural resource and agricultural rents. We also find effective research and development expenditures in developing countries to have positive influence on innovation. Finally, we observe that the Arabian Gulf countries experience lower labour productivity growth in non-traditional sector as the oil prices increase. Key References: Aghion, P., Boustan, L. P., Hoxby, C. M. & Vandenbussche, J., 2009. The Causal Impact of Education on Economic Growth: Evidence from U.S.. Washington, D.C., Brookings Papers on Economic Activity. Barro, R. J., 1991. Economic Growth in a Cross-Section of Countries. Quarterly Journal of Economics, 106(2), pp. 407-443. Barro, R. J., 2012. Convergence and Modernization Revisited. NBER Working Paper Series, p. Working Paper Number 18295. Djankov, S., McLiesh, C. & Ramalho, R., 2006. Regulation and Growth. Economic Letters, 92(3), pp. 301-462. Freeman, C., 2002. Continental, national and sub-national innovation systems—complementarity and economic growth. Research Policy, 31(2), pp. 191-211. Hall, B. H., Mairesse, J. & Mohnen, P., 2010. Chapter 24 – Measuring the Returns to R&D. In: B. H. Hall & N. Rosenberg, eds. Handbook of the Economics of Innovation. Amsterdam: North-Holland (imprint of Elsevier), pp. 1033-1082. Jalilian, H., Kirkpatrick, C. & Parker, D., 2007. The Impact of Regulation on Economic Growth in Developing Countries: A Cross-Country Analysis. World Development, 35(1), pp. 87-103. Keller, K. R. I., 2006. Education Expansion, Expenditures per Student. Global Economic Review, XXXV(1), pp. 21-42. Loayza, N. V., Oviedo, A. M. & Servén, L., 2005. Regulation and Macroeconomic Performance. World Bank Policy Research Working Papers, The World Bank(Washington D.C.), p. Number 3469. Lundvall, B.-Å., 2007. Innovation System Research and Policy: Where it came from and where it might go. Oslo, The Centre for Advanced Study (CAS) at the Norwegian Academy of Science and Letters.

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Innovation Policy and Growth

Education, Research & Development, Government Effectiveness and Business Policy

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Abstract

This paper examines the relationship between innovation represented by labour productivity growth in non-traditional sectors and innovation policy for a cross-section of countries. Innovation policy is characterized by investments in tertiary education and research and development as a percentage of Gross Domestic Product (GDP), the freedom in the business environment, as well as the overall government effectiveness. Our results confirm beta-convergence, that is, the economic convergence between richer and poorer countries. We could show a significant positive effect of the interaction between government effectiveness and government expenditures in tertiary education as a percent of GDP on labour productivity growth in non-traditional sectors. Also, a positive relationship between the growth variable and effective research and development expenditures for developing countries was observed. We could not uncover a relationship between other innovation policies and growth. Non-traditional sector labour productivity growth in the oil rich Arabian Gulf countries was observed to be consistently slower than western countries. We were unable to discern the reasons behind this slower growth and to confirm or reject any dynamics related to the resource curse.

Keywords: Innovation policy, growth, technological change, developing countries, Arabian Gulf countries

Contents

1. Introduction

In this work we analyse how individual innovation policies and their interactions influence innovation globally, in developed and developing countries[i]. Growth literature moving beyond capital and labour introduces knowledge, technological change, and innovation as drivers of growth[1]. It discusses healthy institutions as necessary for technological change, and points towards innovation policy in order to nurture the institutions that promote knowledge production and technological progress. The lumping together of the factors that contribute to human capital, physical capital, and institutional capabilities has been considered as a common deficit in the literature and a need for deeper enquiry into the importance of complementarities in policies that go into affecting activities, capabilities and institutional arrangements has been emphasized (Easterly & Levine, 2001; Freeman, 2002; Aghion, et al., 2009).

While discussing education and research and development (R&D) policy in the context of innovation and growth studies there has been a debate whether higher education and R&D expenditures have higher returns for developed countries in comparison to developing countries. An important insight therein is that the question of inefficiencies in the translation of innovation policies to growth is often left unanswered. Consequently, we try to disentangle how innovation policies work keeping in view the interaction with the effectiveness of government.

We investigate the factors that contribute to technological stagnation in developed countries and innovation policies that support developing countries in their path towards

[1] Solow's works, and studies by Denison, showed that something other than labour and capital was responsible for increasing growth rates in the US (Solow, 1957; Denison, 1963). Romer (1986) incorporated technology as an endogenous factor in constructing a model of increasing returns of technology and knowledge for long-run growth. Nelson and Winter's (1982) work on the evolutionary approach views the free market economic structure as continuously evolving with emphasis on the influence of institutions on economic activity.

the frontier. We consider different strategies may be required to sustain innovation in various conditions and also provide a glimpse of the nature of innovation in Arabian Gulf countries, that are characterised by a high share of natural resource rents in the economy.

While acknowledging that defining the ideal combination of institutions and policies that are important for innovation is a complex task, we favour a conceptually broad approach to innovation policy. To exploit our framework, we use an indicator that proxies the dependent variable innovation for both developed and developing countries. That is labour productivity growth exclusive of natural resource rents and agricultural value added[ii] referred to as labour productivity growth in the following text unless specified otherwise The explanatory variables of innovation policy for education and research and development are constructed by interacting expenditures with the effectiveness of government. Our identification strategy comprises five-year labour productivity growth rates regressed as a function of initial labour productivity, relevant innovation policy variables lagged by five years, control variables and dummy variables.

The results confirm the convergence effect between countries that has been widely discussed in the literature (Barro, 1991; Barro, 2012). The importance of the government effectiveness, tertiary education expenditures and R&D expenditures is uncovered in the results in global settings as well as in the case of developed and developing countries. Finally, we glance over the relationship between the state of innovation in the Arabian Gulf countries and its relationship with fluctuating oil prices.

The literature focussing on growth impact of innovation polices related to education, R&D, business and governance is discussed in Section 2. Our identification strategy is drawn out in Section 3. The data for indicators accordingly selected and constructed are presented in Section 4. Outcomes and discussions related to the effect of innovation policies in the global context, as well as for developed and developing countries are

presented and discussed in Section 5 and 6. Finally, we discuss the policy implications of the results, and present our concluding remarks in Section 7.

