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ICT AND ECONOMIC GROWTH NEXUS:CASE OD CENTRAL ASIAN COUNTRIES

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Abstract:

The Government of Uzbekistan declared the year of 2020 as "The Year of Science, Education and Development of the Digital Economy" and is implementing the State Program, aiming at to liberalize the economy, improve market related incentives, encourage private enterprises, to reduce the role of the public sector by introducing ICT and Internet, developing digital economy. In order to understand the causal relationship between ICT investment and economic growth researchers have exert many effort in the world. The results are different: in developed countries the impact of ICT on economic growth is more powerful than in developing countries. This paper aims at finding and measuring causality between Economic growth and ICT development in emerging economies of Central Asian Countries by using panel data overthe period of 19 years from 2000 – 2018.The research findings revealed that inflation, trade openness, final consumption expenditure and unemployment impact significantly on GDP per capita in Central Asian countries. The econometric analysis showed that ICT affects to per capita positively and significantly: one percent increase in ICT contributes to GDP per capita 0.1669 percent (fixed broadband subscriptions) and 0.2218 percent (internet usage).Thus we concluded that information and communication technology together with economic indicators are key part of economic development in Central Asian countries. Reduction of inflation and unemployment allow expanding businesses, to create new job places in the digital economy.

Keywords: liberalize the economy, Economic growth and ICT, digital economy, GDP

1.INTRODUCTION

Nowadays in the conditions of coronovirus pandemic and global crisis, downturn of industries, an implementation of modern information-communication technologies (ICT) in the economymakes possibility to avoid the negative effect of the pandemic, to develop online communications, bilateral trade, small businesses and support private entrepreneurial entities.Today the role of the ICT sphere has been growing. According to the World Bank's statistics the share of ICT is more than 5.5 % of the world GDP[1]. Scientific researches witness that the more the share of ICT, the more the GDP growth is. For example, the increase of wideband linesfor 10% in economy networks, raises the growth of GDP for 1.4%. This figure reached 2.5% in China[2]. The increase of information usage by two times through mobile networks raises the world GDP per capita by 0.5%[3]. Therefore, there is a positive relationship between ICT and economic growth.Due to economic reforms that were made during the years of independence in Uzbekistan, many new enterprises, small and medium sized businesses were established and on the ICT basis modern management systems were introduced. Nowadays the share of ICT in GDP of Uzbekistan is accounted for 1.9% and it is planned to increase it up 10 per cent by 2030. But now the implementation of ICT and the Internet in business activity, in exporting and in information sharingand the return from investment directed to the economy is still low. It is well known, that investments directed to the economy of Uzbekistan could lead to the development of science and technologies, to better administration of enterprises and improvement of living conditions of population, and wide use of ICT is becoming a major factor in the modernization of the economy. All these dictate the necessity of using ICT, new technologies in deepening of provided economic reforms and structural changes, in efficient exploitation of these technologies, in implementing of the long - term digital economy program 2030 and increase of their productivity.The rest of the paper is organized as follows. Section 2 provides review of empirical literature on the research topic. This is followed model specification and methodology section. The fourth section analyzes and describes the research results. Section 5 includes final comments, recommended policy implications.

