The Effects of FDI, ICT, CO2 Emissions and Financial Development on Economic Growth: Evidence From The APEC

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Abstract: We research the impact of foreign direct investment (FDI), information and communication technology (ICT), financial development, and CO2 emissions on economic growth. The study was carried out using the OLS regression method with data from 20 countries and territories belonging to the Asia-Pacific Economic Cooperation (APEC) period 2000 - 2020. Empirical results find that Foreign Direct Investment (FDI) has a positive impact on the economic growth of developing countries, but not an impact on the economic growth of developed countries in APEC, while the development of the information and communication technology (ICT) system has a negative effect. However, ICT has an unclear impact on the economic growth of developed countries. Besides, a country's financial development as represented by its financial liquidity index (DLIQLIA) has a negative impact on economic growth, especially for developing countries. In addition, domestic financial development is not a catalyst for FDI to have an impact on economic growth in that country. CO2 emissions have a positive impact on economic growth and have a greater impact on economic growth in developed countries than in developing countries. The results have practical implications from which to make policy proposals for economic growth, environmental protection, and effective access to technology.

Keywords: CO2 emissions, Economic growth, FDI, Financial development, ICT

1. Introduction

1.1. Reason

The study of economic growth is a complex process, upheaval and has evolved over the years. From the early works of Adam Smith and Malthus to this day, researchers and economists have always tried to explain and step-by-step affirm the necessity of economic growth for the development of each country and the whole world (Boldeanu & Constantinescu, 2015). The issue that needs attention is which factors have an impact on economic growth. What should we do to guarantee economic development while still meeting the requirements of reality?

Economic growth is an issue that has always been of interest to many economists, from the initial studies of Schumpeter (1911) on the role of financial development in economic growth to recent studies about the impact of foreign direct investment on economic growth. However, Hong (2015) has newer findings when studying the combination of the above two factors, FDI and financial development, on economic growth. This relationship has been studied extensively and is a crucial aspect of economic growth. It seems that studies on this issue are still quite limited in terms of space and time. Therefore, with the economy and times constantly fluctuating, it is crucial to have up-to-date data and research to make informed decisions.

Besides, today, when the world is in the context of the Industrial Revolution 4.0, along with the Internet, ICT has transformed manufacturing processes in most industries in many countries (Maurseth, 2018). The study of ICT infrastructure has received a lot of attention in recent studies due to its potential role in contributing to economic growth. However, empirical evidence on the importance of ICT infrastructure for growth is still scant in the literature (Nam, 2021). A correct and comprehensive understanding of both the opportunities and challenges of ICT is one of the prerequisites for developing and growing the economy in the most optimal direction.

Along with that, over the past three decades, CO2 emissions have increased significantly due to various economic and non-economic activities (Sarwar et al,. 2019). The current increase in

CO2 emissions is the biggest threat to environmental change (Muhammad & Khan, 2019). This is considered a challenge that shows that environmental protection is urgent to prevent some negative impacts on human health while ensuring sustainable development. Efforts to mitigate global warming and reduce CO2 emissions have become priorities in national and international climate policies (Haggar, 2012). How to maintain green development is very important in the future. Therefore, currently, determining the impact of CO2 emissions on growth is still an issue that attracts a lot of attention from researchers.

This study can add to the CO2 emissions literature and also provide a real understanding of the impact of CO2 emissions, ICT, FDI, and financial development on APEC's economic growth in general and of each group of developed and developing countries in the APEC block in particular. To achieve the "Sustainable Development Goals" by 2030, policymakers, governments, and researchers are constantly looking for solutions that bring ecological balance along with economic development. Therefore, we researched the topic "The effects of FDI, ICT, CO2 emissions and Financial Development on Economic Growth: Evidence from the APEC". From there, make policy recommendations to promote sustainable economic development through upgrading industrial structure.

2. Literature Review

2.1 FDI

The Impact of FDI on Economic Growth, foreign direct investment (FDI) is the movement of capital or assets from one country to another receiving investment. The following analysis will provide an overview of the theories, thereby drawing the role of FDI in economic growth.

Classical Economic Growth Theory, classical theories focus on factors of production such as labor, capital, and land. The classical theory of Smith (1776) suggested that land and population

played an important role in growth. If you want to grow, you must expand your land and increase your population. Adam Smith considers income distribution as one of the most important factors determining the growth rate of a country. However, Ricardo (1817) argued that output growth requires growth in inputs, which means that for growth, more land must be used for farming, but the limitation of agricultural land leads to a tendency to reduce the profits of both producers and affects economic growth.

Karl Marx (1818-1883) further developed factors that affect economic growth including land, labor, capital, and technical progress. He argues that falling profit rates do not prevent capital accumulation. Capitalists could increase their rate of profit back by bringing machines into production. In addition, Keynesian analysis with the Harrod-Domar model (Harrod, 1939**;** Domar, 1947) assumes that expansion and the prediction of a higher saving (for investment) rate can promote economic growth higher. The logic of this theory is that the income of a country (as well as an individual) consists of two items, saving (for investment) and consumption, so the larger the savings rate, the faster the growth. Later, Kaldor (1957) proposed that savings could vary and would reach the value needed to bring the real growth rate back to its guaranteed path.

Exogenous Growth Theory, the growth model of Solow (1957) assumes flexible substitution of capital and labor. The land is fixed and is replaced by physical capital. Because capital is different from land, it can be produced and accumulated. Capital accumulation increases production capacity and improves labor productivity, opening the prospect of overcoming the law of diminishing returns.

The basic Solow model emphasizes the role of capital in production and savings to generate new capital. However, the model cannot account for a real trend in average incomes increasing over time around the world. A new research direction opens: if the technology level is allowed to increase over time, the average capital and average income will increase accordingly. Technological progress is included in the analysis of the extended Solow model. Because there is no incentive to produce new technology, the model is forced to assume that the technology grows exogenously.

Through exogenous growth theory, FDI affects economic growth through its impact on total domestic investment (Herzer et al,. 2008).

Endogenous Growth Theory, the endogenous growth model considers technology as an endogenous variable of the model, while knowledge capital is the determining factor in the rate of technological progress. Here, knowledge capital is defined as knowledge spillover - positive externalities (Romer, 1986), human capital Lucas (1988), and R&D activities (Romer, 1990). Thus, output is related to capital, labor, and knowledge (Romer, 1990). Clearly, the authors always try to understand the interaction between knowledge capital and technological progress, thereby explaining how the combination between them leads to economic growth. The model of Romer (1986) explains economic growth following technological progress as capital accumulation. Pervasive knowledge can generate returns to scale across the economy as more and more people use knowledge. The combination of technical progress and returns to scale makes it possible for an economy to sustain economic growth in the long run. Thereby, it is found that economic growth depends on the level of investment for each type of capital (Lucas, 1988). Therefore, investment plays a very important role in promoting economic growth. Endogenous growth theory focuses on the development of production technology in the host country and assumes that FDI is more efficient than domestic investment (de Mello, 1999).

Experimental Research Evidence, a study of de Mello (1997) shows that FDI has a positive impact on economic growth in 17 OECD countries through capital, technology, and human resources. The study of De Gregorio (1992) shows that there is a positive impact between FDI on economic growth and the productivity of FDI is higher than the productivity of investment in the country. Borensztein et al,. (1998) concluded that FDI has a positive impact on economic growth through industrial transmission channels. However, this impact is also affected by another factor: the quality of human resources in the receiving country. For the group, there are several other factors: low costs, low tariff barriers, a free and investor-friendly investment environment that help the economies of developing countries benefit from FDI.

However, the study of Hong (2015) shows that FDI has a negative effect on economic growth in the host country. The study of Falki (2009) shows that there is a negative and not statistically significant relationship between FDI and economic growth in Pakistan. And some other studies such as Bende-Nabende et al,. (2001), the study of Li & Liu (2005), and Chaudhury et al,. (2020) have similar results.

2.2 Financial Development

The Impact of Financial Development on Economic Growth, the financial system plays a particularly important role in promoting economic growth by performing basic functions such as generating information about investments, monitoring investments for corporate and risk management purposes, mobilizing and allocating savings, and promoting favorable transactions (Levine, 2005). In addition, the early studies by Schumpeter (1911) on financial development clearly stated and provided an objective view of economic development theory. He said that economic development is driven by innovation in financial intermediaries, businesses need access to credit to finance the application of technical advances as well as new technologies, thereby can promote business activities. Agreeing with Levine (2005), Goldsmith (1969), Vanags (1971), Gurley & Shaw (1955) all affirmed that the development of the financial system will promote economic growth. With high economic growth, there will also be developed financial markets, and in those countries, developed financial markets lead to higher economic growth by increasing the size of savings and improving efficiency investment (McKinnon, 2010; Shaw, 1973). In other words, financial markets play an important role when it comes to providing liquidity to investors (Diamond & Dybvig, 1983). In addition, financial intermediaries reduce the amount of savings held as unproductive liquid assets and prevent the misallocation of capital due to liquidity needs (Bencivenga & Smith, 1991). Grossman & Stiglitz (1980) also show that the stock market stimulates the production of information about firms and with the growing liquid financial markets, agents easily gather information and seek profits.