2. Innovation policies and the path towards successful innovation based growth

The innovation literature is distributed between "narrow" and "broad" focus on policies. In the "narrow" sense only formal R&D systems and organizations systematically active in knowledge generation and diffusion are the focus. An example of application of the systems of innovation framework in the former sense is World Bank Knowledge Assessment Methodology (Chen & Dahlman, 2005). It is argued that discussing systems of innovation in a narrow sense "leaves significant elements of innovation-based economic performance unexplained" (Lundvall, 2007). In the "broad" sense the core knowledge producing and disseminating institutions are embedded in a wider socio-economic system and the relative success of innovation policies is a function of influences and linkages beyond these core institutions (Freeman, 2002). Among the works that discuss new-to-the-world innovation in the latter sense Furman, Porter and Stern (2002) integrate ideas-driven growth theory, microeconomics-based models of national competitiveness and industrial clusters theory and considers R&D manpower, knowledge and technology base as important sources of innovation, and Archibugi & Coco (2004) define innovation system through patents, publications, ICT, electricity consumption, and education.

Aghion et. al (2009) set out to estimate plausible causality of the effect of education on growth, using actual measures of investment in education. While raising doubts whether instrumenting lagged spending overcomes biases caused by omitted variable such as institutions especially in the case of small low variation data (Vandenbussch, et al., 2004) they show that there are positive effects of exogenous increase in education expenditure related to four years' tertiary education in U.S. states close to the world frontier (Aghion, et al., 2009). Krueger and Lindahl (2001) find societal returns to schooling in terms of

increased growth in cross-country analysis; in particular the relationship is statistically significant and positively associated with subsequent growth for countries with the lowest level of initial education.

Faster growing countries in Asia have had higher expenditures on primary education, while secondary and tertiary education investment not having positive significant results consistently is suggested to be due to inefficiencies in resource allocation (Keller, 2006). In other studies, government expenditures on education relate positively to growth in developing countries even when accounting for government budget constraints (Bose, et al., 2007). All in all, a substantial publication selection bias towards a positive impact of education on growth, a variation in estimated coefficients due to type of education variable used, and as such an absence of a representative authentic growth effect of education is observed in the literature (Benos & Zotou, 2014). The growth variable itself does not impact the variations in the growth effect of education and the inclusion of other policy variables in the studies such as openness, public spending, and health variables implies a lower estimated impact of education on growth (Benos & Zotou, 2014). We follow from this the importance of considering a framework that considers education as set within "broad" policies for innovation based growth.

Loayza, et al. (2005) find that heavier regulatory burden reduces growth and volatility and that these effects are reduced in higher quality of overall institutional framework. In a simple model Djankov et. al (2006) observe the effect of business regulations as represented by the doing business indicators while considering the effect of initial level of growth, and control variables and other determinants of growth that include corruption, law and order, political system, primary and secondary school enrolment, and civil conflict. Whereas they find that going from the worst to the best quartile of business regulation shows a 2.3 percentage increase in annual growth rate, they also observe that the effects of improvement in primary and secondary education from worse to better

quartiles of policy or output are significantly lower than the effects of business regulation on growth rate. Hanusch (2012) suggest based on evidence that regulations related to credit, contract enforcement, costs, time, starting a business, registering property, and protection of investors within realm of business policies are statistically significantly related to economic growth.

Griffith and team (2004) find that R&D as represented by BERD is statistically and economically important in the catch up process as well as for stimulating innovation directly and suggest that the social rate of return of R&D has been underestimated in the literature as many studies only focus on the United States. A look into cross-country labour productivity differences due to investment in R&D reveals that R&D investment has significant positive impact on productivity (Lichtenberg, 1993). Nadiri and Kim (1996) find rates of returns of domestic R&D expenditures to be in the range of 14 to 16% and adding the effect of spill-overs of international R&D spending for 6 advanced economies showed the returns to be 23 to 26% varying amongst the countries. Hall, Mairesse, and Mohnen (2010) in their review of the econometric literature measuring the private and social returns to R&D find that the literature identifies private returns to R&D as strongly positive, social returns to be even greater and that most estimates for public-funded R&D are found to be less productive in terms of private returns. In many research avenues the incentives to invest in R&D is determined on the basis of private returns and not social returns. As such it may be that developing countries are not able to achieve maximum potential in R&D due to inappropriate social policies (Griffith, et al., 2004).

Jalilian, Kirkpatrick and Parker (2007) find that there is strong causal link between government regulation, regulatory quality indices, and economic performance. Other cross-sectional studies also report causal effects of governance on long run income per capita, using instrumental variables (Kaufmann & Kraay, 2002). Also the mechanism behind this causal link has been examined and one path through which government

effectiveness improves economic performance is by creating a better investment environment (Kirkpatrick, et al., 2006). It can be deliberated further that government effectiveness translates into high economic growth not only through the path of providing a good investment environment but also by creating good environment for innovation policies to be effective.

The common theme that emerges from the literature is that innovation policies work in coherence with each other and have a combined and complementary effect on growth measure. The translation of policy to growth has to go through the governments' ability to effectively turn inputs of policy into growth.