[1]www.wb.org
[2] http://broadbandtoolkit.org
[3] http://gsma.com/publicpolicy

2.LITERATURE REVIEW

In the last three decades, numerous studies have been undertaken to examine the impact of ICT on a country's economic performance, fueled largely by Robert Solow's (1957) seminal work. In the paper, Solow argued that the United States (US) economic growth during 1950s and 1960s was attributed mainly to 'technological change' as opposed to the conventional factors of labor and capital. Since then, various firm, industry and country level studies have been undertaken on this issue, primarily for developed countries, whilst developing countries have been studied more recently. The effects of ICT on the economic growth level have been examined for the past decades by several researchers using various methods, data sets and various time periods at the country levels or panel of countries. Majority of empirically analyzed papers found out that development of ICT use leads to growth in GDP per capita, employment and productivity in a country. In the context of negative findings, Berndt et al. (1992) examined the contribution of ICT capital to US industries' productivity growth and found a negative relationship. Parsons et al. (1990) argued that Canadian banks did not reap good benefits from their ICT capital investments. Similar findings were reported by Morrison (1997) whom reported insignificant relationship between ICT and economic growth of the US firms. Some of the studies had found positive and significant relationship between ICT and economic growth. In early 1990s, Lau and Tokutsu (1992) investigated the contribution of ICT investment on economic growth in the US for the period 1960 to 1990. The empirical result showed that nearly half of the growth in the aggregate national output in the US was attributed to ICT investment than non-ICT capital or labor. Schreyer (2000) estimated the impact of ICT on labor productivity amongst G7 nations. He found that the employed sample countries (i.e. Germany, Canada, Italy, Japan, US and UK) had benefited significantly from ICT investment in terms of remarkable average annual labor productivity growth over the period 1990 to 1996. Daveri (2000) updated Schreyer's (2000) research work and extended it to another eleven OECD countries. Apart from using similar data, Daveri also added software to ICT capital. Here, the author found similar results - ICT contributed substantially to economic growth during the later part of 1990s for all the sample countries (though the magnitudes differ greatly across the countries).

Several studies have examined the contribution of ICT to economic development of developing countries in recent years. To quote a few, Kuppusamy and Solucis (2005) and Kuppusamy and Shanmugam (2007) examined the impact of ICT to Malaysia over the periods 1975 – 2002 and 1983 – 2004, respectively. It was found that ICT investment has statistically improved Malaysia's economic growth in both studies. Piatkowski (2003) indicates that in Poland, ICT investment contributed on average 0.47 of a percentage point or 8.9% of GDP growth and 12.7% or 0.65 of a percentage point contribution to labor productivity during 1995 to 2000. A study provided the results below, on the contribution of ICT to economic growth.Poh (2001) investigated the impact of ICT investment on overall productivity in Singapore over the period 1977 to 1997. The estimated result showed that ICT capital generated significant rate of return to the economy. Two years later, Kim (2003) examined the impact of ICT on productivity and economic growth in Korea during 1971 to 2000 sample period. The results showed that ICT capital contributed 16.3% to the output growth and has had strong positive effect on the growth of labor productivity in the long run.According to the research conducted by the World Economic Forum (World Economic Forum, 2013) a 10 percent rise in the ICT sector of a country leads to a 0.76 percentage rise in GDP per capita, also a 1.03 percentage increase in the rates of employment. The results of a study by OECD (OECD, 2010) indicated that ICT has a driving role in decreasing poverty by making new job places and sources of earnings; also it reduces the expenditure of poorer people for both health and education.Another research conducted by (Czernich et al., 2009), proved a positive effect of ICT on the economic growth, in the paper the impact of fixed broadband infrastructure on the growth of economy has been analyzed for 25 OECD countries from 1996 to 2007. The results indicated that a 10 percent increase in the broadband penetration can lead to 0.9 – 1.5 percent increase in GDP growth per capita. It must be noted that the issue of ICT and economic growth has received much attention with respect to the developed countries as opposed to the developing countries. John et al. (2006, p.51), highlighted that ICT enhances economic growth of developing countries by way of: providing cheaper, quality, and empowered communication to marginalized communities. Reduce inequalities in terms of access to education, training and employment and allow boosting economic growth.

3.RESEARCH METHODOLOGY

Having reviewed the literature on the relationship between ICT and economic growth and providing correlation matrix the following list of variables have been selected to best describe the effect of ICT on economic growth in Central Asian Countries: Fixed Broadband Subscriptions, Percentage of Individuals Using the Internet, Inflation, Foreign Direct Investment,Unemployment, Trade Openness, Final Consumption Expenditure. This study entirely used secondary data sources covering the year ranged from 2010 to 2018. Data are collected fromthe "World Development Indicators" (WDI) database World Bank.