Experimental Research Evidence , m any researchers have chosen topics related to financial development and economic growth as a guideline for their research work. The study conducted by King & Levine (1993), found a positive relationship between economic growth and financial development. This relationship is explained by the fact that financial development increases profits based on the innovation of the provision of three services. Similarly, other studies with similar results determining that financial development has a positive effect on economic growth (Rioja & Valev, 2004; Rousseau & Wachtel, 2001).

On the other hand, there are also studies that argue that financial development has a negative impact on economic growth. Typically, there is a study by Lan & Trung (2019) , which uses panel data and generalized moment estimation methods with data taken from 1961-2015 from more than 135 countries. As a result, there exists an inverted U-shaped relationship between bank credit and economic growth. That is, when exceeding the threshold of 103% of GDP, increasing the credit/GDP ratio will reduce economic growth and vice versa. Research by Kieu et al,. (2016) and Hong (2015) found a negative relationship between financial development and economic growth. However, the estimation results of the groups of developed, developing and underdeveloped countries show that there is a difference in the impact of financial development on economic growth between groups of countries. Specifically, financial development has a positive impact on economic growth in developed countries and a negative impact on the remaining two groups of countries. This is explained by the fact that the financial system in developed countries is more stable, with less chance of rapid growth leading to collapse. The studies of Chee & Nair (2010) and Loayza & Rancière (2006) also have similar results. The reason for this result can be attributed to the short-term instability and fragility of the financial systems in those countries (Loayza & Rancière, 2006).

2.3 CO2 Emission

The Relationship between CO2 Emission and Economic Growth, carbon dioxide (CO2) is a colorless, odorless, and non-toxic gas formed from the combustion of carbon or during the respiration of living organisms and is considered a greenhouse gas. The amount of CO2 in the atmosphere stores heat and causes weather variations, causing global temperatures to rise and other climate changes to occur. It can be seen that CO2 emissions are a significant contributor to climate change and global warming. Tollefson (2020) suggests that global temperatures will increase by 5 to 6°C by the end of the 21st century if the current rate of greenhouse gas increase remains the same. It can be seen that the increase in issues related to climate change has pushed countries to shift towards economic low-carbon emissions development quickly (Stern, 2007; Zhou & Li, 2019) and promote the goals of the Paris Agreement (Ren et al,. 2022). To achieve the goal, countries must face many challenges when energy is an essential driving force for economic development as well as a direct factor in increasing CO2 emissions. Evidence that China's rapid economic development is also accompanied by a rapid increase in energy consumption and the emission of many greenhouse gases (Riti et al,. 2017).

In general, previous empirical studies have left behind a treasure trove of literature but there is still no consensus among viewpoints. The results indicate that the relationship between CO2 emissions and economic growth is very diverse, it may not exist or be a two-way relationship or a one-way impact from CO2 emissions to economic growth and vice versa. Therefore, this study examined the impact of CO2 emissions on economic growth in APEC countries and the differences between groups of countries in the region.

Experimental Research Evidence, many studies support the existence of the Kuznet curve such as Maddison's (2008) study examining the causal relationship between economic growth and CO2 emissions through Granger tests. Research results show that there is a two-way relationship between GDP and CO2, similar results when dividing countries by income group. Mamun et al,.

(2014) researched 5 groups of countries including low-income countries; medium-low income; medium-high income; high income within the OECD, and high income outside the OECD. It shown that, except for the group of high-income countries, the Kuznets curve was a common phenomenon globally.

Some other studies believe that the relationship between CO2 emissions and economic growth exists in an N shape. In the study of Akpan & Chuku (2011) was shown that economic growth is significantly associated with increased environmental degradation in Nigeria both in the short and long term. Similarly, Adebayo et al,. (2020) also found that the relationship between CO2 emissions and economic growth is N-shaped.

In addition, many experimental studies also do not support the environmental Kuznets curve (EKC) theory. In particular, the study of Galeotti et al,. (2006) testing stationarity and cointegration of panel data with data from 24 OECD countries from 1960 to 2002 confirms that the environmental Kuznets curve (EKC) is still a fragile concept. Research by Chebbi & Boujelbene (2008) for Tunisia from 1971 - 2004 and research by Saboori et al,. (2011) conducted with Iranian data from 1971 - 2007, both studies used the ARDL distributed lag regression method and also relied on the theory of the environmental Kuznets curve and the research results did not support it. Increasing pollution levels cause economic growth to expand.

2.4 Digital infrastructure

Impact of Digital Infrastructure (ICT - Information and Communication Technology) on Economic Growth, digital infrastructure or technology in general is measured through information and communication technology (ICT). Information and communication technology (ICT) has been a very dynamic investment area over the past decade (OECD, 2004). Since the 1990s, ICT has been one of the tools of technical innovation to modify the economic and industrial structure. These benefits were most evident during the period linked with the profound changes

brought on by the COVID-19 pandemic when ICT made it possible for the "new normal" to operate (Mińska-Struzik et al,. 2021). Romer (1986) contends that the diagnosis of long-term economic growth predicated on an increase in the margin of production leads to the enhancement of input quality, which contributes positively to achieving a competitive advantage. This attribute is evident through the use of technology, which is emerging more rapidly in larger countries than in smaller ones. ICT helps disseminate ideas among institutions and encourages the role of competition in the development of innovative products that contribute to the creation of effective activities in a macro economy. Classical endogenous theory predicts ICT's contribution to economic prosperity by introducing new processes, innovative products, and business models (Liao & Zeng, 2023). ICT increases business revenue by cutting costs, providing new job opportunities, and promoting market efficiency (abid et al., 2023). Karaman Aksentijević et al,. (2021) argue that IT contributes significantly to economic growth. The impacts of IT are significant on economic growth in lower-middle-income and low-income countries. However, this impact is insignificant in high- and middle-income countries. Thus, in business operations, where ICT plays an important role, the benefits of ICT-induced productivity gains are real in the economy. More specifically, the benefits of innovations brought about by ICT have an impact on economic change. Besides, ICT also plays an important role in promoting competitiveness, as well as improving productivity in all sectors of the economy. Research by Chowdhury (2006) suggests that every 1% increase in the number of Internet users will reduce the impact of inflation by 40%. This characteristic explains the influence of communication technology on the economic environment. The results also show that the ICT investment sector has a positive impact on the overall expansion of the market. Despite the obvious important impacts of ICT on the economy and society at large, the growth impact from ICT is still hard to find in the macro data. In addition, the growth rate tends to decrease for decades and this is seen as the Solow paradox (Maurseth, 2018).

Experimental Research Evidence, many studies have documented that ICT is a driver of economic growth (Thong et al,. 2020; Zhang et al,. 2022). Choi & Yi (2009) found that in the period

from 1990-2000, ICT stimulates economic growth. However, from 1990-2015, the study showed that ICT has significant negative effects on economic growth. The study by Toader et al,. (2018) and Nam (2021) about the European Union and Vietnam also showed similar results, digital infrastructure or ICT has a positive impact on economic growth. However, Pohjola (2002) did not find any statistically significant correlation between ICT investment and economic growth when studying 43 countries from 1985-1999. According to the author, this result is due to the accessibility of communication technology and the existence of outdated technology in many developing countries. Kallal et al,. (2021) analyzed Tunisia during the period 1997–2015 and found that in the long run, ICT has a positive impact on economic growth. Otherwise, in the short term, the result is a negative impact. Papaioannou & Dimelis (2007) found that investment in ICT only promotes growth in developed countries. Appiah-Otoo & Song (2021) examined the impact of ICT on economic growth by comparing rich (HIC) and poor (MIC and LIC) countries from 2002 to 2017. They found that ICT increases economic growth in both rich and poor countries. The findings also further showed that the gains from ICT in poor countries are larger than those of rich countries. Niebel (2018) investigates the importance of ICT for economic growth based on a sample of 59 countries over the period 1995–2010. The regression of the full sample of countries reveals an output elasticity of ICT that is larger than the ICT factor compensation share, indicating possible spillovers and complementarities of investments in ICT. These excess returns confirm the positive impact between ICT and economic development. However, the regressions for the three country subsamples reveal rather small differences in the output elasticities of ICT between developing, emerging, and developed countries. As a consequence, there is no clear statistical indication that developing and emerging countries are gaining more from investments in ICT than developed economies. Besides, Yousefi (2011) shows that the impact of ICT is more significant in middle-income countries than in high-income countries and in both cases, it contributes positively to economic growth. This demonstrates that a country's income level influences different responses to the development of the telecommunications industry.

