Technology, Trade Specialization and Development: Jumping to Technology Development Era

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Abstract

Developing countries often are characterized as producers and exporters of a few types of natural resource based goods. Intuition dictates that these countries should change their strategy from being merely merchandise producers to technology developers in order to experience higher level of development. Hence, the study analyses the effect of technology production and export specialization on the per capita income and growth of some countries in West and East Asia and the Pacific and investigates their behavior in this regard. Moreover, some recommendations are drawn for East- West Asian economic relationships from these results.

Keywords: Technology, International Trade, Development, Comparative Advantage

JEL Classification Numbers : F14, O3, O57

Introduction

There is an emphasis on accumulated capital and physical investment for meeting a higher level of productivity and economic growth in developing countries since two hundred years ago. Fagerberg (2006) argues that "this perspective arguably reflects the important role played by "mechanization" as a mean for productivity advance". Solow (1956) in his contribution to the theory of economic growth demonstrates that under similar circumstances investment in poor countries would be more profitable than in the richer one, therefore, former would be characterized by higher investment and faster economic growth. But evidence does not support this tendency towards higher level of growth (Fagerberg, 2006). Romer (1990) shows that difference in knowledge as a factor can explain this gap.

On the other hand, some economists highlight the effect of international trade on income and growth (e.g. Frankel & Romer, 1999 and Weinhold & Rauch, 1997). This effect goes beyond a simple volume change because of better reallocation of resources (Bauer, 2008), Learning effects and international knowledge and technology spillovers (Castellani, 2001 and Keller, 1997 and Grossman & Helpman, 1994 and Young, 1991) and specialization (Weinhold & Rauch, 1997).

Rosenberg (2004) argues that there are two ways of increasing the output of the economy: first, increasing the number of inputs that apply in productive process and second, thinking about new ways in which more output can be got from the same number of inputs. As resources are scarce, later is likely to be more effective than the former. As it is clear all roads directly or indirectly end to the knowledge and technology advancement in order to higher development and growth. But the problem is that when

we study about trade, comparative advantage is highlighted in most textbooks and researches. These comparative advantages mostly are due to the production and export of natural resources in developing countries. For instance, Mehrara and Rostami (2006) find out Iran has comparative advantage on goods which are based on its static advantages like handicrafts, textile, garments, natural resources and agriculture. Mahdavi and Malekshahi (2004) indicate that Iran has comparative advantage on petrochemical productions which is because of its crude oil resources. Thus, these countries stuck in a vicious circle; export of goods which are produced due to static comparative advantages and using the gains for importing the capital goods and technology. Therefore, developing countries become merchandise producers instead of being technology developers. This cause they get away of knowledge and specialization which is needed for competition in international markets and consequently higher level of income and economic growth. Hence, their lower level of productivity and growth will not improve except they change their strategy from being a merchandise producer to technology developer and rely on dynamic comparative advantage i.e. comparative advantages that develop over time through R&D and learning process.

Therefore, this hypothesis is examined that when countries can meet higher level of productivity and growth that they can be specialized in export of capital goods and technology instead of exploiting their natural endowments. Export of technology can be interpreted as countries advancement in knowledge and technology which is needed for international competition and consequently higher growth and productivity. This study has organized as follows: a brief review of existing literature has come in second section.

Third section is dedicated to data and their resources. Methodology and outcome analysis have delineated in section four. Conclusion has come in section five.

Literature Review

There is an ample of studies through which the effect of total international trade on productivity and growth has been examined (e.g. Bauer, 2008 ; Alcala and Ciccone, 2003 ; Bernard and Jensen, 2001 ; Harris and Kherfi, 2000 ;and Frankel and Romer, 1999). At the lower level, there are studies that examine the effect of specialization on productivity and growth. According to Ricardo's classic analysis, regions specialize due to their comparative advantages. Furthermore, national differences in technological capabilities can shape their specialization and trade. But as Grossman and Helpman (1994) argue the pattern of relative technological capabilities is entirely arbitrary in this model. As a consequence, the model has nothing to say about the type of goods in which a country with certain characteristics might be expected to export.