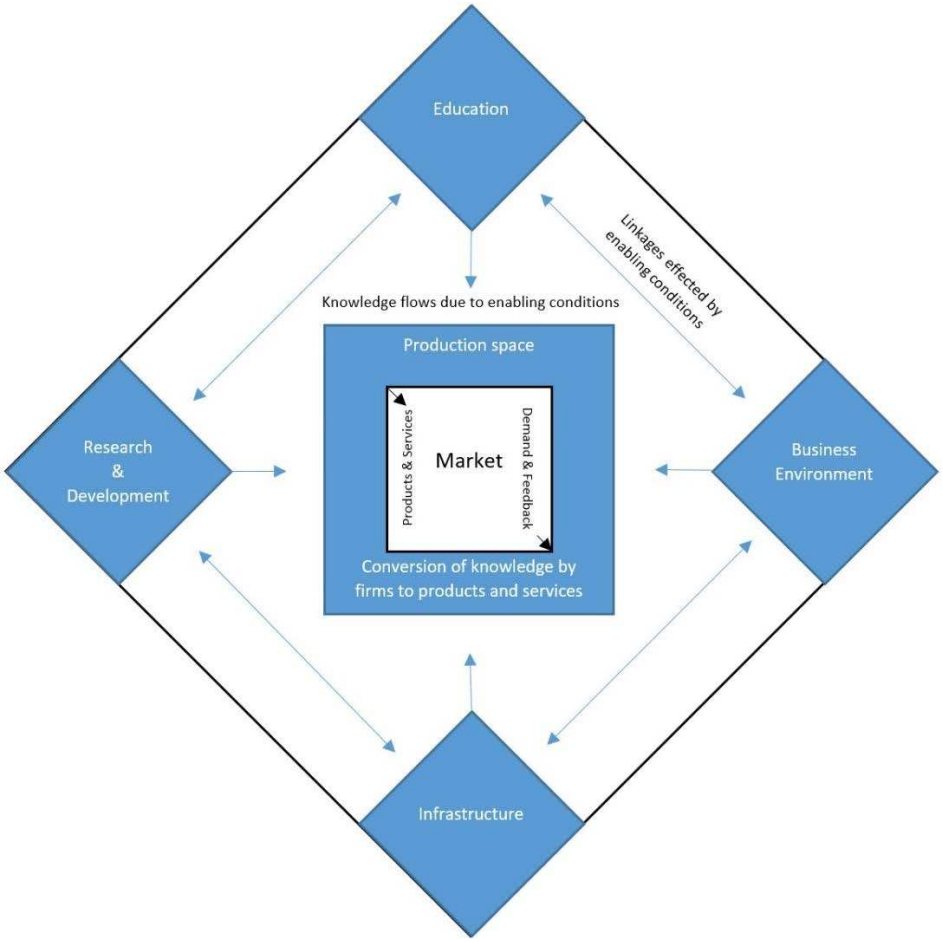

Figure 1 – Innovation Policy Framework Conditions

Figure 1 above represents our interpretation of how the flows of knowledge enable growth in innovation through increase in productivity in an economy. The innovation eco-system is thus arranged into conditions, linkages, the firms and the market itself. The change in state of these conditions is determined through natural transformation and policy. The education condition is affected by government policies as government financing of the tertiary education system, policies determining graduate ratios in science and technology fields, alignment to labour demand from market, university autonomy, and others. Similarly, research and development conditions are impacted by government expenditure on research and development, type of research grants, targeted scientific field grants, competitiveness of grants, intellectual property regime, and private sector research funding, and so forth. Business conditions are related to industrial policies, competition policy, entrepreneurship policy, taxation policy, financial policy, health of financial sector, availability of finance, and market access for firms that create new products or services. Infrastructure conditions include availability of ICTs, Transport, Energy, Standard-Setting, Metrology, Security, etcetera. Finally, it is considered that without efficient and effective linkages the production of knowledge as well as transfer of knowledge for creation of new products and services would be hampered. For innovation to thrive in the production space it is important that the innovation environment conditions are healthy, governed by sound policy, with effective linkages across various conditions as well as the production space and consequently the market that would consume the innovations and drive the productivity growth.

3. Identification Strategy

For understanding innovation based growth through the framework outlined in Figure 1 above our approach focusses on factors that can be actively influenced by policy. The empirical hypothesis that translates our question about how individual innovation policies and their interactions influence innovation globally, in developed and developing countries is that innovation based growth or labour productivity growth in the modern sector is a function of innovation policy and the effectiveness of innovation policy.

We propose that the intial level of labour productivity, interaction of government effectiveness with educational expenditures, and research and development respectively, and facilitative business environment in the countries are important drivers of innovation. In order to estimate this we run an Ordinary Least Squares regression with exogenous variation in explanatory variables of policy.

The dependent variable is defined as the natural log of the ratio of final to initial labour productivty, where final labour prodctivity is taken to be five years after the initial measure. The explanatory variables are lagged by 5 year. A three years average from the initial year is used to smoothen out one-off effects for the countries. The explanatory variables thus included in the estimation are the natural logartihm of initial labour productivity lagged five years, interaction of government effectiveness and government expenditures in tertiary education as a percentage of GDP lagged five years - hereon refered to as effective tertiary education expenditures, interaction of government effectiveness and gross expenditures on research and development percent GDP lagged five years - here on refered to as effective R&D expenditures and index of economic freedom lagged five years. Innovation is a medium to long term phenomenon and innovation policies typically take long time to bare fruit. Using lagged variable accomodates for long term nature of innovation and also provides a way to exclude reverse causality.

Literature provides evidence that intial level of labour productivity is a determinant of growth as such we account for initial level of labour productivity in the estimation equation (Barro, 1991). Also, initial level of education has an impact on how innovation policies influence the role of tertiary education expenditures on innovation itself (Keller, 2006). Natural resource and agricultural endowment is also influences the growth path of a country (Lederman & Maloney, 2007). Finally a country's regional situation influences its growth trajectory as well. We introduce regional dummies, educational attainment in terms of years of education from primary to tertiary level, natural resource rents as a percent of GDP, and agricultural value added as a percent of GDP as additonal control variables.

The estimation equation thus takes the form;

$$\Delta_{tN\text{-}t1}\ln(\text{labprod}) = \alpha_0 + \beta_o \bullet \text{labprod}_{t1} + \beta_1 \bullet \text{goveff}_{t1} \bullet \text{edu}_{t1} + \beta_2 \bullet \text{goveff}_{t1} \bullet \text{r\&d}_{t1} + \beta_3 \bullet \text{ioef}_{t1} + \text{natresrents}_{t1} + \text{agrirents}_{t1} + \text{eduattain}_{t1} + \text{regional dummies} + \hat{\epsilon} \quad \text{Equation 1}$$

Table 1 – Variable Definitions

Variable	Definition
$\Delta_{tN\text{-}t1}$ ln(labprod) Log Productivity Growth	Natural log of the ratio of final to initial labour productivity
labprod $_{t1}$ Initial Productivity	Natural log of initial labour productivity
goveff • edu Effective Tertiary Education	Interaction of government effectiveness and government expenditures on tertiary education as a percent of GDP - initial
goveff • r&d Effective R&D	Interaction of government effectiveness and gross expenditures on research and development as a percent of GDP - initial
ioef IOEF	Index of economic freedom - initial
natresrents Natural Resource Rents	Natural resource rents as a percentage of GDP - initial
agrirents Agricultural Value Added	Agricultural value added as a percentage of GDP - initial
eduattain Educational Attainment	Number of years of schooling from primary to tertiary level - initial

Note: The subscript "t1" in Equation 1 and the reference "initial" in Equation 1Table 1 specifies the magnitude of the variable during the initial year(s) considered. The subscript "tN" in Equation 1 and the reference "final" in Equation 1Table 1 specifies the final year. As such the change in growth is considered between t1 and tN. In our work this period of growth is 5 years and the policy variables are lagged by 5 years from the final year for which a five-year growth rate is considered.

In addition, we evaluate the same equation for labour productivity growth including natural resource rents and agricultural value added. This helps us identify differences in the influence of innovation policies on pure innovation based growth versus mixed innovation and traditional sector[iii] growth and confirm the robustness of our results. We also estimate the model for developed and developing country groups separately to understand the differences in the influence of innovation policies and analyse the need of varying policies for both groups. The 15 year data from 1998 to 2013 data is regressed in three groups of five years. The results for each period is observed to understand period specific differences. These period specific difference are controlled for through a period dummy in the pooled dataset regression that is aimed at generating larger data set leading to significant and robust coefficients.