2.5 The Relationship between FDI, Financial Development, and Economic Growth

The role of FDI and development in the financial sector for economic growth has been one of the topics of most interest to researchers in recent years. There are many empirical studies showing that the financial sector is an important part of the economic growth process. This shows that a good financial system is an essential condition for the development of a market economy (King & Levine, 1993; Levine, 2005), so countries tend to be more interested in attracting FDI. Besides, financial development also helps the economies of FDI recipient countries to absorb more fully the benefits of this capital inflow (Hermes & Lensink, 2003; Patrick, 1966). In the long run, financial sector development is crucial for FDI to have a positive effect on economic growth (Choong et al,. 2004). However, Hermes & Lensink (2003) conducted a study with 67 countries in Latin America and Asia and found that 37 out of 67 countries have sufficiently developed financial systems to allow FDI to contribute positively to economic growth. Accordingly, in the initial regression model, the variable measuring FDI has a negative regression coefficient, which is statistically significant, but when adding to the model of the interaction variable between FDI and financial development, the interaction variable has a positive index, statistically significant numbers. And almost all other countries that are in Sub-Saharan Africa have very weak financial systems and consequently, FDI does not contribute positively to growth. Research by Hong (2015) finds that financial development has no impact on the relationship between FDI and economic growth in ASEAN countries in the period 1995-2013, and the author has argued that the instability and fragility of the financial system in the ASEAN region can be the cause of the non-statistically significant interaction variable between FDI and financial development. The results also show that the interaction variable has a positive impact on developing and underdeveloped countries. In particular, the regression coefficient of the interaction variable in the group of underdeveloped countries is the highest, showing that the role of financial development in the relationship between FDI and economic growth in the group of underdeveloped countries is the largest. FDI only promotes economic growth when the financial development index is large, which means that the

economy of the receiving country can only absorb the benefits of FDI when the domestic financial market achieves a certain level of development (Azman-Saini et al,. 2010).

3. Data and Methodology

3.1 Data

The paper analyzed data sheets were collected from 20 countries within the Asia-Pacific Economic Cooperation (APEC) during the period of 2000 to 2020. The majority of the data used in our paper was obtained from reputable sources such as the World Bank (WB) and International Monetary Fund (IMF).

3.2 Regression Model and Variables

Regression Model, based on Hong's (2015) study, which examines the impact of FDI, financial development and the interaction between these variables on economic growth, we have expanded the topic to investigate the additional impact of CO2 emissions and digital infrastructure on the dependent variable.

Therefore, we have the regression model below:

$$\mathbf{GROWTH_{i,t} = \beta_0 + \beta_1 FDI + \beta_2 FINDEV_{i,t} + B_3 (FDI \times FINDEV)_{i,t} + \beta_4 CO2_{i,t} + \beta_5 TECH_{i,t} + \beta_6 CONTROLS_{i,t} + \varepsilon_{i,t}}$$

With the proxy for financial development is credits to private sector from the sources of financial intermediaries (PRICRE):

$$\mathbf{GROWTH_{i,t} = \beta_0 + \beta_1 FDI + \beta_2 PRICRE_{i,t} + B_3 (FDI \times PRICRE)_{i,t} + \beta_4 CO2_{i,t} + \beta_5 TECH_{i,t} + \beta_6 CONTROLS_{i,t} + \varepsilon_{i,t}} \quad (1)$$

With the proxy for financial development is liquidity index of the financial system (LIQLIA):

$$\mathbf{GROWTH_{i,t} = \beta_0 + \beta_1 FDI + \beta_2 LIQLIA_{i,t} + B_3(FDI \times LIQLIA)_{i,t} + \beta_4 CO2_{i,t} + \beta_5 TECH_{i,t} + \beta_6 CONTROLS_{i,t} + \varepsilon_{i,t}} \quad (2)$$

Table 3.1 Variables used in the model

	Name	Variable name	Calculation	Expectation
Dependent variable				
1	Economic Growth	**GROWTH**	Growth rate of real GDP per capita (%)	
Independent variable				
2	Foreign Direct Investment	**FDI**	FDI/real GDP (%)	+
3a	Liquidity of the financial system	**LIQLIA**	M2/real GDP (%)	+
3b	Credits to private sector	**PRICRE**	Credits to private sector/real GDP (%)	+
4	CO2 emissions	**CO2**	Metric tons per capita (tons)	+
5	Digital infrastructure	**TECH**	Percentage of population using the Internet (%)	+
Control variables				
6	Trade openness	**TRAOPE**	Total import and export/real GDP (%)	+
7	Population growth	**POPGO**	Population growth rate (%)	-
8	Government expenditure	**GOVEXP**	Total government expenditure/real GDP (%)	+/-

9	Gross capital formation	**GCF**	Gross capital formation/real GDP (%)	+

Hypothesis

Hypothesis H1: FDI positively influences economic growth.

Hypothesis H2: Financial development positively influences economic growth.

Hypothesis H3: The interaction between FDI and Financial development positively influences economic growth.

Hypothesis H4: CO2 emissions positively influences economic growth.

Hypothesis H5: Digital infrastructure positively influences economic growth.

3.3 Methodology

In panel data analysis, it is crucial to verify the stationarity of the data before starting the research process. The authors use the Phillips-Perron's Fisher test to check for stationarity in the data. We also employ different models like Pooled OLS, Fixed Effects Model (FEM), Random Effects Model (REM) and use statistical tests like F-test, Breusch Pagan test and Hausman test to compare and select the most appropriate model.

Moreover, the seasonality of the data along with the previous issues is another factor to consider in the regression analysis. To control for this and increase data stability, the authors constructed a model with a dummy variable for the year and evaluated the model's reliability.

Finally, to address any existing misspecifications and validate the reliability of the study after selecting the optimal model, the authors use the Feasible Generalized Least Squares (FGLS) estimation. The FGLS method helps to rectify any existing shortcomings in the analysis and enhance the credibility of these findings.

4. Results

4.1 Descriptive Statistics

Our raw data set presents descriptive statistics of the variables in the author's proposed research model for 20 countries and territories belonging to the Asia-Pacific Economic Cooperation (APEC) forum in the period from 2000 to 2020, excluding Taiwan, which corresponds to 420 observations in the sample. An overview of the data about the descriptive statistics for the variables used in our study is presented in table 4.1

Table 4.1 Descriptive statistics of the variables in the research model

Variables	Observations	Mean	Standard Deviation	Min	Max
GROWTH	420	2.4109	3.4156	-12.1539	13.6358
FDI	420	4.7431	7.6373	-3.8118	58.5184
PRICRE	420	96.3923	55.8888	12.8777	258.9028
LIQLIA	420	105.0157	71.1779	20.0125	454.7032
CO2	420	7.3815	5.7897	0.5129	21.7058
TECH	420	50.1116	29.5680	0.2542	96.5051
TRAOPE	420	104.1828	95.1260	19.5596	442.6200
POPGO	420	1.1217	0.7957	-1.4745	5.3215
GOVEXP	420	27.7993	8.7366	12.9741	50.8146
GCF	420	25.3586	6.2153	10.4374	46.6601

Source: Compilation of the author team from Stata 17.0

This table presents summary descriptive statistics for the main variables used in this study. During the study period, the average value of the GROWTH variable in the 20 countries was 2.4109, with minimum and maximum values of -12.1539 and 13.6358, respectively. The standard

deviation of this variable is 3.4156. Foreign direct investment (FDI) flows by each country and territory show the smallest value of -3.8118 and the largest value of 58.5184 (2015), the average net capital inflow of APEC is 7.6373. Regarding private sector credit (PRICRE), a proxy for financial development, the average ratio is 55.8888, ranging from 12.8777 to 258.9028. Another financial development index (LIQLIA) has a mean value of 105.0157, ranging from 20.0125 to 454.7032. For CO2 emissions (CO2), there are data ranging from 0.5129 to 21.7058, with an average of 7.3815. Finally, digital infrastructure (TECH) has the highest value of 96.5051 and the lowest value of 0.2542, reaching an average value of 29.5680.