Most studies about the relationship between specialization and productivity and growth examine the effect of former, in its absolute sense, on the later irrespective of the nature of the specialization. Specialization in this sense leads to higher productivity growth in the form of learning (Dalum et al., 1999). Grossman and Helpman (1994) count some channels through which this learning process takes place. First, learning process could occur due to learning by doing which can generate either as a by-product of activities undertaken of other purposes or as the result of more deliberate efforts to create knowledge. Second, International process can ease learning process with respect to international transmission of technology. However, technological progress would have no bearing on comparative advantage in this circumstance. Moreover, if a sector with lower

growth prospects has comparative advantage in a country and thus larger or more productive, trade can *tilt the equilibrium growth path in the "wrong" direction* (Grossman and Helpman, 1994). Third, Innovation is another path of learning process. Grossman and Helpman (1994) explicate that:

> *A Patent or trade secret typically gives an innovator the ability to exercise monopoly power in the product market. That is a firm with propriety access to an innovative technology usually can price above marginal cost without losing all of its sales.*

On the other hand research investments are intended to reduce the production costs and improve quality of the various inputs.

As it is clear specialization can affect productivity and growth through its impact on knowledge and technology. Therefore, specialization in creation and export of technology or capital goods pushes a country to generate and catch up higher levels of knowledge and technology. This kind of specialization in world market induce competitive pressures that lead to technological upgrading, efficiency gains in production as well as in management procedures which is essential for growth and higher level of productivity(Crespo-Cauresma and Worz, 2005). Furthermore, technological specialization has a significant effect on international competitiveness (Gustavsson et al., 1996). Krugman (1986) points out that a country in global economy which is known as more advanced has an absolute advantage in producing all goods. But it has comparative advantage about more sophisticated goods. As technological gap matters relatively least for the goods which experience the slowest technological progress, the more

technological advanced country produces and exports the more knowledge-intensive goods.

There are some empirical studies in which the effect of type of specialization on productivity and growth has been examined. For instance, Crespo-Cuaresma and Worz (2005) find out that export in technology-intensive industries have a higher potential for positive externalities coupled with higher productivity levels covering 45 developed and developing countries and including 33 industries over 1981 – 1997. Dalum et al. (1999) indicate that specialization in activities offering high levels of technological opportunity are expected to have a positive impact on growth for 11 industries in OECD over 1965-1988. These studies often have to consider lots of industries which are not very conclusive for our purpose. Our aim in this study is to compare specialization in capital goods and technology to specialization in production of natural resources in a conclusive aggregate level that is plausible regarding to the new datasets.

Data

Data have been collected from West and East Asia and Pacific for 24 countries over 1988 to 2003. Collection of countries has been dictated by availability of data for each country. Name of included countries has been indicated in Table-1, appendix. West Asian countries are well known for their natural resources especially crude oil, mines and agriculture and East Asian countries characterized by their rapid growth in manufacturing and technology-intensive productions. Definition of data and their sources have come in the following.

Data about international trade are available from *United Nations Commodity Trade Statistics Database*[1] . All data have been converted to U.S. dollars using exchange rates supplied by the reporter countries. Data have come in different international commodity classification standards which *Standard International Trade Classification* (SITC), Revision 3 has been applied in this research which gives proper time series as well as appropriate classification for necessary aggregate level. Following formula has been utilized for calculation of export specialization index:

$$xs_{in} = \frac{\frac{x_{in}}{x_i}}{\frac{x_n}{x}}$$

Where xs_{in} denotes index of specialization of country *i* in commodity class *n* . x_{in} is export of commodity class *n* from country *i*. x_i is total export of country *i*. x_n denotes total export of *n* from included countries and x is total export of included countries. As Iapadre (2001) demonstrate:

> *One problem of the normalized market share lies in the fact that its measure of specialization is asymmetric: it rages from 1 to infinity for products in which a country reveals comparative advantage, but only from zero to 1 for comparative disadvantage products. This asymmetry creates problems in econometric work on specialization patterns.*

One solution for this problem is generating a symmetric index by the following procedure:

$$rcax_{in} = \frac{xs_{in} - 1}{xs_{in} + 1}$$

[1] Available at their website: http://comtrade.un.org/db/

Where $rcax_{in}$ is symmetric specialization index of export of class *n* from country *i*. In a same way symmetric specialization index of import for each country can be calculated.

As a measure for productivity level GDP per capita based on purchasing power parity has been utilized. Data are in constant 2000 international dollar. Productivity growth is calculated as first difference of logarithm of productivity level. Average annual growth of gross fixed capital formation based on constant local currency has been used as a measure for investment. All of these three measures have been collected from World Development Indicators (2005) prepared by the World Bank.