4. Data

The indicators used include government expenditure on tertiary education as a percent of GDP, gross expenditure on research and development as a percent of GDP, index of economic freedom and government effectiveness from world governance indicators. Country dummies are assorted into groups based on geographical criteria. In addition to initial labour productivity, initial educational attainment represented by years of education from primary to tertiary level, share of natural resource rents, and share of agricultural value added are used as control variables.

Labour Productivity is calculated in terms of real GDP per labour force. The labour productivity indicator is constructed by using the GDP from World Bank Development Indicators (The World Bank, 2014) and number of employees' data from Penn Worlds Table Version 8.1 (Feenstra, et al., 2015). The use of Purchasing Power Parity (PPP) GDP[iv] ensures that the data is comparable across time and countries in level and growth rate. We exclude natural resource rents and agricultural value added for the growth measure. Literature suggests that innovation based growth is less likely to reflect in

traditional industries such as those in natural resource and agricultural sectors (Becheikh, et al., 2006). The indicator for total natural resource rents as a percentage of GDP is represented by the total natural resource rents percent of GDP indicator defined as the sum of oil rents, natural gas rents, coal rents, mineral rents, and forest rents[v] (The World Bank, 2014). Agriculture in Agricultural value added corresponds to International Standard Industrial Classification (ISIC) divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production.

The education policy in this work is represented by government expenditure on tertiary education as a percentage of GDP. Tertiary education is considered as most important and direct contributor to innovation. When interpreting this indicator however, we should keep in mind in some countries, the private sector and/or households may fund a higher proportion of total funding for education, thus making government expenditure appear lower than in other countries.

Gross domestic expenditure on research and development or R&D (GERD) as a percentage of GDP is the total intramural expenditure on R&D performed in a national territory or region during a given year, expressed as a percentage of GDP of the national territory or region (UNESCO Institute of Statistics, 2015). The data is used as an indication of research and development policy. The ideal case would be to use GovERD that is government expenditure in research and development as a percentage of GDP. We use the GERD measure because it captures wider geographical and time space and is a good representative on what similar higher expenditures can achieve.

We use the Index of Economic Freedom as an indicator of government policy toward business. The Index of Economic Freedom is an annual index and ranking created by The Heritage Foundation and The Wall Street Journal in 1995 to measure the degree of economic freedom in the world's nations (The Heritage Foundation & The Wall Street Journal, 2016). The creators of the index took an approach similar to Adam Smith's in

The Wealth of Nations, that "basic institutions that protect the liberty of individuals to pursue their own economic interests result in greater prosperity for the larger society". The index of economic freedom is based is on ten quantitative and qualitative factors; property rights, freedom from corruption, fiscal freedom, government spending, business freedom, labor freedom, monetary freedom, trade freedom, investment freedom, and financial freedom. Each of the ten economic freedoms within these categories is graded on a scale of 0 to 100. A country's overall score is derived by averaging these ten economic freedoms, with equal weight being given to each.

It would have been ideal to use Ease of Doing Business data from the World Bank Doing Business Indicators. The ten constitutive measures used in the composite ease of doing business indicator are, starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency (The World Bank, 2015). As such ease of doing business accounts for objective as well as subjective measures that are directly related to business policy in the country. However, due to limited time period availability we resort to using the Index of Economic Freedom that relates to business environment in a relative bird-eye manner.

Finally, among indicators used for construction of explanatory variables government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. (The World Bank, 2015). It is notable that the indicator is a mix of quality and perception of infrastructure, bureaucratic, state, and policy stability. As such is used as a measure of expected effectiveness of innovation policies as related to the enabling condition that effect linkages amongst various policy conditions and knowledge flow necessary for innovation *(See Figure 1 – Innovation Policy Framework Conditions)*.

Governance is difficult to account for using any kind of measure. As such we find it important to touch up on the topic of the selection of Government Effectiveness as an interaction term for the policy measures of expenditures in tertiary education and research and development in more detail. The representative sources for constructing this indicator include quality of bureaucracy, institutional effectiveness, excessive bureaucracy or red tape, infrastructure, quality of primary education, satisfaction with public transportation system, satisfaction with roads and highways, satisfaction with education system, basic health services, drinking water and sanitation, electricity grid, transport infrastructure, maintenance and waste disposal, infrastructure disruption, state failure, and policy instability. The composite is constricted from weighted average of the individual indicators obtain through an Unobserved Components Model (UCM). The UCM assigns greater weight to data sources that tend to be more strongly correlated with each other. This weighting improves the statistical precision of the aggregate indicators, and typically does not affect very much the ranking of countries on the aggregate indicators. There are two rationales for using Government Effectiveness. First it is indicative of the governments' ability to implement their policies and as such the interactive term represents the efficiency of each dollar spent. Second, the interaction of Government Effectiveness with the expenditures can be looked at with much simpler view that is of representing the policies as related to the governance environment. Both explanations relate well to the definition of Government Effectiveness indicator and its use in the context of this paper and the framework represented graphically in Figure 1.

Table 2 - Summary Statistics

Variable	Countries	Years	Mean	Std Dev	Min	Max
$\Delta_{yN\text{-}y1}$ ln(labprod) Log Productivity Growth	150	1998-2013	0.55914	0.36419	-0.45232	1.54076
$labprod_{y1}$ Log Initial Productivity	157	1998-2013	9.61430	1.18327	6.88386	12.08405
goveff.edu Effective Tertiary Education	164	1998-2013	0.48310	0.42726	0.02356	2.19834
goveff.r&d Effective R&D	129	1998-2013	0.48488	0.71567	0.00331	3.42706
ioef IOEF	177	1998-2013	57.74	12.19	8.9	89.06
natresrents Natural Resource Rents	187	1998-2013	6.29	10.56	0	86.17
agrirents Agricultural Value Added	164	1998-2013	16.83	14.51	0	61.80
eduattain Educational Attainment	182	1998-2013	11.79	3.21	3.1	20.23

The indicator constructed to represent innovation based growth that is our variable of interest is the natural log of the ratio of final to initial labour productivity excluding natural resource rents and agricultural value added. It has a mean of 0.56 with a standard deviation of 0.36. The natural log of initial labour productivity in our dataset has a mean of 9.61 and a standard deviation of 1.18. As discussed previously, the variable effective government expenditures on tertiary education is constructed by interacting the index of government effectiveness with the government expenditures on tertiary education as a percent of GDP. The same approach is taken to construct the variable effective GERD as a percent of GDP. The prefix effective signifies an interaction with measure of government effectiveness. Effective expenditure is obtained by the interaction of the measure of government effectiveness that runs from 0 to 1 by actual percent expenditures per GDP in the relevant policy areas. As such government effectiveness is translated as the percentage of effectiveness of each dollar spent or simply the interaction of the governance environment with the policy measures. The variable related to effective tertiary education

expenditures and effective research and development expenditures have similar means of 0.48% however the standard deviation is 0.42 and 0.72 respectively.