Table.1: Thevariables, their notations, measurement and the data sources

Indicators	Notations	Data sources
GDP per capita in current and PPP prices, US dollars	lngdp	the "World Development Indicators" (WDI) database World Bank
Fixed Broadband Subscriptions per100 inhabitants	lnfsub	the "World Development Indicators" (WDI) database World Bank

Individuals Using the Internet, percentage	lninternetusers	the "World Development Indicators" (WDI) database World Bank
Inflation, annually percentage of population	lninf	the "World Development Indicators" (WDI) database World Bank
Foreign Direct Investment, % of GDP	lnfdi	the "World Development Indicators" (WDI) database World Bank
Unemployment, % of active population	unemp	the "World Development Indicators" (WDI) database World Bank
Trade-openness, % of GDP	lntrade	the "World Development Indicators" (WDI) database World Bank
General-government's-final-consumption-expenditure , % of GDP	lnconexp	the "World Development Indicators" (WDI) database World Bank

The specified econometric models evaluate the impact of several ICT and digital economy determinants on economic growth of Central Asian countries namely: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan for the 19 years from 2000 to 2018.In the used econometric models, economic growth is the dependent variable indicated by GDP per capita (in US dollars at current price and PPP).

To identify the causality of ICT with economic growth in Central Asian countries the following regression equations have been used:

$$\mathbf{Lngdp = \beta_0 + \beta_1 Lnfsub_i + u_i (1)}$$

$$\mathbf{Lngdp = \beta_0 + \beta_1 Lnfsub_i + \beta_2 Lninternet_i + u_i (2)}$$

$$\mathbf{Lngdp = \beta_0 + \beta_1 Lnfsub_i + \beta_2 Lninternet_i + \beta_3 Lninf_i + u_i (3)}$$

$$\mathbf{Lngdp = \beta_0 + \beta_1 Lnfsub_i + \beta_2 Lninternet_i + \beta_3 Lninf_i + \beta_4 Lnfdi_i + u_i \ (4)}$$

$$\mathbf{Lngdp = \beta_0 + \beta_1 Lnfsub_i + \beta_2 Lninternet_i + \beta_3 Lninfi + \beta_4 Lnfdi_i + \beta_5 unemp_i + u_i \ (5)}$$

$$\mathbf{Lngdp = \beta_0 + \beta_1 Lnfsub_i + \beta_2 Lninternet_i + \beta_3 Lninfi + \beta_4 Lnfdi_i + \beta_5 unemp_i + \beta_6 trade_i + u_i (6)}$$

$$\mathbf{Lngdp = \beta_0 + \beta_1 Lnfsub_i + \beta_2 Lninternet_i + \beta_3 Lninfi + \beta_4 Lnfdi_i + \beta_5 unemp_i + \beta_6 trade_i + \beta_7 conexp_i + u_i (7)}$$

As we know that in the panel data study data consists of repeated observations of the same units, regarding to the current case they are sampled countries. The current panel data in use is balanced, as the period for all of the countries is the same. Implementation of panel data to research enables to control variables; those neither can be observed nor measured, namely: cultural-factors among the sampled countries. Further, using panel data is preferred to investigate variables, which change over time, however not from one region to other.This method investigates the causality among independent variables and the output in the same units. Each country has its particular characteristic which possibly can influence the independent variables. When implementing fixed effect model, it is assumed that the determinants are affected by specific characteristics and this must be checked. It known that there is relationship between independent variables and error term and in order to terminate the influence of those characteristics of independent variables the fixed effect techniques are used. One of the essential principles of fixed effect model is that all those techniques impact each region individually. Since each country differs from any other the error term is constant. Given that fixed effect model is applied to investigate the causes of change in any sampled country.

4.DISCUSSION OF REGRESSION RESULTS

The OLS regression results are summarized in Table 2. The columns labeled (1) through (7) each report separate regressions. Each regression has the same dependent variable, Fixed Broadband Subscriptions.The entries in the table are the estimated regression coefficients, with their standard errors below them in parenthesis, certain F –statistics and the final three rows contain summary statistics for the regression, as indicated by the description in each row. The asterisk indicate whether the t – statistics, testing the hypothesis that relevant coefficient is zero, is significant at 1% level (three asterisks, or 5 %level (two asterisks). All the information regarding regression equations (1) to (7) presented in the tabular format.