The measure of Law and Order is collected from POLCON project by Henisz (2002) and defined as:

> *A country with a sound law and order tradition has sound political institutions, a strong court system and provisions for an orderly succession of power. This indicator reflects the degree to which the citizens of the country are willing to accept the established institutions to make and implement laws and adjudicate disputes. A high point total means that there is a strong law and order tradition, while a low point total means that there is a tradition of depending on physical force or illegal means to setting claims.*

Data about the stock of accumulated patents per capita have been retrieved from Lederman and Saenz (2005). This index is used as a proxy for accumulated knowledge existed in a county. Absolute extent of latitude has been collected from Easterly (2001). Definition and summary statistics of these variables have been indicated in Table-2 of appendix.

Methodology and Outcome Analysis

Capturing the effect of trade specialization on productivity and growth and for tracing the effect of technology through this line, index of trade specialization for four main categories has been calculated: 1- Food and live animals (group 0)2- Crude minerals, inedible, except fuels (group 2) 3- Mineral fuels, lubricants and related minerals(group 3) 4- Machinery and transport equipments (group 7). As it is clear specialization in the first three categories could be occurred because of natural and geographical advantages without any need to a tremendous research or designing programs or creating very complicated technologies, while specialization in forth category mostly as capital goods needs a high level of R&D activities for new designs, solutions for complicated problems and competing with new technologies. Therefore, specialization in forth category will make a country to be advanced in term of technology while the first three one do not have this impact.

As Goh and Olivier (2002) point out when countries have been specialized in import of capital goods they can obtain lots of learning opportunities through which growth process could be promoted (see also Busse and Groizard, 2006). Hence, index of specialization in capital goods import (i.e. import of forth category) also is added to the model to catch and examine this effect. The study is carried out two times. Once it examines the effect of specialization on the level of productivity and then it studies the effect of specialization on its growth.

Specialization and Level of Productivity

Some variables are included to control the effect of specialization on the level of productivity. First factor is institution which is noted as a significant factor on the level of productivity in different studies (e.g. Hansson, 2006 , Lederman and Saenz, 2005 , Alcala and Ciccone, 2003). Index of Rule of Law is included as a proxy for institutions in a country. The other line which is emphasized in this context is the effect of geographical characteristics on productivity through its effect on trade (e.g. Alcala and Ciccone, 2003). However, some studies point out that geographical distance cannot be a serious obstacle for trade (Azerbaijani et al., 2003 and Frankel and Romer, 1999). Latitude of each country is included to control for effect of this factor. Therefore, the model is

$$gdpppp2k = \alpha + \beta(law\_order) + \gamma(abslat) + \delta rcam7 + \sum_i \lambda_i rcax_i \ , \ i = 0,2,3,7$$

Where, *gdpppp2k* is productivity level with purchasing power parity method, *law_order* is index of rule of law, *abslat* is absolute extent of latitude, rcam7 denotes index of specialization in import of capital goods, and $rcax_i$ is index of specialization in export of four abovementioned groups.

The problem of endogeneity has been reported in different studies (see Rodriguez and Rodrik, 1999; Amable, 2000; Baldwin, 2003 and Lederman and Maloney, 2002). Hence, the stock of accumulated patents per capita is employed as instrumental variable. This variable is outcome of research and innovative activities and investment of a country. This endogeneity can be diagnosis via a simple OLS regression between Instrumental Variable (IV) and other variables. The result of this regression has indicated in Table-5 of appendix. Model *m1* shows the relationship between patent stock and the level of productivity and *m2* shows the relationship between IV and index of

specialization in export of capital goods. Both show a positive and significant relationship therefore, this instrument will take into account and a 2SLS method is employed to estimate the parameters. The outcome of estimation has come in Table-6. F-statistics 24.03 rejects the hypothesis that all coefficients equals zero however, R^2 is not very high. Institutions (i.e. rule of law) and geographical factor (i.e. latitude) show a positive and quite significant effect on productivity level at 0.01 level, while, specialization in import of capital goods has negative and significant effect on the level of productivity at 0.05 level. This result does not support those of Goh and Olivier (2002) and Busse and Groizard (2006). All of export specialization indices indicate a positive and significant impact on productivity at 0.01 level except specialization in group of food and live animals which is negative and insignificant. This can happen because of multicollinearity between this group and group 2 (i.e. Crude minerals, inedible, except fuels). Correlation between these two groups is 0.7670 and has been shown in Table-3. Therefore, this model is re-examined without group 2 to check for multicollinearity. As it has been shown in model *b_2SLS* of Table-6, coefficient of this variable became positive and significant at 0.1 level. The most important point is that coefficient of specialization in export of capital goods is greater than other kinds of specialization in both models.