The Index of Economic Freedom ranges from 8.9 at its minimum to 89.06 at its maximum level. It is noteworthy that the number of countries for which these data points are available varies from 129 for effective GERD percent GDP to 177 for index of economic freedom for the year between 1998 to 2013. However, in our regression between 95 to 106 countries are represented depending on the time period and extent of the data available. The correlation coefficient of effective tertiary education expenditures and effective tertiary education expenditures is 0.57. The same for IOEF with effective tertiary education expenditures is 0.47 and with effective research and development expenditures is 0.51. The pairwise correlation between our explanatory variables of concern is considered moderate and is not expected have effect on the coefficients of the estimation. In order to make sure that this is the case we also regress excluding two of the explanatory variables and compare the results with the original estimation.

5. Results

Here we present the observed influences of the explanatory variables of concern, on the dependent variable i.e. labour productivity growth excluding natural resource and agricultural rents. Second, we present the result for developed and developing countries. Finally, we glance at how labour productivity growth for the Arabian Gulf countries compares with western countries.

Table 3 – Labour Productivity Growth and Policy Variables

Dependent Variable	**Log Productivity Growth (Net of natural resource rents and agricultural value added)**					
	Period 1	Period 2	Period 3	Pooled	Pooled	Pooled
	1998-2003	2003-2008	2008-2013	Period 1 & 2	Period 2 & 3	Period 1, 2 & 3
Log Initial Productivity	-0.111***	-0.051	0.039	-0.075***	-0.022	-0.045**
	(0.038)	(0.037)	(0.028)	(0.025)	(0.027)	(0.021)
Effective Tertiary Education	0.024	0.035	0.041*	0.029	0.048*	0.041*
	(0.040)	(0.041)	(0.023)	(0.028)	(0.025)	(0.021)
Effective R&D	-0.005	-0.037	-0.01	-0.023	-0.022	-0.018
	(0.029)	(0.030)	(0.019)	(0.020)	(0.020)	(0.016)
IOEF	0.003	0	-0.003	0.002	-0.002	-0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Arabian Gulf Dummy	-0.118	-0.268**	-0.148	-0.215**	-0.278***	-0.269***
	(0.142)	(0.125)	(0.114)	(0.087)	(0.097)	(0.078)
Period 1				-0.068***		0.103***
				(0.017)		(0.019)
Period 2					0.149***	0.147***
					(0.018)	(0.017)
R-squared	0.402	0.401	0.072	0.423	0.384	0.418
N	95	101	105	196	206	301
*** p<0.10, ** p<0.05, *** p<0.01**						

Note: Regional dummies, educational attainment, natural resource rents, and agricultural value added included as control variables

The first result that is observed in Table 3Table 3 above is that of the beta-convergence. We observe that the initial labour productivity is negatively and statistically significantly correlated to labour productivity growth for pooled data from multiple periods. An increase of 1% in the country's initial labour productivity results in the ratio of final to

initial labour productivity to be lower by 0.045%. Countries with relatively lower labour productivity are able to grow faster and hence converge to the frontier. We observe that effective expenditures on tertiary education as a percent of GDP have a positive relationship in all periods with the explanatory variables. The pooled data for the three periods shows that there is a statistically significant positive relationship between effective tertiary education spending as a percent of GDP of the country and labour productivity growth. In this case the magnitude of increase is considerable i.e. an increase of 1 percent in average effective tertiary education expenditure as a percentage of GDP would result in an increase of 4.2 % in labour productivity growth. To simplify, a country effectively investing 1 % of their GDP in tertiary education will improve their growth rate by 4.2% if they invest an equivalent of 2% of their GDP in tertiary education. Since this variable is represented by an interaction of government effectiveness and tertiary education expenditure as a percent of GDP it is useful to break down this result. A hypothetical country with 1% effective expenditure on tertiary education as a percent of GDP driven by 0.45 government effectiveness, investing 2.2 % of GDP as tertiary education expenditure and having an annual growth rate of 3 percent can improve its growth rate to 3.13 % (that is an increase by 4.2%) by increasing its effective expenditure to 2% that could be accomplished either by improving government effectiveness to 0.9 or tertiary education expenditure as a percent of GDP to 4.4 %.

We do not observe positive results for effective R&D expenditure percent of GDP for the complete set of countries. We observe no statistically significant results Index of Economic freedom. The magnitudes are small and the pooled data for the three periods show inconsistent correlation for the business policy and labour productivity growth. The signs of the coefficients for effective tertiary education, effective R&D and IOEF do not vary and the magnitudes do not vary by considerable extent when included individually in the estimation, that is, while excluding the remaining two explanatory policy variables. This

confirms that the moderate pairwise correlation for our explanatory variables discussed in Section 4 has no influence on the final results.

The following table shows discrete results for developed and developing countries. It provides a unique perspective into differences in innovation policy requirement for developing countries in contrast with developed countries.

Table 4 – Labour Productivity Growth and Policy Variables – High Income OECD and Developing Countries Separately

Dependent Variable	Log Productivity Growth Developed Countries			Log Productivity Growth Developing Countries		
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
	Period 1 & 2	Period 2 & 3	Period 1, 2 & 3	Period 1 & 2	Period 2 & 3	Period 1, 2 & 3
Log Initial Productivity	-0.001	0.057	0.032	-0.076**	-0.024	-0.043*
	(0.088)	(0.083)	(0.066)	(0.030)	(0.033)	(0.026)
Effective Tertiary Education	0.022	0.023	0.020	0.024	0.038	0.036
	(0.038)	(0.035)	(0.028)	(0.041)	(0.033)	(0.028)
Effective R&D	-0.006	-0.009	-0.009	0.164	0.165*	0.166*
	(0.020)	(0.019)	(0.015)	(0.103)	(0.097)	(0.079)
IOEF	-0.002	0.002	0	0.002	-0.004	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
R-squared	0.172	0.632	0.491	0.349	0.326	0.321
N	44	45	67	127	135	196
*** p<0.10, ** p<0.05, *** p<0.01,**						

Note: Regional dummies, time dummies, educational attainment, natural resource rents, and agricultural value added included as control variables

We can observe for developing countries in Table 4 that both effective tertiary educational expenditures and effective research and development expenditures have a positive effect on labour productivity growth for developing countries[2]. The relationship between effective R&D expenditures as a percent of GDP and labour productivity growth is statistically significant. An increase of 1 % in effective R&D expenditures as a percent of

[2] Note that when resource and agricultural dependency dummies are used instead of actual resource rents and agricultural value added the pooled data for three periods shows significant results at 90% for both effective tertiary education and R&D expenditures.