4.2 Results

Regression Results with DLIQLIA

Table 4.2 Regression results with DLIQLIA

Variables	All (REM)	Developing Countries (REM)	Developed Countries (REM)
FDI	0.1036***	0.2635**	0.0354
DLIQLIA	-0.0326*	-0.2139***	0.0098
FDI x DLIQLIA	-0.0018	0.0319***	-0.0035***
DCO2	0.8120***	0.6101**	1.5623***
TECH	-0.0486***	-0.0560***	-0.0178

TRAOPE	-0.0005	0.0023	0.0033
DPOPGO	0.3350	6.4781***	0.1177
DGOVEXP	-0.3175***	-0.1851***	-0.3755***
GCF	0.1837***	0.2171***	0.1055**
Constant	-0.1357	-1.4324	0.1538
Observations	400	240	160
Countries	20	12	8
R squared	0.5563	0.5887	0.7072
F test	-	-	-
λ2	231.53***	182.63***	170.11***
Hausman test	15.30*	16.15*	12.49

*The symbols ***, **, * represent statistical significance at 1%, 5%, 10%, respectively*

Source: Compiled by the author's team

The regression results in table 4.2 provide evidence that FDI increases economic growth (GROWTH) in APEC countries. Statistical evidence from our sample shows a positive relationship between FDI and GROWTH at the 1% significance level. This relationship is similar in the case of developing countries but is somewhat less strong than the total sample at the 5% statistical significance level, while for developed countries it is not statistically significant. These findings are consistent with the research of de Mello's (1997), De Gregorio (1992), Borensztein et al,. (1998) show that FDI has a positive impact on economic growth.

Next, financial development expressed through the liquidity of the financial system (DLIQLIA) reduces economic growth at a statistically significant level of 10%, which in the case of developing countries also reduces economic growth economic growth and the impact is stronger than in the total sample; developed countries are not statistically significant. This demonstrates the fragility of the financial systems of APEC countries, especially developing countries. This study has similar results to those of Kieu et al,. (2016), Hong (2015)**,** Lan & Trung (2019).

The relationship between FDI and financial development has no impact on the economic growth of APEC countries. However, for developing countries, there is a positive impact, similar to the studies of Choong et al,. (2004), Hermes & Lensink (2003), Hong (2015). The regression coefficient of the interaction variable is negative but relatively small for developed countries. This result shows that the role of financial development in the relationship between FDI and economic growth in developing countries is more important.

Next, CO2 emissions (DCO2) have a positive impact on economic growth and are statistically significant at the 1% level. The results obtained by the statistical team are similar to the results of two research articles by Muhammad & Khan (2019), Lee & Brahmasrene (2014). From the table above, it can also be seen that the CO2 regression coefficient of the two groups of countries has a positive and statistically significant impact on economic growth in developed countries more than in developing countries. Developed countries, also known as technological countries, will emit a lot of CO2. The change in the volume of the economy will also be very large. This is consistent with the research of Chebbi & Boujelbene (2008), Saboori (2011).

For digital infrastructure (TECH), this variable is statistically significant at the 1% level and has a negative impact on economic growth in the model. This result is consistent with research by Kallal et al,. (2021) analyze Tunisia (a developing country during the period 1997–2015). Research shows that in the long term, IT has a positive impact on economic growth, but in the short term, it has a negative impact. This study is also consistent with the group's results on the relationship between IT and the economic growth of developing countries. Developing countries account for

12/20 APEC countries. Meanwhile, IT has an unclear impact on the economic growth of developed countries, possibly due to a lack of research data and a lack of universality, reducing the persuasiveness of research.

Check the Robustness of the Research Model by Using the DPRICRE Variable

The authors continue to regress the research model with the DPRICRE variable to test the model's robustness. It shows that the independent variables tend to have an impact on the GROWTH variable, similar to DLIQLIA's model. From the results of model research, the author has achieved the initially set goal. The use of DPRICRE produced similar results, indicating a level of certainty in the regression results.

Table 4.3 Regression Results with DPRICRE

Variables	REM
FDI	0.0952***
DPRICRE	-0.0443*
FDI x DPRICRE	0.0005
DCO2	0.8467***
TECH	-0.0486***
TRAOPE	-0.0002

DPOPGO	0.5154
DGOVEXP	-0.3407***
GCF	0.1920***
Constant	-0.2775
Observations	400
Countries	20
R squared	0.5703
F test	-
λ2	219.64***
Hausman test	12.35

*The symbols ***, **, * represent statistical significance at 1%, 5%, 10%, respectively*

Source: Compiled by the author's team

Check the Robustness of the Research Model by Using the Seasonal Adjustment

One problem that the research model may encounter in regression is the seasonality of the data, which can affect the stability of the data. According to research by Zaremba et al,. (2021); Bakry et al,. (2022), to eliminate the seasonality of research data, the author uses year dummy variables. Specifically, the group adjusted the research model as follows:

$$\mathbf{GROWTH_{i,t} = \beta_0 + \beta_1 FDI + \beta_2 FINDEV_{i,t} + B_3(FDI \times FINDEV)_{i,t} + \beta_4 CO2_{i,t} + \beta_5 TECH_{i,t} + \beta_6 CONTROLS_{i,t} + \sum_{i=1}^{21} \Upsilon_d^k \ TIMDUM_i^k + \varepsilon_{i,t}}$$

$TIMDUM_1$ = 1 for the year 2000, 0 for other years; $TIMDUM_2$ = 1 for 2001, 0 for the rest; and similarly for the years 2002 to 2020. The regression results presented in the table below show

that after seasonal adjustment, the data set is still statistically significant, with the regression coefficient not too different from that without seasonal adjustment. In addition, the impact direction of FDI, DCO2, and TECH remains the same as the original at the 1% significance level. Thereby, making the regression results of the study more certain. However, DLIQLIA is not statistically significant, and the interaction variable becomes statistically significant at the 10% level. The team will study this more closely using the FGLS method.

Table 4.4 Regression Results by Seasonal Adjustment

Variables	REM
FDI	0.0812***
DLIQLIA	0.0188
FDI x DLIQLIA	-0.0022*
DCO2	0.6995***
TECH	-0.0502***
TRAOPE	-0.0003
DPOPGO	-0.0474
DGOVEXP	-0.0731

GCF	0.1401***
Constant	-3.7612***
Seasonal adjustment	Yes
Observations	400
Countries	20
R squared	0.5703
F test	-
λ2	219.64***
Hausman test	12.35

*The symbols ***, **, * represent statistical significance at 1%, 5%, 10%, respectively*

Source: Compiled by the author's team

Check the Robustness of the Research Model by Using the FGLS Method

After selecting a suitable model, the author's team carried out tests for heteroscedasticity and autocorrelation. However, both of the above models have these defects. Since then, the research team has used the FGLS method to control the phenomenon of autocorrelation and variance, according to Westerlund & Narayan (2014). The FGLS method will estimate the model according to the OLS method (even in the case of the existence of autocorrelation and heteroscedasticity). The errors drawn from the model will be used to estimate the matrix of variance—the covariance of the error. Finally, use this matrix to transform the original variables and estimate the values of the parameters to look for in the model. The results of the regression are presented in the following table:

Table 4.5 Regression Results by FGLS Method

Variables	FGLS	FGLS
FDI	0.0651**	0.0663**
DLIQLIA	-0.0272**	0.0092
FDI x DLIQLIA	-0.0009	-0.0007
DCO2	0.8411***	0.3676**
TECH	-0.0309***	-0.0295***
TRAOPE	0.0014	-0.0004
DPOPGO	0.2458	-0.0404
DGOVEXP	-0.2766***	-0.0810**
GCF	0.2263***	0.2234***
Constant	-2.0273**	-6.9147***
Seasonal adjustment	No	Yes
Observations	400	400
Countries	20	20
λ2	367.09***	859.46***

*The symbols ***, **, * represent statistical significance at 1%, 5%, 10%, respectively*

Source: Compiled by the author's team

The regression results from the table 4.5 show that the FGLS estimation method for both seasonal adjustment and non-seasonal adjustment give the same results when regressing with the DLIQLIA variable. All have high statistical significance, and the magnitude of the regression coefficient is not significantly different (except for DLIQLIA, which is statistically significant at the 5% level when non-seasonal adjustment and is not statistically significant when seasonal adjustment). From there, make the research team's conclusions more certain.

5. Conclusion

Research studies on the impact of foreign direct investment (FDI) on economic growth do not reach a consensus. This study was conducted to try to determine the impact of FDI inflows on economic growth and examine the effect of FDI inflows on economic growth through financial development. We use the OLS regression method with data from 20 countries of the Asia-Pacific Economic Cooperation (APEC) for the period 2000 - 2020 to calculate the impact of many factors on economic growth. Factors include FDI, financial development, digital infrastructure (ICT), and CO2 emissions.