Although the table does not report t – statistics, they can be computed from the information provided. Regressions that include the control variables measuring fixed broadband subscriptions and internet users are reported in column (3) to (7). Controlling for these characteristics cuts the effect of the fixed broadband subscriptions and internet users on per capita GDP respectively: in one forth and two and half times. In all cases

the coefficients on the fixed broadband subscriptions and internet users remain statistically significant at the 5 % level. In the four specifications with control variables, regressions (4) through (7), an increase of fixed broadband subscriptions and internet users by one percent lead to increase economic growth respectively approximately to 0.16 and 0.15 percent other factors hold constant.The ICT characteristic variables are potent predictors of economic growth. The fixed broadband subscriptions alone explain only a small fraction of the variation in per capita GDP: R^2 = 0.279 and together withinternet users jumps to R^2 = 0.376. Adding more 5 control variables to the model has increased R^2 to 0.8091.

This paper investigates the impact of information and communication technologies on economic growth in the case of 5 Central Asian countries by implementing panel data for the period of 19 years from 2000 to 2018. The regression assumptions and several tests recommended by empirical econometric literature (Gujarati, 2013) have been checked (See appendix 1), in order to choose the model, which best shows the impact of ICT use on economic growth. For the implemented tests, the descriptive tables and findings are presented. The findings of the descriptive analyses, tests and statistics indicated that all sampled variables have positive but not all of them are significant for the chosen period of time. Overall outcome of the study adduced that each of the chosen indicators meets all the requirement of panel analyses.

The main aim of conducting regression analysis is to separate the relations among each independent variables and dependent variables.If the correlation is strong among the variables, then it would be more problematic to make changes in variables. As the independent variables have a tendency to change in harmony, it is generally problematic for the model to evaluate the causality among independent variables and the dependent variables. The constructed correlation matrix has been given in the Appendix 1. Analysis showed that information and communication technology has not very much correlation among the independent variables selected to analyze the economic growth in Central Asian countries, where main indicators of ICT namely: the highest correlation have been found out between control variable (fixed broadband subscriptions) and the dependent variable (GDP per capita), the correlation is 0.5397 and this is still normal. GDP per capitaand percentage of individuals using the internet have the highest correlation with the rate of 0.58.4 between percentage of individuals using the internet and GDP per capita.Applied economic control variables have not multicollinearity problem with economic growth while only trade openness and capital formation have released 0.3879 and 0.3467 correlation with foreign direct investment respectively for the economic growth of the sampled Central Asian countries.Taking into consideration the nature of the panel analyses, and we have to select either fixed effect or random effect model for the analyses. Thus,Hausman test has been employed. The findings from Hausman test is given in Appendix 2. Outcome of the analyses for Hausman test indicated that fixed effect model is applicable in the current case of analyses because the probability is lower than 0.05 (See Appendix 3). Variance Inflation Factor Test (VIF). The Variance Inflation Factor Test is applied to find multicollinearity in regression analysis. The problem of Multicollinearity happens when there is correlation among the variables in the applied model. If this problem exists it can badly influence to the results of regression and the test measures in what level the variance of regression affected because of the multicollinearity problem in the selected model (Stephanie, 2015). Thus, this VIF test has been applied in order to avoid and prevent data from multicollinearity problem and the findings in the appendix 7 have been released. The results indicated that in the model, there is not multicollinearity problem that can adversely affect to the results from the run of regression. The results from the VIF test have been carried out and VIF is 3.51 less than 10.Madden and Savage (2008), analyzed empiricallythe correlation offoreign direct investment with economic development, with the data for 28 EUmember developed countries from 1990 to 1995. The outcome of the research indicated a positive correlation between the indicators.The found results released that foreign direct investment (FDI) has positive butinsignificant effect on GDP per capita fordeveloping countries.