GDP in developing countries would result in an increase in the labour productivity growth rate to increase by 27.5 % for pooled data of periods 1, 2 and 3. This result is consistent with Nadiri and Kim (1996) who find the rate of return for domestic R&D spending to be between 23% and 26% varying amongst different countries. The breakdown of government effectiveness and R&D expenditures can be explained in similar terms as effective education expenditures as a percent of GDP. A hypothetical country with 1% effective expenditure on research and development as a percent of GDP driven by 0.45 government effectiveness, investing 2.2 % of GDP as research and development expenditure and having an annual growth rate of 3 percent can improve its growth rate to 3.825 % (that is an increase by 27.5%) by increasing its effective expenditure to 2% that could be accomplish either through improving government effectiveness to 0.9 or research and development expenditure as a percent of GDP to 4.4 %. As in the case of the regression where all countries are included, we find that the signs of the coefficients for effective tertiary education, effective R&D and IOEF do not vary and the magnitudes do not vary by considerable extent when included individually in the estimation. This confirms that the moderate pairwise correlation for our explanatory variables discussed in Section 4 has no influence on the final results in the case where the regression is carried out for developed and developing countries separately. We observed that including all the explanatory variable resulted in slightly lower magnitudes of the coefficients than if only one of the explanatory variables of policy was included at a time.

In robustness tests we find that, including the natural resource rents and agricultural value added in the regression equation instead of resource dependency dummy does not change the results to any considerable extent. The exclusion of the educational attainment represented by average years of schooling also does not affect the results. Finally, we would like to discuss causality. In our work we have accounted for initial economic state of the country, initial level of educational attainment in the country region specific differences, and time period specific differences. Also, the labour productivity growth

variable is lagged by a period of five years in order to exclude the possibility of reverse causality. As such we can assume plausible causality in the case where we observe statistically significant relationships. As such it is plausible that an interaction of higher government effectiveness and higher investment in tertiary education as a percent of GDP leads to higher labour productivity growth excluding natural resource and agricultural rents that acts as a proxy of innovation.

Arabian Gulf countries - A special case?

We also present notable results for Arabian Gulf country dummies in contrast to the reference region Western Europe and Nordic countries in Table 5 below and compare them to those already seen in Table 3 above. We observe much lower growth in labour productivity in non-traditional[iii] sector in comparison with the reference group. With rising oil prices from 2003 onwards the majority of the growth in Arabian Gulf economies was based on resource rents. We observe in Table 5 below that the same regression without excluding natural resource and agricultural rents results in diminished statistical significance for the Arabian Gulf countries' dummy variable.

Table 5 – Total Labour Productivity Growth and Policy Variables

Dependent Variable	**Log Productivity Growth (Inclusive of natural resource rents and agricultural value added)**					
	Period 1	Period 2	Period 3	Pooled	Pooled	Pooled
	1998-2003	2003-2008	2008-2013	Period 1 & 2	Period 2 & 3	Period 1, 2 & 3
Log Initial Productivity	-0.084***	-0.053**	0.009	-0.074***	-0.041	-0.065***
	(0.026)	(0.026)	(0.022)	(0.018)	(0.027)	(0.020)
Effective Tertiary Education	0.013	0.036	0.011	0.022	0.013	0.007
	(0.028)	(0.029)	(0.018)	(0.020)	(0.025)	(0.020)
Effective R&D	-0.014	-0.050**	-0.006	-0.030**	-0.027	-0.019
	(0.020)	(0.021)	(0.015)	(0.015)	(0.020)	(0.016)
IOEF	0.001	-0.002	-0.001	-0.001	-0.003	-0.002*
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Arabian Gulf Dummy	-0.098	-0.164*	-0.08	-0.112*	-0.081	-0.065
	(0.098)	(0.088)	(0.092)	(0.064)	(0.097)	(0.074)
R-squared	0.402	0.401	0.072	0.423	0.384	0.418
N	95	101	105	196	206	301
*** p<0.10, ** p<0.05, *** p<0.01**						

Note: Regional dummies, time dummies, educational attainment, natural resource rents, and agricultural value added included as control variables

The result indicates that the growth in non-natural resource sector has been slower in comparison with the reference group. This effect is also shown in the figure below. Here two Arabian Gulf countries and two from the reference group are compared. It is observed

that lower non-traditional sector labour productivity growth in the Arabian Gulf countries Oman and Saudi Arabia is associated with higher oil prices and vice versa but not for the two countries from the reference group Norway and Netherlands. This provides confirmation that the representation of the non-traditional sector in labour productivity growth of the Arabian Gulf countries is partly driven by oil prices.