Based on the initial research objectives and expectations about the influence of the variables, we have regresss and obtained the following results:

- First, FDI has a positive impact on the economic growth of developing countries but has no impact on the economic growth of developed countries in APEC. Besides, while developed countries in APEC are not affected by financial development, developing countries in APEC are significantly negatively affected. The financial development of the region, especially developing countries, needs to be maintained and further improved to avoid negative impacts when a crisis occurs that will damage the financial system, leading to negative impacts on economic growth.

- Second, financial development plays a role in promoting the positive impact of FDI on economic growth in developing countries and vice versa for developed countries. Thus, this result shows that the role of financial development in the relationship between FDI and economic growth in developing countries is the most important.
- Third, CO2 emissions have more influence on economic growth in developed countries than in developing countries. Because in the process of economic development, developed countries, also known as technological countries, will emit a lot of CO2 and the change in the volume of the economy will also be very large. However, to transition to a sustainable economy, the focus is on decoupling economic growth from CO2 emissions. This involves promoting energy efficiency, the use of renewable energy, and low-carbon technologies to achieve sustainable growth (Balsalobre-Lorente et al,. 2023). Thus, to reduce CO2 emissions and maintain sustainable economic growth, we recommend government and management agencies should also increase the use of various policy tools to strengthen and promote measures to reduce CO2 emissions, improve the efficiency of economic growth, and develop a sustainable economy.
- Four, in the long term, ICT has a positive impact on economic growth, but in the short term, it has a negative impact on the economic growth of developing countries. Meanwhile, ICT has an unclear impact on the economic growth of developed countries. The cause of this negative impact may be due to the underdeveloped information and communication system in the region. Therefore, we recommend that policymakers study the negative impacts of information and communications technology (ICT) systems on the economic growth of the region in general and each country in particular. From there, practical measures can be taken to help increase the effectiveness of ICT on economic growth.
- Finally, economic growth is also negatively affected by government spending (DGOVEXP), while gross capital formation (GCF) has a positive impact on economic

growth. In addition, trade openness (TRAOPE) and population growth (DPOPGO) have no impact on the economic growth of countries in APEC.

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APPENDIX

Appendix 1: Stationarity of table data

Phillips-Perron Fisher Unit Root Test on GROWTH

Null Hypothesis: Unit root (individual unit root process)
Series: GROWTH
Date: 08/08/23 Time: 04:05
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	97.1704	0.0000
PP - Choi Z-stat	-4.63118	0.0000

Phillips-Perron Fisher Unit Root Test on FDI

Null Hypothesis: Unit root (individual unit root process)
Series: FDI
Date: 08/08/23 Time: 04:06
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	173.833	0.0000
PP - Choi Z-stat	-8.21291	0.0000

Phillips-Perron Fisher Unit Root Test on PRICRE

Null Hypothesis: Unit root (individual unit root process)
Series: PRICRE
Date: 08/08/23 Time: 04:06
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	18.3762	0.9987
PP - Choi Z-stat	5.09691	1.0000

Phillips-Perron Fisher Unit Root Test on D(PRICRE)

Null Hypothesis: Unit root (individual unit root process)
Series: D(PRICRE)
Date: 08/08/23 Time: 04:07
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 380
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	183.694	0.0000
PP - Choi Z-stat	-8.91421	0.0000

Phillips-Perron Fisher Unit Root Test on LIQLIA

Null Hypothesis: Unit root (individual unit root process)
Series: LIQLIA
Date: 08/08/23 Time: 04:08
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	53.7647	0.0716
PP - Choi Z-stat	3.87325	0.9999

Phillips-Perron Fisher Unit Root Test on D(LIQLIA)

Null Hypothesis: Unit root (individual unit root process)
Series: D(LIQLIA)
Date: 08/08/23 Time: 04:08
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 380
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	392.135	0.0000
PP - Choi Z-stat	-13.5340	0.0000

Phillips-Perron Fisher Unit Root Test on CO2

Null Hypothesis: Unit root (individual unit root process)
Series: CO2
Date: 01/20/24 Time: 12:50
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	39.6137	0.4875
PP - Choi Z-stat	2.81030	0.9975

Phillips-Perron Fisher Unit Root Test on D(CO2)

Null Hypothesis: Unit root (individual unit root process)
Series: D(CO2)
Date: 01/20/24 Time: 12:48
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 380
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	183.704	0.0000
PP - Choi Z-stat	-9.26067	0.0000

Phillips-Perron Fisher Unit Root Test on TECH

Null Hypothesis: Unit root (individual unit root process)
Series: TECH
Date: 08/08/23 Time: 04:11
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	98.0492	0.0000
PP - Choi Z-stat	2.98026	0.9986

Phillips-Perron Fisher Unit Root Test on TRAOPE

Null Hypothesis: Unit root (individual unit root process)
Series: TRAOPE
Date: 08/08/23 Time: 04:14
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	99.1841	0.0000
PP - Choi Z-stat	-2.58696	0.0048

Phillips-Perron Fisher Unit Root Test on POPGO

Null Hypothesis: Unit root (individual unit root process)
Series: POPGO
Date: 08/08/23 Time: 04:15
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	41.8578	0.3902
PP - Choi Z-stat	1.45293	0.9269

Phillips-Perron Fisher Unit Root Test on D(POPGO)

Null Hypothesis: Unit root (individual unit root process)
Series: D(POPGO)
Date: 08/08/23 Time: 04:19
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 380
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	127.974	0.0000
PP - Choi Z-stat	-6.18247	0.0000

Phillips-Perron Fisher Unit Root Test on GOVEXP

Null Hypothesis: Unit root (individual unit root process)
Series: GOVEXP
Date: 08/08/23 Time: 04:20
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	40.5981	0.4439
PP - Choi Z-stat	0.94824	0.8285

Phillips-Perron Fisher Unit Root Test on D(GOVEXP)

Null Hypothesis: Unit root (individual unit root process)
Series: D(GOVEXP)
Date: 08/08/23 Time: 04:20
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 380
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	206.356	0.0000
PP - Choi Z-stat	-9.20775	0.0000

Phillips-Perron Fisher Unit Root Test on GCF

Null Hypothesis: Unit root (individual unit root process)
Series: GCF
Date: 08/08/23 Time: 04:23
Sample: 2000 2020
Exogenous variables: Individual effects
Newey-West automatic bandwidth selection and Bartlett ke...
Total (balanced) observations: 400
Cross-sections included: 20

Method	Statistic	Prob.**
PP - Fisher Chi-square	68.9703	0.0030
PP - Choi Z-stat	-3.12901	0.0009

Appendix 2: Correlation analysis of variables

1. Matrix of correlation coefficients in model (using the first difference of the LIQLIA variable, representing the financial development variable)

```
. pwcorr GROWTH FDI DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,sig star(0)
```

	GROWTH	FDI	DLIQLIA	DCO2	TECH	TRAOPE	DPOPGO
GROWTH	1.0000						
FDI	0.0894 0.0671	1.0000					
DLIQLIA	-0.2016 0.0000	0.1586 0.0015	1.0000				
DCO2	0.2554 0.0000	0.0029 0.9544	-0.1271 0.0109	1.0000			
TECH	-0.3273 0.0000	0.1912 0.0001	0.1420 0.0044	-0.1075 0.0315	1.0000		
TRAOPE	0.0590 0.2274	0.8056 0.0000	0.1388 0.0054	0.0142 0.7776	0.0969 0.0471	1.0000	
DPOPGO	0.0858 0.0864	-0.0040 0.9363	-0.0782 0.1183	-0.0111 0.8243	0.0076 0.8790	-0.0326 0.5151	1.0000
DGOVEXP	-0.3185 0.0000	0.0329 0.5118	0.3215 0.0000	-0.1505 0.0025	0.1103 0.0274	0.0072 0.8859	-0.0823 0.1003
GCF	0.3994 0.0000	-0.0220 0.6529	0.0426 0.3960	0.1151 0.0213	0.0598 0.2214	-0.0646 0.1866	0.0216 0.6667

	DGOVEXP	GCF
DGOVEXP	1.0000	
GCF	0.0201 0.6889	1.0000

2. VIF between variables in model (using the first difference of the LIQLIA variable, representing the financial development variable)

```
. vif
```