Table 2: Results of Regressions of GDP per capita on ICT Indicators andCharacteristic Control Variables using Panel Data on Central Asian Countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln_fsub	**0.2055*** **	**0.0551*** **	**0.0575*** **	**0.1551*** **	**0.1547*** **	**0.1737*** **	**0.1670*** **
	(0,0303)	**(0,0158)**	**(0,0162)**	**(0,0595)**	**(0,0467)**	**(0,0412)**	**(0,0352)**
Ln_internetusers		**0.3844*** **	**0.3695*** **	**0.3841*** **	**0.0916*** **	**0.0469*** **	**0.1473*** **
		(0,0206)	**(0,0248)**	**(0,0864)**	**(0,0387)**	**(0,0197)**	**(0,0421)**
Ln_inf			**-0.0489*** **	**-0.2492****	**-0.1820****	**-0.1729****	**-0.2218****
			(-0,0144)	**(-0,1465)**	**(-0,08153)**	**(-0,08014)**	**(-0,0869)**

Ln_fdi				**0.1191****	**0.0349****	**0.2324*****	**0.1301****
				(0,08108)	**(0,0177)**	**(0,0864)**	**(0,0759)**
Unemp					**-0.2915*****	**-0.2241*****	**-0.1604*****
					(-0,0397)	**(-0,0373)**	**(-0,0338)**
Trade						**-1.6217*****	**-1.6069*****
						(- 0,3201)	**(- 0,273)**
Conexp							**-0.1241*****
							(-0,0219)
Intercept	**23.784*****	**22.819*****	**22.965*****	**22.263*****	**25.422*****	**26.148*****	**22.294*****
	(0,5388)	**(0,5768)**	**(0,6868)**	**(0,5404)**	**(0,6038)**	**(0,5499)**	**(0,4388)**
SER	**0,6541**	**0,2958**	**0,3004**	**0,3032**	**0,2695**	**0,2703**	**0,2597**
R^2	**0,2792**	**0,376**	**0,3629**	**0,4286**	**0,6522**	**0,7344**	**0,8091**
Number of obs	**95**	**95**	**92**	**90**	**90**	**90**	**90**

Source: Authors' estimations using STATA software

Since, Central Asian countries are developing, theforeign direct investments showed positive but insignificant effect on GDP per capita. Yousefi(2011) used data for 62 different levels of countries to analyze whether ICT would promote the improvement of economic developments. Findings from the research indicated that ICT affects more significantly on the economic growth of developed countries rather developing countries. Thus, the researcher highlighted that for lower-income countries, economic development is not really depend on investments in information and communication technologies. Other researchers analyzed potential effect of FDI and ICT to productivity. Dimelisand Papaioannou (2010) in the occasion of 42 selected developing and developed countries from 1993 to 2002. The outcome of the analyses indicated positively and significantly effects of ICT for all sampled countries, however the impact can be even more powerful for the developing countries. Regarding to the FDI, econometric estimation showed a positive and significant effect on developed countries, but in the case of developing countries the impact is positive but insignificant. Thus, null hypothesis has been accepted.

In our econometric model one percent increase in fixed broadband subscriptions would lead to 0.167 percent increase in GDP per capita, keeping all other variables constant. So, null hypothesis has been rejected. The variable inflation showed negative and significant effect that one percentage decrease in inflation would lead to 0.22 percent increase in GDP per capita, by keeping all other things constant in the selected Central Asian countries.The effects of fixed broadband subscriptions has been investigated and analyzed byCzernich et al., (2009), the researches proved a positive and significant effect of ICT on the economic growth, in the paper the impact of fixed broadband infrastructure on the growth of economy has been analyzed for 25 OECD countries from 1996 to 2007. The results indicated that a 10 percent increase in the broadband penetration can lead to 0.9 – 1.5 percent increase in GDP growth per capita.In our example, one percent increase in the percentage of individuals using the internet can lead GDP per capita 0.22 percent increase, while all other things are constant.