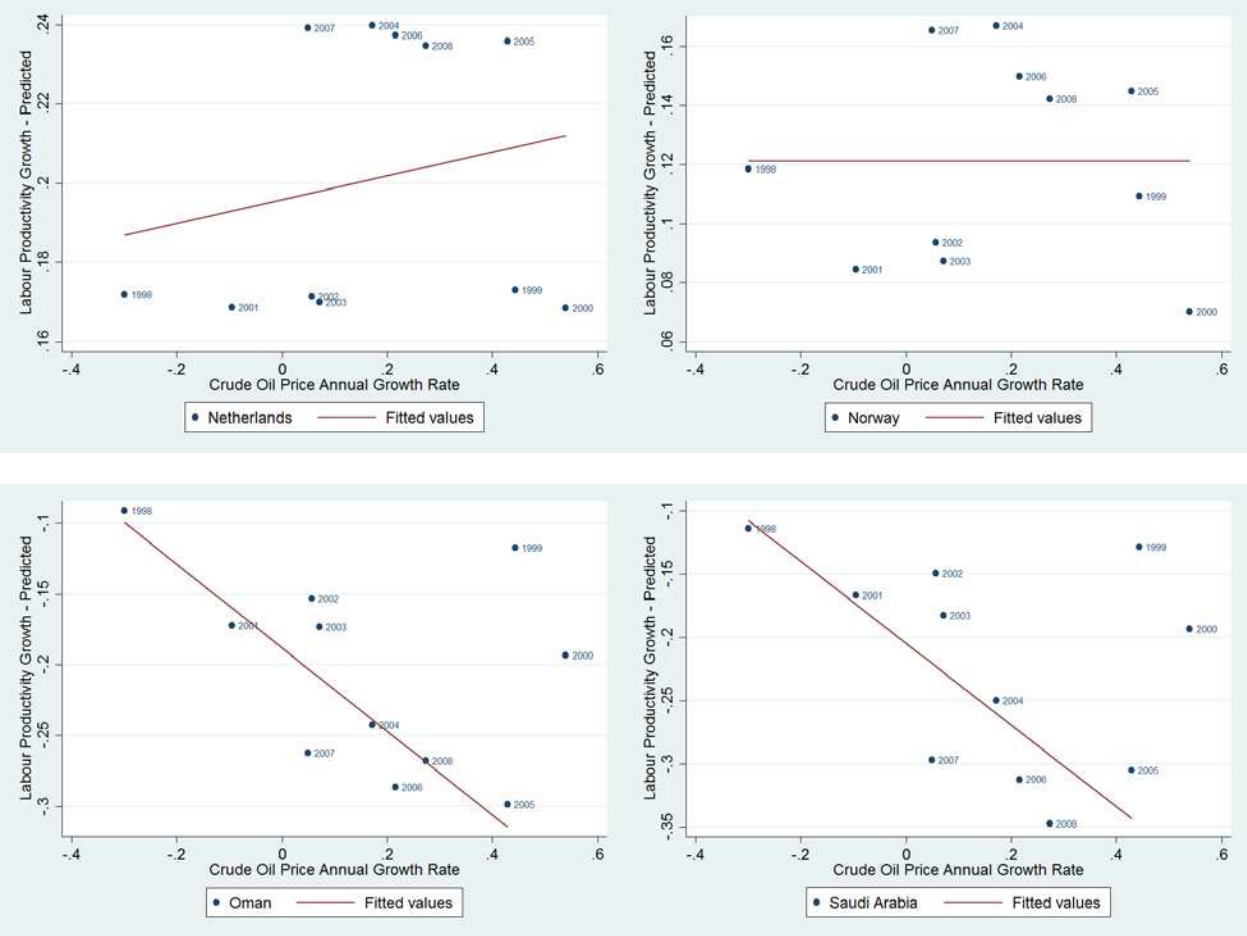

Figure 2 – Predicted labour productivity growth as a function of annual growth rate of crude oil prices

6. Discussion of Results

As presented in the Section 5 we observe beta-convergence that has been repeatedly confirmed in the literature (Barro, 2012). Barro (1991) points out that countries converge due to diminishing returns to reproducible capital. Further we observe that there is significant and positive relationship between the interaction of government effectiveness and government expenditure in tertiary education, and labour productivity excluding natural resource and agricultural rents. This answers one of the question raised in Keller (2006) where the returns to tertiary education are not found to be consistently positive. The reason put forward in that work is that tertiary education investment seems to indicate inefficiency in resource allocation. Our work confirms through inclusion of effectiveness interaction that tertiary education policy when applied effectively and efficiently leads to labour productivity growth in non-traditional sectors. Here we would also challenge the notion that primary and secondary investment has priority over tertiary education investment on the basis of economic return, as our work accounts for the initial educational attainment in the form of years of education primary to tertiary. This is important for policy makers as significant societal returns to tertiary education while accounting for initial state of education are demonstrated.

The next result that requires attention is that of the developing countries and developed countries observed disjointedly. The coefficients for effective research and development expenditures in developing countries show consistently positive and statistically significant for the three periods and the pooled data. Literature often highlights the importance of research and development expenditures for developed countries and speculates the opposite for developing countries. Griffith et al (2004) points out that non-developed countries are not able to achieve maximum potential in R&D due to inappropriate social policies. Our results highlight that the influence of the interaction of government effectiveness with research and development expenditures on labour productivity growth excluding natural resource and agricultural rent is positive. Through these results, the

importance of looking at innovation policies as a complete set within an innovation eco-system rather than only looking at them individually is highlighted further. These result are unique and first of their kind in confirming the interaction of sound governance and innovation policy measures such as expenditures in tertiary education and research and development.

Finally, in terms of the explanatory variables of interest we do not find any relationship between labour productivity growth and index of economic freedom. Whereas we put forward a premise that good business environment is conducive to transformation of knowledge and research into marketed goods and services, we were unable to show it. The results may be a consequence of the type of indicator we have selected to represent this conducive business environment. As discussed while explaining the data in Section 4, the IOEF presents a bird-eye view of the business environment, and while the World Bank's ease of doing business offers closer and more direct representation of the business policy in the countries' the time series was limited to fewer years. Another reason may be that labour productivity growth may have shorter response time to business policies. It would be ideal in future research to work with different time lags for business conditions and to work with indicators that objectively represent the business environment in the countries.

In terms of expanding the discussion on the special case of Arabian Gulf countries, one of the crucial policy implication that can be derived is that, in order for the Arabian Gulf countries to increase the share of non-traditional sector in overall output they would have to devote resources towards tertiary education and R&D. This is in a context where government effectiveness in the Arabian Gulf countries is typically lower than their European counterparts. As such another route to increased innovation albeit long term is to improve government effectiveness, reduce bureaucratic hurdles, improve communication within the government institutions as well as with the private sector and invest in overall infrastructure that supports the innovation environment. This would lead

to higher returns of the increased tertiary education investment and a quicker path towards an innovation economy moving from the current natural resource based economy.

7. Conclusion

This paper presents the analyses of the relationship between innovation policy and innovation based economic growth in macro-economic setting. It establishes the correlation and plausible causality between innovation policies and growth in a cross-sectional evaluation among countries. A selection of innovation policies was chosen based on literature review and state-of-the-art "broad" innovation policy approach. Innovation policy in this work is represented by indicators of investment and policy index representing three major innovation policy areas of education, research and development, and business. The policy implementation capability and potential of the governments are also considered critical and analysed.

We provide novel evidence of the importance of considering the interaction of innovation policies and the environment that they are promulgated. Most importantly we find that the labour productivity growth effects of expenditures in tertiary education and research and development are dependent on the interaction with sound governance. The results show there is significant and positive relationship between the interaction of government effectiveness with government expenditure in tertiary education as a percent of GDP and labour productivity excluding natural resource and agricultural rents. We also find effective research and development expenditures in developing countries to have positive influence on innovation. Finally, we observe that the Arabian Gulf countries experience lower labour productivity growth in non-traditional sector as the oil prices increase. This is an interesting finding and motivates further investigation into the nature of innovation performance and growth in this group of countries.

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9. References

Aghion, P., Boustan, L. P., Hoxby, C. M. & Vandenbussche, J., 2009. *The Causal Impact of Education on Economic Growth: Evidence from U.S..* Washington, D.C., Brookings Papers on Economic Activity.

Archibugi, D. & Coco, A., 2004. New Indicator of Technological Capabilities for Developed and Developing Countries (ArCo). *World Development,* 32(4), p. 629–654.

Barro, R. J., 1991. Economic Growth in a Cross-Section of Countries. *Quarterly Journal of Economics,* 106(2), pp. 407-443.