Specialization and Growth

The general type of model to be estimated is an adjusted form of which is suggested by Bensidoun et al.(2001):

$$\ln y_{it} - \ln y_{it-1} = \alpha_i + \beta \ln y_{it-1} + \sigma \ln inv_{it} + \phi rcam7_{it} + \lambda_j \sum_j rcax_{jit} + \varepsilon_{it}$$

Where y_{it} is average of the PPP GDP per capita of country *i* for time *t* to *t-5*. inv_{it} denotes the investment rate on average for period $t-5$ to $\tau-1$. *Rcam7* is index of specialization in import of capital goods. *rcax* denotes the specialization indicators of export. α_i shows individual fixed effects. A first difference transformation wipes out the individual effects.

$$\ln y_{it} - \ln y_{it-1} = \beta(\ln y_{it-1} - \ln y_{it-2}) + \delta(\ln inv_{it} - \ln inv_{it-1}) + \gamma(rcam7_{it} - rcam7_{it-1}) + \lambda_j \sum_j (rcaxj_{it} - rcaxj_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1})$$

As it is common the generalized method of moments (GMM) is used to estimate this equation as the within estimator is inconsistent in the case of a dynamic panel-data model. In addition, the GMM allows the issue of endogeneity of right-hand side variables to be simultaneously handled. But utilizing GMM estimators come with its price. This model may need a large sample size (Hayashi, 2000). The consequence is that the efficient GMM estimator can have poor small sample properties.

Specialization indices are considered as endogenous and the stock of granted patents are applied as additional instrument. The robust standard errors applied to overcome potential heteroskedasticity. The result has been indicated in Table-7. Arrelano-Bond test for autocovariance in residuals of order 1 is 0.0805 which rejects the null hypothesis of no autocorrelation. Thus, the lag of endogenous variables (i.e. specialization variables) is included to solve the autocorrelation problem. Test statistics of 0.2072 does not reject the null hypothesis of no autocorrelation of order one. First difference of import of capital goods and its lag shows a positive effect on growth however, just its lag is significant. Among the specialization indices just specialization in

export of capital goods is positive and has significant effect on growth in 0.1 significant level. Other types of specialization do not show a significant effect on growth.

Conclusion

To sum up, 2SLS and GMM regressions have been applied to examine the effect of specialization in export of capital goods on productivity level and growth. There is strong evidence that higher level of specialization in export of capital goods and technology accompanies with higher level of productivity. However, specialization in agriculture, minerals and energy has positive effect on productivity but the specialization in capital goods and technology shows higher coefficient. Specialization in export of capital goods and technology shows a positive and significant effect on growth of productivity, nevertheless, this evidence is not very strong. There is no evidence that specialization in export of other types of goods has positive, significant effect on growth. Specialization in import of capital goods and technology shows a more significant effect in this regard.

Andersson and Ejermo (2006) point out that specialization and comparative advantage can be created by investment in technology and knowledge. Darvishi and Asgari (2006) demonstrate East Asian countries switched their comparative advantage through this investment from agriculture to industrial sector. But structural change of the economy is not possible without an effective and well defined country's innovation system and technology transfer (Gubriel, 2002).

There are different schemes through which knowledge and technology can be acquired (Gubriel, 2002):

1- Acquiring non-documented knowledge
2- Internal R&D
3- Reverse engineering
4- Contract R&D
5- Acquisition of a company with technology
6-Strategic R&D partnership
7-Licensing
8- Purchasing
9-Joint Venture

While just a few methods are performed in Iran (e.g. licensing, purchasing or reverse engineering), other paths to technology advancement are mostly ignored. Among these schemes, especially *strategic R&D Partnership* and *joint venture* between East and West Asian countries can ease learning by interacting which is an essential element in learning of tacit knowledge and innovation.

But the problem is that acquiring technological leadership requires not only intensive research activity but also a high rate of investment (Gustavsson et al., 1996). Fostering the rate of investment needs a lower level of macroeconomic, socio-political and governance uncertainty (Mellati, 2008). Furthermore, new financial instruments with respect to Islamic law are needed in order to reduction of financial risks and uncertainties in this regard. Clearer and strictly enforced intellectual property rights are also suggested by lots of researchers and institutions.