Choi and Yi (2009) showed a positive and important role of the internet use for economic development by implementing data for 208 countries for a period of 10 years (1991-2000). When evaluating, the researchers included other controlling variables (trade openness, unemployment), and the outcome is generally followed the literature; internet usageand trade openness showed apositive and significant effect on the growth of economy while final consumption and unemployment indicated a negativeeffect.In the case of trade openness, one percentage increase in the rates of trade openness would lead to 1.6069% increase in GDP per capita, with keeping everything constant. Regarding to consumption expenditure and unemployment, one percentage increase in each variable separately, would cause GDP per capita to decrease by 0.1241 and 0.1603 percent respectively by keeping all other things constant.

In our investigations trade openness contributes to economic growth more than other variables, and one percentage increase in the share of trade openness would lead to 1.6069 percentage increases in GDP per capita. Meijers (2014) aimed to find out whether internet directly impacts on economic growth or it has influence on economic development more indirectly within trade. The author used data for 162 countries from 1990 to 2008 and the results indicated that internet use does not impact directly to the economic growth but it has positive and significant affect indirectly through trade.

5.CONCLUSION

With the development of the digital economy, ICT is widely penetrated in all spheres, and it is believed to improve intensive Economy growth rather than exhausting resources to maintain economic growth in the long-run, especially on a per-capita basis. The ICT undoubtedly contributes much to improve enterprises technology and socio – economic development too. It can facilitate the new countryside construction; create more comfortable urban and rural life. Extension of digital economy has become a driving force for innovative development and modernization.Rapid technological progress in the production of ICT goods and services may contribute to more rapid multi factor productivity (MFP) growth in the ICT-producing sector. Moreover, greater use of ICT may contribute to network effects, such as lower transaction costs and more rapid innovation, which will improve the overall efficiency of the economy

Having analyzed the data implemented and obtained results, the possible interpretation and explanation with the empirical literature review, the following conclusions are driven..In this study, two the main and very important explanatory variables of ICT and five economic control variables have been applied. The independent variables are: Fixed broadband subscriptions, percentage of individuals using the internet, foreign direct investment, inflation, trade openness, final consumption expenditure, and unemployment and capital formation. Beingone of the first papers, which analyzed and evaluated the causality between ICT and economic growth in Central Asian countries, especially those 5 "stan" countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan), this paper is based on several tests and analysis, particularly,co linearity test, Hausman test, Modified Wald Test Heteroskedasticity, Wooldridge test in "autocorrelation", Correlation matrix of residuals, Pesaran's test of cross sectional independence and variance inflation test.Based on the driven tests' analyses and evaluations regarding to the issue of causality between information and communication technology (ICT) and economic growth in Central Asian countries, there the following several conclusions made according to the objectives of the study. Having followed the empirical results of recent research papers and studies, the obtained results and analyses show that ICT affects to GDP per capita positively and significantly. Therefore, one percent increase in ICT contributes to GDP per capita 0.1669 percent (fixed broadband subscriptions) and 0.2218 percent (internet usage).

In the case of economic indicators, the results released that inflation, trade openness, final consumption expenditure and unemployment impact significantly on GDP per capita in Central Asian countries. Thus, information and communication technology together with economic indicators are key part of economic development in Central Asian countries.In order to encourage sustainable economic development, governments and policy makers in Central Asian countries should put more emphasis on rising investment in mobile-phone sector, since this infrastructure is much cost effective and useful rather fixed line phones. Additionally, authorities are supposed to promote and increase ICT usage to penetrate internet use and broadband acceptation, paying more attention to shorten the divided gap between rural and urban places. To improve government management and increase efficiency in public-administration, the authorities should apply e-government. Moreover, they should encourage expanding of ICT usage in private business and organizations sectors as well by several policy remedies, for example: tax reductions, subsidy, improving e commerce and promoting public to private co-operations in order to develop telecommunication infrastructure and service. In this regard the Republic of Uzbekistan can be given as a good role model for the rest of the analyzed 4 Central Asian countries. This year at the suggestion of President ShavkatMirziyoyev, the Republic of Uzbekistan has been named "2020- the Year of Science, Education and Development of the Digital Economy", and the President (ShavkatMirziyoyev, 2020) stated that "for all of us, the acquisition of modern knowledge, true enlightenment and high culture should become a constant necessity of life", and the president highlighted that in this regard the ICT prevalence is the key driver.