Barro, R. J., 2012. Convergence and Modernization Revisited. *NBER Working Paper Series,* p. Working Paper Number 18295.

Becheikh, N., Landry, R. & Amara, N., 2006. Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993–2003. *Technovation*, pp. 644-664.

Benos, N. & Zotou, S., 2014. Education and Economic Growth: A Meta-Regression Analysis. *World Development,* Volume 64, pp. 669-689.

Bose, N., Haque, M. E. & Osborn, D. R., 2007. Public Expenditure and Economic Growth: A Disaggregated Analysis for Developing Countries. *The Manchester School,* Volume V, pp. 533-556.

Chen, D. H. C. & Dahlman, C. J., 2005. The Knowledge Economy, the KAM Methodology and World Bank Operations. *The Knowledge Assessment Methodology (KAM) website (www.worldbank.org/kam),* 19 October.

Denison, E. F., 1963. The Sources of Economic Growth in the United States and the Alternatives Before Us. *Journal of the American Statistical Association,* December, 58(304), pp. 1168-1171.

Djankov, S., McLiesh, C. & Ramalho, R., 2006. Regulation and Growth. *Economic Letters,* 92(3), pp. 301-462.

Easterly, W. & Levine, R., 2001. What have we learned from a decade of empirical research on growth? It's Not Factor Accumulation: Stylized Facts and Growth Models. *The World Bank Econ Review,* 15(2), pp. 177-219.

Feenstra, C., R., Inklaar, R. & Timmer, M. P., 2015. *The Next Generation of the Penn World Table forthcoming in American Economic Review.* [Online] Available at: www.ggdc.net/pwt

Freeman, C., 2002. Continental, national and sub-national innovation systems—complementarity and economic growth. *Research Policy,* 31(2), pp. 191-211.

Furman, J. L., Porter, M. E. & Stern, S., 2002. The determinants of national innovative capacity. *Research Policy,* p. 899–933.

Griffith, R., Redding, S. & Reenen, J. V., 2004. Mapping the two faces of R&D: productivity growth in a Panel of OECD Industries. *The Review of Economics and Statistics (First Published in 2001 - IFS Working Papers Number W00/02, Institute of Fiscal Studies, London),* 86(4), pp. 883-895.

Hall, B. H., Mairesse, J. & Mohnen, P., 2010. Chapter 24 – Measuring the Returns to R&D. In: B. H. Hall & N. Rosenberg, eds. *Handbook of the Economics of Innovation.* Amsterdam: North-Holland (imprint of Elsevier), pp. 1033-1082.

Hanusch, M., 2012. The Doing Business Indicators, Economic Growth and Regulatory Reform. *World Bank Policy Research Working Papers,* p. Number 6176.

Jalilian, H., Kirkpatrick, C. & Parker, D., 2007. The Impact of Regulation on Economic Growth in Developing Countries: A Cross-Country Analysis. *World Development,* 35(1), pp. 87-103.

Kaufmann, D. & Kraay, A., 2002. Growth Without Governance. *World Bank Policy Research Working Papers,* World Bank(Washington DC.), p. Number 2928.

Keller, K. R. I., 2006. Education Expansion, Expenditures per Student. *Global Economic Review,* XXXV(1), pp. 21-42.

Kirkpatrick, C., Parker, D. & Zhang, Y.-F., 2006. 'Foreign Direct Investment in Infrastructure in Developing Countries: Does Regulation Make a Difference?'. *Transnational Corporations,* 15(1), pp. 143-171.

Krueger, A. B. & Lindahl, M., 2001. *Journal of Economic Literature,* Volume XXXIX, pp. 1101-1136.

Lederman, D. & Maloney, W. F., 2007. *Natural Resources: Neither Curse nor Destiny,* Washington DC.: The World Bank.

Lichtenberg, F. R., 1993. *R&D Investment and International Productivity Differences.* Ann Arbor, Michigan, University of Michigan Press, pp. 89-110.

Loayza, N. V., Oviedo, A. M. & Servén, L., 2005. Regulation and Macroeconomic Performance. *World Bank Policy Research Working Papers,* The World Bank(Washington D.C.), p. Number 3469.

Lundvall, B.-Å., 2007. *Innovation System Research and Policy: Where it came from and where it might go.* Oslo, The Centre for Advanced Study (CAS) at the Norwegian Academy of Science and Letters.

Nadiri, M. I. & Kim, S., 1996. International R&D Spillovers, Trade and Productivity in Major OECD Countries. *NBER Working Papers ,* National Bureau of Economic Research(Cambridge, Massachusetts), p. Number 5801.

Nelson, R. R. & Winter, S. G., 1982. *An Evolutionary Theory of Economic Change.* 1st ed. Cambridge, Massachussets and London, England: The Belknap Press of Harvard University Press.

Romer, P. M., 1986. Increasing Returns and Long-Run Growth. *The Journal of Political Economy,* October, 94(5), pp. 1002-1037.

Solow, R. M., 1957. Technical Change and the Aggregagte Production Function. *The Review of Economics and Statistics,* August, 39(3), pp. 312-320.

The Heritage Foundation & The Wall Street Journal, 2016. *Explore the Data.* [Online] Available at: http://www.heritage.org/index/explore

The World Bank, 2014. *World Development Indicators.* [Online] Available at: http://data.worldbank.org/data-catalog/world-development-indicators [Accessed 24 July 2014].

The World Bank, 2015. *Doing Business - Measuring Business Regulation,* Washington D.C.: s.n.

The World Bank, 2015. *The World Governance Indicators (WGI) Project,* Washington D.C.: s.n.

UNESCO Institute of Statistics, 2015. *UIS.STAT,* Montreal: s.n.

Vandenbussch, J., Aghion, P. & Meghir, C., 2004. Growth and the Composition of Human Capital. *Journal of Economic Growht,* XI(2), pp. 97-127.

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[i] Developed countries in the context of this paper are consider the OECD 1973 countries. Low income, middle income countries and high-income non-OECD countries are considered as developing countries.

[ii] Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.

[iii] Traditional sector in the context of this paper is defined and natural resource and agricultural sector. Other sectors are considered non-traditional sectors or modern.

[iv] PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current international dollars. (The World Bank, 2014).

[v] Oil rents are the difference between the value of crude oil production at world prices and total costs of production, Natural gas rents are the difference between the value of natural gas production at world prices and total costs of production, Coal rents are the difference between the value of both hard and soft coal production at world prices and their total costs of production, Mineral rents are the difference between the value of production for a stock of minerals at world prices and their total costs of production - Minerals included in the calculation are tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite and phosphate, and Forest rents are roundwood harvest times the product of average prices and a region-specific rental rate (The World Bank, 2014).