Temporary protection policies that induce an economy to specialize in production and export of capital goods and technology are suggested by Krugman and Venables (1993). Strict protectionist hampers competition pressures while complete openness does not let process toward shaping specialization and comparative advantage takes place.

Other strategy which is experienced by East Asian countries is shifting from the mere assembly of imported inputs to a more domestically integrated and higher value-

added form of exporting known as *full-package supply* or *original equipment manufacturing* (OEM) production (Gereffi, 1999). Shaping industrial clusters are based on availability of a strong local base of specialized suppliers which are essential for OEM production system can be useful for this purpose.

Bibliography

Alcala, Francisco and Antonio Ciccone, 2003, Trade and Productivity", Quarterly Journal of Economics, 119(2):613-646.

Amable, Bruno, 2000, "International Specialization and Growth", Structural Change and Economic Dynamics,11(4):413-431.

Andersson, Martin and Olof Ejermo, 2006, "Technological Specialization and the Composition of Export Flows- An Analysis of Swedish Regions' Trade With Europe", Paper For the DIME Workshop on Dynamics of Knowledge Accumulation, Competitiveness, Regional Cohesion and Economic Policies, Vienna.

Azerbaijani, Karim and Seied Komeil Taiebi and Hosein Karimi Hosnijeh, 2003, "The Most Proper Trade-Local Condition on Basis of Globalization and Integration Indices For Iranian Economy", Iranian Economy Research,13:75-107.

Baldwin, Robert E., 2003, "Openness and Growth: What's the Empirical Relationship?", NBER Working Paper No.9578.

Bauer, Christian, 2008, "Trade, Productivity, and semi-endogenous Growth", Bavarrian Graduate Program in Economics Discussion Paper, No.56.

Bensidoun, Isabelle and Guillaume Gaulier and Deniz Unal-Kesenci, 2001, "The Nature of Specialization Matters for Growth: An Empirical Investgation" CEPII Working Paper,No.13.

Bernard, Andrew B. and J. Bradford Jensen, 2001, "Exporting and Productivity: The Importance of Reallocation" Available at SSRN: http://ssrn.com/abstract=167569.

Busse, Matthias and Jose L. Groizard, 2007, "Technology Trade in Economic Development." The World Economy, 31(4):569-592.

Castellani, David, 2001, "Export Behavior and productivity Growth : Evidence From Italian Manufacturing Firms",Review of World Economics, 138(4):605-628.

Crespo-Cauresma, Jesus and Julia Worz, 2005, "On Export Composition and Growth", Review of World Economics, 141(1):33-49.

Darvishi, Bagher and Heshmatullah Asgari, 2006 , "Direction of Comparitive Advantage of Some East Asian NICs and Its Comparison With Iran", Economic Research, :263-297.

Dalum, Bent and Keld Laursen and Bart Verspagen, 1999, " Does Specialization Matter for Growth?" Industrial and Corporate Change, 8(2):267-288.

Easterly, William R., 2001 , "The Lost Decades: Developing Countries' Stagnation in Spite of Policy Reform 1980-1998 Dataset", Journal of Economic Growth, 6(2):135-157..

Fagerberg, Jan, 2006, "Innovation, Technology and the global knowledge economy: Challenges for future growth." Paper Prepared for "Green Roads to Growth" Project and Conference, Copenhagen.

Frankel, Jaffrey and David Romer, 1999, " Does Trade Cause Growth?" The American Economic Review, 98(3):379-399.

Goh, Ai-Ting and Jacques Olivier, 2002, "Learning By Doing, Trade in Capital Goods and Growth", Journal of International Economics, 56(2):411-444.

Gereffi, Gari, 1999, "International trade and Industrial Upgrading in the Apparel Commodity Chain.", Journal of International Economics, 48(1):37-70.