Variable	VIF	1/VIF
FDI	3.18	0.314424
TRAOPE	3.10	0.322929
DLIQLIA	1.17	0.856299
DGOVEXP	1.14	0.875630
TECH	1.09	0.918820
DCO2	1.06	0.944992
GCF	1.03	0.969741
DPOPGO	1.01	0.985907
Mean VIF	1.60	

Appendix 3: Regression model with DLIQLIA (All)

1. Regression model by methods: OLS, FEM, REM

```
. reg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF
```

Source	SS	df	MS	Number of obs	=	400
				F(9, 390)	=	32.63
Model	1982.41086	9	220.267873	Prob > F	=	0.0000
Residual	2632.98142	390	6.7512344	R-squared	=	0.4295
				Adj R-squared	=	0.4164
Total	4615.39227	399	11.5673992	Root MSE	=	2.5983

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.1175943	.0327095	3.60	0.000	.0532853	.1819033
DLIQLIA	-.0230535	.0198749	-1.16	0.247	-.0621288	.0160217
c.FDI#c.DLIQLIA	-.0021949	.0015158	-1.45	0.148	-.0051751	.0007853
DCO2	.7339389	.2297988	3.19	0.002	.2821395	1.185738
TECH	-.0394077	.0046539	-8.47	0.000	-.0485575	-.0302579
TRAOPE	-.0018654	.0023943	-0.78	0.436	-.0065727	.0028419
DPOPGO	.4317141	.3938071	1.10	0.274	-.3425364	1.205965
DGOVEXP	-.3086918	.0529512	-5.83	0.000	-.4127974	-.2045862
GCF	.2230239	.0213063	10.47	0.000	.1811344	.2649134
_cons	-1.447073	.6229353	-2.32	0.021	-2.671805	-.2223418

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,fe

Fixed-effects (within) regression               Number of obs      =       400
Group variable: COUNTRYmh                       Number of groups   =        20

R-squared:                                      Obs per group:
     Within  = 0.3654                                         min =        20
     Between = 0.2872                                         avg =      20.0
     Overall = 0.2957                                         max =        20

                                                F(9,371)           =     23.74
corr(u_i, Xb) = -0.4688                         Prob > F           =    0.0000
```

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.0944449	.0385739	2.45	0.015	.0185941	.1702958
DLIQLIA	-.0365075	.018062	-2.02	0.044	-.0720242	-.0009907
c.FDI#c.DLIQLIA	-.0018298	.0014319	-1.28	0.202	-.0046455	.0009858
DCO2	.8238499	.2111376	3.90	0.000	.4086733	1.239026
TECH	-.0539827	.0070057	-7.71	0.000	-.0677585	-.040207
TRAOPE	.0141403	.0071509	1.98	0.049	.000079	.0282015
DPOPGO	.1544813	.3644891	0.42	0.672	-.5622424	.871205
DGOVEXP	-.3191378	.0478712	-6.67	0.000	-.4132707	-.225005
GCF	.1485371	.037183	3.99	0.000	.0754212	.221653
_cons	-.3386883	1.18999	-0.28	0.776	-2.67866	2.001283

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,re

Random-effects GLS regression                   Number of obs     =       400
Group variable: COUNTRYmh                       Number of groups  =        20

R-squared:                                      Obs per group:
     Within  = 0.3543                                         min =        20
     Between = 0.5563                                         avg =      20.0
     Overall = 0.4143                                         max =        20

                                                Wald chi2(9)      =    231.53
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.1035891	.0360761	2.87	0.004	.0328811	.174297
DLIQLIA	-.0326267	.0183652	-1.78	0.076	-.0686218	.0033684
c.FDI#c.DLIQLIA	-.0018308	.0014398	-1.27	0.204	-.0046529	.0009912
DCO2	.8120364	.2141435	3.79	0.000	.3923228	1.23175
TECH	-.0486394	.0058823	-8.27	0.000	-.0601685	-.0371102
TRAOPE	.0004879	.0033163	0.15	0.883	-.0060119	.0069877
DPOPGO	.3349933	.3632779	0.92	0.356	-.3770182	1.047005
DGOVEXP	-.3174945	.0487467	-6.51	0.000	-.4130364	-.2219527
GCF	.1837318	.0290795	6.32	0.000	.126737	.2407266
_cons	-.1356596	.8465928	-0.16	0.873	-1.794951	1.523632

2. Model selection test

```
. hausman FEM REM
```

	Coefficients (b) FEM	(B) REM	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
FDI	.0944449	.1035891	-.0091441	.0136549
DLIQLIA	-.0365075	-.0326267	-.0038808	.
c.FDI# c.DLIQLIA	-.0018298	-.0018308	9.93e-07	.
DCO2	.8238499	.8120364	.0118135	.
TECH	-.0539827	-.0486394	-.0053434	.0038049
TRAOPE	.0141403	.0004879	.0136524	.0063354
DPOPGO	.1544813	.3349933	-.180512	.0296906
DGOVEXP	-.3191378	-.3174945	-.0016433	.
GCF	.1485371	.1837318	-.0351947	.0231724

b = Consistent under H0 and Ha; obtained from **xtreg**.
B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**.

```
Test of H0: Difference in coefficients not systematic

    chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =  15.30
Prob > chi2 = 0.0830
(V_b-V_B is not positive definite)
```

3. Matching model results

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,re

Random-effects GLS regression                   Number of obs     =       400
Group variable: COUNTRYmh                       Number of groups  =        20

R-squared:                                      Obs per group:
     Within  = 0.3543                                         min =        20
     Between = 0.5563                                         avg =      20.0
     Overall = 0.4143                                         max =        20

                                                Wald chi2(9)      =    231.53
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.1035891	.0360761	2.87	0.004	.0328811	.174297
DLIQLIA	-.0326267	.0183652	-1.78	0.076	-.0686218	.0033684
c.FDI#c.DLIQLIA	-.0018308	.0014398	-1.27	0.204	-.0046529	.0009912
DCO2	.8120364	.2141435	3.79	0.000	.3923228	1.23175
TECH	-.0486394	.0058823	-8.27	0.000	-.0601685	-.0371102
TRAOPE	.0004879	.0033163	0.15	0.883	-.0060119	.0069877
DPOPGO	.3349933	.3632779	0.92	0.356	-.3770182	1.047005
DGOVEXP	-.3174945	.0487467	-6.51	0.000	-.4130364	-.2219527
GCF	.1837318	.0290795	6.32	0.000	.126737	.2407266
_cons	-.1356596	.8465928	-0.16	0.873	-1.794951	1.523632

Appendix 4: Regression model with DLIQLIA (Developing Countries)

1. Regression model by methods: OLS, FEM, REM

```
. reg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==0
```

Source	SS	df	MS	Number of obs	=	240
				F(9, 230)	=	22.98
Model	1612.36824	9	179.152026	Prob > F	=	0.0000
Residual	1793.12033	230	7.79617535	R-squared	=	0.4735
				Adj R-squared	=	0.4529
Total	3405.48857	239	14.2489061	Root MSE	=	2.7922

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.255099	.0975532	2.61	0.010	.0628868	.4473113
DLIQLIA	-.17838	.0586332	-3.04	0.003	-.2939067	-.0628532
c.FDI#c.DLIQLIA	.0252177	.0130197	1.94	0.054	-.0004355	.0508709
DCO2	.6112765	.274681	2.23	0.027	.0700638	1.152489
TECH	-.0539776	.0073583	-7.34	0.000	-.068476	-.0394792
TRAOPE	.0010237	.0044135	0.23	0.817	-.0076725	.0097198
DPOPGO	7.538831	2.355948	3.20	0.002	2.896833	12.18083
DGOVEXP	-.1842737	.0775168	-2.38	0.018	-.3370074	-.0315399
GCF	.2347199	.0258472	9.08	0.000	.1837924	.2856474
_cons	-1.814872	.8174763	-2.22	0.027	-3.425571	-.2041725

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==0,fe

Fixed-effects (within) regression               Number of obs      =       240
Group variable: COUNTRYmh                       Number of groups   =        12

R-squared:                                      Obs per group:
     Within  = 0.4228                                         min =        20
     Between = 0.3107                                         avg =      20.0
     Overall = 0.3841                                         max =        20

                                                F(9,219)           =     17.82
corr(u_i, Xb) = -0.0459                         Prob > F           =    0.0000
```