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The results for the Multicollinearity Test are provided in the Appendix 1.

Appendix 1

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. corr ln_gdp ln_fdi ln_fsub ln_inf ln_internetusers cen_trade cen_conexp cen_unemp capform
(obs=90)
```

	ln_gdp	ln_fdi	ln_fsub	ln_inf	ln_int~s	cen_tr~e	cen_co~p	cen_un~p	capform
ln_gdp	1.0000								
ln_fdi	0.0421	1.0000							
ln_fsub	0.5397	-0.0386	1.0000						
ln_inf	-0.0607	-0.1059	-0.0500	1.0000					
ln_interne~s	0.5840	-0.0401	0.5706	-0.3929	1.0000				
cen_trade	-0.5423	0.3879	-0.1521	0.0720	-0.3509	1.0000			
cen_conexp	-0.3533	-0.2997	0.0554	0.0432	0.1118	-0.0435	1.0000		
cen_unemp	-0.7440	-0.0723	-0.3544	0.1888	-0.6011	0.4173	0.2244	1.0000	
capform	0.3118	0.3467	0.0035	-0.3720	0.3047	-0.0795	-0.2392	-0.5131	1.0000

Source: Authors' estimations using STATA software

The findings for the Hausman Test are given in the Appendix 2

```
. hausman fixed, sigmamore

Note: the rank of the differenced variance matrix (4) does not equal the number of coefficients being tested (8); be sure
      this is what you expect, or there may be problems computing the test.  Examine the output of your estimators for
      anything unexpected and possibly consider scaling your variables so that the coefficients are on a similar scale.
```

	Coefficients (b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
ln_fdi	.0086551	.1299907	-.1213356	.0490227
ln_fsub	.0710629	.166993	-.09593	.0140565
ln_inf	-.0017101	.2218388	-.2235489	.0647953
ln_interne~s	.2036961	.1473294	.0563667	.1076364
cen_trade	-.3809272	-1.606935	1.226007	.4298528
cen_conexp	-.0528617	-.1241051	.0712434	.0431728
cen_unemp	-.0824103	-.1603478	.0779374	.0825633
capform	.0187761	.0000297	.0187463	.0101693

```
                b = consistent under Ho and Ha; obtained from xtreg
     B = inconsistent under Ha, efficient under Ho; obtained from xtreg

  Test:  Ho:  difference in coefficients not systematic

              chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =       70.86
            Prob>chi2 =      0.0000
            (V_b-V_B is not positive definite)

.
```

Appendix3

```
. xtreg ln_gdp ln_fdi ln_fsub ln_inf ln_internetusers cen_trade cen_conexp cen_unemp capform

Random-effects GLS regression                   Number of obs     =         90
Group variable: id                              Number of groups  =          5

R-sq:                                           Obs per group:
     within  = 0.8058                                         min =         16
     between = 0.9250                                         avg =       18.0
     overall = 0.8091                                         max =         19

                                                Wald chi2(8)      =     343.37
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000
```

ln_gdp	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ln_fdi	.1299907	.0796462	1.63	0.103	-.0261131	.2860944
ln_fsub	.166993	.0361432	4.62	0.000	.0961537	.2378323
ln_inf	.2218388	.0910405	2.44	0.015	.0434027	.4002749
ln_internetusers	.1473294	.0624736	2.36	0.018	.0248834	.2697755
cen_trade	1.606935	.2748366	-5.85	0.000	-2.145604	-1.068265
cen_conexp	-.1241051	.0220539	-5.63	0.000	-.1673299	-.0808803
cen_unemp	-.1603478	.0374541	-4.28	0.000	-.2337565	-.086939
capform	.0000297	.0105671	0.00	0.998	-.0206813	.0207408
_cons	22.79575	.4382645	52.01	0.000	21.93676	23.65473
sigma_u	0					
sigma_e	.24256081					
rho	0	(fraction of variance due to u_i)				

```
.
```

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