Grossman, Gene M. and Elhanan Helpman, 1994, “Technology and Trade”, NBER Working Paper No.4926.
Gubriel, Roman, 2002, “Impact of Innovation and Technology Transfer on Economic Growth: The Central and Eastern Europe Experience.” Available at: www.eadi.org/fileadmin/WG_Documents/Reg_WG/gurbiel.pdf
Gustavsson, Patrik and Par Hansson and Lars Lundberg, 1996, “Technology Resource Endowments and International Competitiveness”, TSER Project: Technology, Economic Integration and Social Cohesion. Paper is available at http://meritbbs.unimaas.nl/tser/tser.html or http://www.merit.unimaas.nl/tser/teis003.pdf
Hansson, Gustav, 2006, “Institutions and Their Measures: A Black Box of Goodies”, Goteborg University, Working Papers in Economics No.206.
Harris, Rick and Samer Kherfi, 2000, “Productivity Growth and Trade Specialization”, Centre for The Study of Living Standards Conference on the *Canada- U.S. Manufacturing Productivity Gap*, Ottawa, Ontario, Janauary 21-22.
Hayashi, F., 2000, “Econometrics”, First Edition, Princeton University Press.
Henisz, W. J. , 2002, "The Institutional Environment for Infrastructure Investment." Industrial and Corporate Change, 11(2): 356-389.
Iapadre, P.Lelio, 2001, “Measuring International Specialization”, IAER,7(2):173-183.
Keller, Wolfgang, 1997, “Trade and the Transmission of Technology”Journal of Economic Growth, 7(1):5-25.
Krugman, Paul and Anthony Venables, 1993, “Integration, Specialization and Adjustment”, NBER Working Paper No.4559.
Kruman, P.R., 1986, “ A technology Gap Model of International Trade” in : K. Jungenfelt and D. Hague, eds., Structural Adjustment in Developed Open Economics, Macmillan Press, London:35-49.
Lederman, Daniel and Laura Saenz, 2005, “Innovation and Development Around the World , 1960-2000” World Bank Policy Research Working Paper 3774.
Lederman, Daniel and William Maloney, 2002, “Trade Structure and Growth.”, The World Bank, Policy Reasearch Working Paper No.3025.
Mahdavi, Abolghasem and Mehran Malekshahi, 2004, “ Evaluation of the Comparative Advantage of Petrochemical products in Iran”, Iran Economic Researches, 21:91-113.
Mehrara, Mohsen and Ali Rostami, 2006, “Iran, convergence in Global Economy and Comparative Advantages” Journal of Economic Researches, 72: 131-162.
Mellati, Ali, 2008, “Uncertainty and Investment in Private Sector: An Analytical Argument and A Review of The Economy of Iran.” PhD Thesis, Gokhale Institute of Politics and Economics, India.
Pagan, A.R. and D. Hall, 1983, “Diagnostics Tests As Residual Analysis”, Econometric Reviews 2(2): 159-218.
Rodriguez, Francisco and Dani Rodrik, 1999, “ Trade policy and Economic Growth:A Skeptic’s Guide to the cross-National Evidence.” NBER Working Paper No.W7081.
Romer,P.M., 1990, “ Endogeneous Technological Change”, Journal of Political Economy, 98:71-102.

Rosenberg, Nathan, 2004, “Innovation and Economic Growth”, OECD, Available at http://www.oecd.org/dataoecd/55/49/34267902.pdf
Solow, R. M. ,1956, “A Contribution to the Theory of Economic Growth.” Quarterly Journal of Economics, 70: 65–94.
Weinhold, Diana and James E. Rauch, 1997, “ Oppenness, Specialization and Productivity growth in Less Developed Countries.” NBER Working Paper, No.6131.
World Bank, 2005, “World Development Indicators”, The World Bank.
Young, Alwyn, 1991, “Learning by Doing and The Dynamic Effects of International Trade.” NBER Working Paper Series, No.3577.

Appendix

Australia	Azerbaijan	Bahrain	China
Indonesia	Iran, Islamic Republic of	Japan	Jordan
Korea, Republic	Kuwait	Lao, PDR	Malaysia
New Zealand	Oman	Papua New Guinea	Philippines
Saudi Arabia	Singapore	Syria	Thailand
Turkey	United Arab Emirates	Vietnam	Yemen