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.2767582	.1301839	2.13	0.035	.0201845	.5333318
DLIQLIA	-.2398415	.0529127	-4.53	0.000	-.3441247	-.1355583
c.FDI#c.DLIQLIA	.0361566	.0116577	3.10	0.002	.013181	.0591322
DCO2	.5684255	.2435036	2.33	0.020	.0885151	1.048336
TECH	-.0522201	.0090233	-5.79	0.000	-.0700036	-.0344365
TRAOPE	.0202563	.0128805	1.57	0.117	-.0051293	.0456419
DPOPGO	5.732254	2.143483	2.67	0.008	1.50776	9.956749
DGOVEXP	-.1909725	.0683304	-2.79	0.006	-.3256418	-.0563032
GCF	.154228	.0479535	3.22	0.001	.0597186	.2487373
_cons	-1.559766	1.572609	-0.99	0.322	-4.659151	1.539619

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==0,re

Random-effects GLS regression                   Number of obs     =       240
Group variable: COUNTRYmh                       Number of groups  =        12

R-squared:                                      Obs per group:
     Within  = 0.4097                                         min =        20
     Between = 0.5887                                         avg =      20.0
     Overall = 0.4696                                         max =        20

                                                Wald chi2(9)      =    182.63
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.2634739	.1056926	2.49	0.013	.0563203	.4706276
DLIQLIA	-.2139308	.055138	-3.88	0.000	-.3219993	-.1058622
c.FDI#c.DLIQLIA	.0319201	.012207	2.61	0.009	.0079949	.0558453
DCO2	.610104	.2566325	2.38	0.017	.1071137	1.113094
TECH	-.055985	.0076378	-7.33	0.000	-.0709548	-.0410151
TRAOPE	.002269	.0057438	0.40	0.693	-.0089886	.0135266
DPOPGO	6.47808	2.22341	2.91	0.004	2.120276	10.83588
DGOVEXP	-.1851013	.0722093	-2.56	0.010	-.326629	-.0435737
GCF	.2170717	.031415	6.91	0.000	.1554995	.278644
_cons	-1.432419	.9880084	-1.45	0.147	-3.368879	.5040423

2. Model selection test

```
. hausman FE RE
```

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
FDI	.2767582	.2634739	.0132842	.0760061
DLIQLIA	-.2398415	-.2139308	-.0259107	.
c.FDI# c.DLIQLIA	.0361566	.0319201	.0042365	.
DCO2	.5684255	.610104	-.0416785	.
TECH	-.0522201	-.055985	.0037649	.0048045
TRAOPE	.0202563	.002269	.0179873	.0115289
DPOPGO	5.732254	6.47808	-.7458257	.
DGOVEXP	-.1909725	-.1851013	-.0058712	.
GCF	.154228	.2170717	-.0628438	.0362303

b = Consistent under H0 and Ha; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 16.15
Prob > chi2 = 0.0638
(V b-V B is not positive definite)

3. Matching model results

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==0,re

Random-effects GLS regression                   Number of obs     =       240
Group variable: COUNTRYmh                       Number of groups  =        12

R-squared:                                      Obs per group:
     Within  = 0.4097                                         min =        20
     Between = 0.5887                                         avg =      20.0
     Overall = 0.4696                                         max =        20

                                                Wald chi2(9)      =    182.63
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.2634739	.1056926	2.49	0.013	.0563203	.4706276
DLIQLIA	-.2139308	.055138	-3.88	0.000	-.3219993	-.1058622
c.FDI#c.DLIQLIA	.0319201	.012207	2.61	0.009	.0079949	.0558453
DCO2	.610104	.2566325	2.38	0.017	.1071137	1.113094
TECH	-.055985	.0076378	-7.33	0.000	-.0709548	-.0410151
TRAOPE	.002269	.0057438	0.40	0.693	-.0089886	.0135266
DPOPGO	6.47808	2.22341	2.91	0.004	2.120276	10.83588
DGOVEXP	-.1851013	.0722093	-2.56	0.010	-.326629	-.0435737
GCF	.2170717	.031415	6.91	0.000	.1554995	.278644
_cons	-1.432419	.9880084	-1.45	0.147	-3.368879	.5040423

Appendix 5: Regression model with DLIQLIA (Developed Countries)

1. Regression model by methods: OLS, FEM, REM

```
. reg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==1
```

Source	SS	df	MS	Number of obs	=	160
				F(9, 150)	=	18.90
Model	560.974188	9	62.3304653	Prob > F	=	0.0000
Residual	494.648805	150	3.2976587	R-squared	=	0.5314
				Adj R-squared	=	0.5033
Total	1055.62299	159	6.63913832	Root MSE	=	1.8159

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.0353979	.0303606	1.17	0.245	-.0245917	.0953876
DLIQLIA	.0097883	.0170545	0.57	0.567	-.0239097	.0434863
c.FDI#c.DLIQLIA	-.003477	.0011442	-3.04	0.003	-.0057378	-.0012162
DCO2	1.562327	.4330096	3.61	0.000	.7067407	2.417913
TECH	-.0178464	.011402	-1.57	0.120	-.0403756	.0046829
TRAOPE	.0032839	.0023328	1.41	0.161	-.0013255	.0078933
DPOPGO	.1176981	.2813235	0.42	0.676	-.4381705	.6735668
DGOVEXP	-.3754679	.0617777	-6.08	0.000	-.4975348	-.253401
GCF	.1054919	.0444634	2.37	0.019	.0176364	.1933474
_cons	.1538229	1.307083	0.12	0.906	-2.42885	2.736496

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==1,fe

Fixed-effects (within) regression               Number of obs      =       160
Group variable: COUNTRYmh                       Number of groups   =         8

R-squared:                                      Obs per group:
     Within  = 0.5312                                         min =        20
     Between = 0.2835                                         avg =      20.0
     Overall = 0.3865                                         max =        20

                                                F(9,143)           =     18.01
corr(u_i, Xb) = -0.5816                         Prob > F           =    0.0000
```

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.0497566	.0321868	1.55	0.124	-.0138668	.11338
DLIQLIA	.0038125	.0164809	0.23	0.817	-.0287651	.0363901
c.FDI#c.DLIQLIA	-.0036409	.0011344	-3.21	0.002	-.0058833	-.0013985
DCO2	1.557773	.4289614	3.63	0.000	.709848	2.405697
TECH	-.0261194	.011548	-2.26	0.025	-.0489462	-.0032926
TRAOPE	.0096955	.0066385	1.46	0.146	-.0034268	.0228179
DPOPGO	.0572556	.2796636	0.20	0.838	-.4955532	.6100644
DGOVEXP	-.3765385	.0596295	-6.31	0.000	-.4944077	-.2586692
GCF	-.0858621	.0777151	-1.10	0.271	-.239481	.0677568
_cons	4.609366	2.297876	2.01	0.047	.0671723	9.15156

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==1,re

Random-effects GLS regression                   Number of obs     =       160
Group variable: COUNTRYmh                       Number of groups  =         8

R-squared:                                      Obs per group:
     Within  = 0.5044                                         min =        20
     Between = 0.7072                                         avg =      20.0
     Overall = 0.5314                                         max =        20

                                                Wald chi2(9)      =    170.11
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0353979	.0303606	1.17	0.244	-.0241077	.0949036
DLIQLIA	.0097883	.0170545	0.57	0.566	-.0236379	.0432144
c.FDI#c.DLIQLIA	-.003477	.0011442	-3.04	0.002	-.0057196	-.0012344
DCO2	1.562327	.4330096	3.61	0.000	.7136434	2.41101
TECH	-.0178464	.011402	-1.57	0.118	-.0401939	.0045012
TRAOPE	.0032839	.0023328	1.41	0.159	-.0012883	.0078561
DPOPGO	.1176981	.2813235	0.42	0.676	-.4336858	.6690821
DGOVEXP	-.3754679	.0617777	-6.08	0.000	-.4965499	-.2543859
GCF	.1054919	.0444634	2.37	0.018	.0183452	.1926385
_cons	.1538229	1.307083	0.12	0.906	-2.408013	2.715659

2. Model selection test

```
. hausman FEM REM
```

	Coefficients (b) FEM	(B) REM	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
FDI	.0497566	.0353979	.0143587	.0106876
DLIQLIA	.0038125	.0097883	-.0059758	.
c.FDI#				
c.DLIQLIA	-.0036409	-.003477	-.0001639	.
DCO2	1.557773	1.562327	-.0045541	.
TECH	-.0261194	-.0178464	-.008273	.0018304
TRAOPE	.0096955	.0032839	.0064116	.0062152
DPOPGO	.0572556	.1176981	-.0604425	.
DGOVEXP	-.3765385	-.3754679	-.0010706	.
GCF	-.0858621	.1054919	-.1913539	.0637389

b = Consistent under H0 and Ha; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

```
Test of H0: Difference in coefficients not systematic

    chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =  12.49
Prob > chi2 = 0.1873
(V_b-V_B is not positive definite)
```

3. Matching model results