Table 1- List of countries

Variable	Definition	Obs	Mean	Std.Dev.	Min	Max
gdpppp2k	GDP per capita (ppp, constant 2000)	364	9235.136	7695.86	588.03	27993.17
gdppercapgrowth	GDP per capita growth (% annual)	369	2.255	5.356	-24.26	20.36
fixcapform	Fix Capital Formation (% of GDP)	336	24.697	7.382	7.64	50.81
law_order	Law and Order	351	4.191	1.289	1	6
patgrntdstk	stock of accumulated patents per capita	334	13791.37	65347.09	0	485960
abslat	Absolute extent of latitude	384	23.505	12.136	1.355	41.202
rcax0	Index of specialization in export of food and live animal industry	270	0.038	0.5331	-0.899	0.839
rcax2	Index of specialization in export of crude minerals, inedible, except fuels	270	-0.024	0.557	-0.893	0.9
rcax3	Index of specialization in export of mineral fuels, lubricants and related minerals	270	-0.061	0.666	-0.999	0.811
rcax7	Index of specialization in export of machinery	270	-0.445	0.411	-0.999	0.266

	and transport equipment					
rcam7	Index of specialization in import of machinery and transport equipment	271	-0.015	0.149	-0.5118	0.2458

Table 2 - list of definition and summary statistics of variables

	law_order	abslat	rcam7	rcax0	rcax2	rcax3
law_order	1.0000					
abslat	0.2185	1.0000				
rcam7	0.0974	-0.4221	1.0000			
rcax0	-0.0580	0.0388	0.0908	1.0000		
rcax2	-0.0673	-0.0207	0.0066	0.7670	1.0000	
rcax3	-0.0048	-0.2247	0.1249	-0.3133	-0.2730	1.0000
rcax7	0.0478	-0.2324	0.2155	-0.1652	-0.1076	-0.6077

Table 3- correlation of explanatory variables in productivity regression

	y5	inv5	rcax0	rcax2	rcax3	rcax7
y5	1.0000					
inv5	-0.0085	1.0000				
rcax0	-0.3458	0.0440	1.0000			
rcax2	-0.2171	-0.0195	0.7670	1.0000		
rcax3	-0.0948	-0.4134	-0.3133	-0.2730	1.0000	
rcax7	0.2702	0.6654	-0.1652	-0.1076	-0.6077	1.0000
rcam7	0.1570	0.3150	0.0908	0.0066	0.1249	0.2155

Table 4- Correlation of explanatory variables in growth regression

Variable	m1	m2
patgrntdstk	.04957993***	2.071e-06***
_cons	8405.7246***	-.48287534***
N	318	226
r2	.18976439	.16106138

legend: * p<0.05; ** p<0.01; *** p<0.001

Table 5-Endogeneity diagnosis regression for productivity

2SLS regression outcome for productivity level

	a_2sls	b_2sls
	b/se	b/se
gdpppp2k		
law_order	2780.201***	2711.549***
	(444.3535)	(474.1251)
abslat	405.1278***	397.1031***
	(85.65172)	(90.63524)
rcam7	-10214.22**	-12492.49**
	(5004.106)	(5377.755)
rcax0	-35.48047	4226.907*
	(2420.644)	(2471.257)
rcax2	4560.93***	
	(1317.22)	
rcax3	11969.98***	12596.4***
	(3389.762)	(3637.945)
rcax7	24029.55***	25659.5***
	(6269.961)	(6750.867)
_cons	483.0134	1464.386
	(2783.497)	(2991.625)
rcax7		
patgrntdstk	2.02e-06***	2.02e-06***
	(3.17e-07)	(3.17e-07)
_cons	-.4722388***	-.4722388***
	(.0264361)	(.0264361)
N	213	213
r2	0.2761	0.1772
F	24.03	23.71

* p<.1, ** p<.05, *** p<.01

Table 6- IV regression outcome for productivity level

	GMM_c b/se	GMM_d b/se
LD.y5	.8665561***	.8539776***
	(.0225295)	(.0268568)
D.rcam7	.0703777***	.0168437
	(.0269018)	(.038914)
LD.rcam7		.0761177***
		(.0292465)
D.rcax0	-.0358289	-.0305493
	(.0236728)	(.0238649)
LD.rcax0		.0093343
		(.0215715)
D.rcax2	-.0014279	-.0015238
	(.037524)	(.0210356)
LD.rcax2		-.0281486
		(.040167)
D.rcax3	-.0020565	-.0058634
	(.0150218)	(.0192865)
LD.rcax3		.014195
		(.0258588)
D.rcax7	.0095511	.0389781*
	(.026017)	(.0217355)
LD.rcax7		-.0331672
		(.0276291)
D.inv5	.1297792***	.1358535***
	(.0364092)	(.0362111)
N	114	108

* p<.1, ** p<.05, *** p<.01

Table 7- GMM regression outcome for productivity growth