```
. xtreg GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF if PT==1,re

Random-effects GLS regression                   Number of obs     =       160
Group variable: COUNTRYmh                       Number of groups  =         8

R-squared:                                      Obs per group:
     Within  = 0.5044                                         min =        20
     Between = 0.7072                                         avg =      20.0
     Overall = 0.5314                                         max =        20

                                                Wald chi2(9)      =    170.11
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0353979	.0303606	1.17	0.244	-.0241077	.0949036
DLIQLIA	.0097883	.0170545	0.57	0.566	-.0236379	.0432144
c.FDI#c.DLIQLIA	-.003477	.0011442	-3.04	0.002	-.0057196	-.0012344
DCO2	1.562327	.4330096	3.61	0.000	.7136434	2.41101
TECH	-.0178464	.011402	-1.57	0.118	-.0401939	.0045012
TRAOPE	.0032839	.0023328	1.41	0.159	-.0012883	.0078561
DPOPGO	.1176981	.2813235	0.42	0.676	-.4336858	.6690821
DGOVEXP	-.3754679	.0617777	-6.08	0.000	-.4965499	-.2543859
GCF	.1054919	.0444634	2.37	0.018	.0183452	.1926385
_cons	.1538229	1.307083	0.12	0.906	-2.408013	2.715659

Appendix 6: Regression model with DPRICRE

1. Regression model by methods: OLS, FEM, REM

```
. reg GROWTH c.FDI##c.DPRICRE DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF
```

Source	SS	df	MS	Number of obs	=	400
				F(9, 390)	=	31.54
Model	1944.20761	9	216.023068	Prob > F	=	0.0000
Residual	2671.18467	390	6.84919145	R-squared	=	0.4212
				Adj R-squared	=	0.4079
Total	4615.39227	399	11.5673992	Root MSE	=	2.6171

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.0998075	.030934	3.23	0.001	.0389892	.1606257
DPRICRE	-.0418155	.0286158	-1.46	0.145	-.098076	.014445
c.FDI#c.DPRICRE	.0003944	.0013724	0.29	0.774	-.0023039	.0030927
DCO2	.7499354	.2304451	3.25	0.001	.2968652	1.203006
TECH	-.0396094	.0046764	-8.47	0.000	-.0488034	-.0304153
TRAOPE	-.0019447	.0024266	-0.80	0.423	-.0067155	.0028261
DPOPGO	.6102638	.3925467	1.55	0.121	-.1615087	1.382036
DGOVEXP	-.3272705	.0529569	-6.18	0.000	-.4313871	-.2231538
GCF	.2293665	.0216181	10.61	0.000	.1868639	.2718691
_cons	-1.536895	.6302217	-2.44	0.015	-2.775952	-.2978382

```
. xtreg GROWTH c.FDI##c.DPRICRE DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,fe

Fixed-effects (within) regression               Number of obs      =       400
Group variable: COUNTRYmh                       Number of groups   =        20

R-squared:                                      Obs per group:
     Within  = 0.3490                                         min =        20
     Between = 0.3042                                         avg =      20.0
     Overall = 0.2936                                         max =        20

                                                F(9,371)           =     22.10
corr(u_i, Xb) = -0.4659                         Prob > F           =    0.0000
```

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.0899694	.0385606	2.33	0.020	.0141446	.1657942
DPRICRE	-.0416491	.0265085	-1.57	0.117	-.0937749	.0104767
c.FDI#c.DPRICRE	.0002836	.0012784	0.22	0.825	-.0022302	.0027975
DCO2	.8675994	.2128908	4.08	0.000	.4489754	1.286223
TECH	-.0539853	.0071404	-7.56	0.000	-.0680261	-.0399445
TRAOPE	.0131034	.0073616	1.78	0.076	-.0013722	.0275791
DPOPGO	.3344405	.365384	0.92	0.361	-.3840429	1.052924
DGOVEXP	-.3464858	.048091	-7.20	0.000	-.4410509	-.2519207
GCF	.1589501	.0377051	4.22	0.000	.0848075	.2330926
_cons	-.5268457	1.219492	-0.43	0.666	-2.924829	1.871138

```
. xtreg GROWTH c.FDI##c.DPRICRE DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,re

Random-effects GLS regression                   Number of obs     =       400
Group variable: COUNTRYmh                       Number of groups  =        20

R-squared:                                      Obs per group:
     Within  = 0.3386                                         min =        20
     Between = 0.5703                                         avg =      20.0
     Overall = 0.4083                                         max =        20

                                                Wald chi2(9)      =    219.64
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0952042	.0354193	2.69	0.007	.0257837	.1646247
DPRICRE	-.0442601	.0267692	-1.65	0.098	-.0967269	.0082066
c.FDI#c.DPRICRE	.0005337	.0012827	0.42	0.677	-.0019803	.0030476
DCO2	.8466717	.2154164	3.93	0.000	.4244633	1.26888
TECH	-.048617	.0059474	-8.17	0.000	-.0602737	-.0369604
TRAOPE	-.0002192	.0033737	-0.06	0.948	-.0068315	.0063931
DPOPGO	.515426	.3629467	1.42	0.156	-.1959364	1.226788
DGOVEXP	-.3407411	.0488893	-6.97	0.000	-.4365623	-.2449199
GCF	.1920214	.0293681	6.54	0.000	.134461	.2495818
_cons	-.2775479	.8574751	-0.32	0.746	-1.958168	1.403072

2. Model selection test

```
. est sto RE

. hausman FE RE
```

	Coefficients			
	(b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
FDI	.0899694	.0952042	-.0052348	.0152447
DPRICRE	-.0416491	-.0442601	.002611	.
c.FDI#				
c.DPRICRE	.0002836	.0005337	-.0002501	.
DCO2	.8675994	.8466717	.0209278	.
TECH	-.0539853	-.048617	-.0053682	.0039515
TRAOPE	.0131034	-.0002192	.0133226	.006543
DPOPGO	.3344405	.515426	-.1809855	.0421329
DGOVEXP	-.3464858	-.3407411	-.0057447	.
GCF	.1589501	.1920214	-.0330713	.0236472

b = Consistent under H0 and Ha; obtained from **xtreg**.
B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**.

```
Test of H0: Difference in coefficients not systematic

    chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =  12.35
Prob > chi2 = 0.1943
(V_b-V_B is not positive definite)
```

3. Matching model results

```
. xtreg GROWTH c.FDI##c.DPRICRE DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,re

Random-effects GLS regression                   Number of obs     =       400
Group variable: COUNTRYmh                       Number of groups  =        20

R-squared:                                      Obs per group:
     Within  = 0.3386                                         min =        20
     Between = 0.5703                                         avg =      20.0
     Overall = 0.4083                                         max =        20

                                                Wald chi2(9)      =    219.64
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0952042	.0354193	2.69	0.007	.0257837	.1646247
DPRICRE	-.0442601	.0267692	-1.65	0.098	-.0967269	.0082066
c.FDI#c.DPRICRE	.0005337	.0012827	0.42	0.677	-.0019803	.0030476
DCO2	.8466717	.2154164	3.93	0.000	.4244633	1.26888
TECH	-.048617	.0059474	-8.17	0.000	-.0602737	-.0369604
TRAOPE	-.0002192	.0033737	-0.06	0.948	-.0068315	.0063931
DPOPGO	.515426	.3629467	1.42	0.156	-.1959364	1.226788
DGOVEXP	-.3407411	.0488893	-6.97	0.000	-.4365623	-.2449199
GCF	.1920214	.0293681	6.54	0.000	.134461	.2495818
_cons	-.2775479	.8574751	-0.32	0.746	-1.958168	1.403072

Appendix 7: Seasonal adjustment with DLIQLIA

1. Regression model by methods: OLS, FEM, REM

OLS

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.0952334	.0284275	3.35	0.001	.0393341	.1511326
DLIQLIA	.027682	.0178977	1.55	0.123	-.0075118	.0628757
c.FDI#c.DLIQLIA	-.0024944	.001312	-1.90	0.058	-.0050743	.0000855
DCO2	.612269	.1996038	3.07	0.002	.2197723	1.004766
TECH	-.0349814	.0047788	-7.32	0.000	-.0443782	-.0255846
TRAOPE	-.0016419	.0020663	-0.79	0.427	-.005705	.0024213
DPOPGO	.0016182	.3462184	0.00	0.996	-.6791783	.6824146
DGOVEXP	-.0478812	.0518351	-0.92	0.356	-.1498087	.0540463
GCF	.2113031	.0186014	11.36	0.000	.1747257	.2478805
N0	0	(omitted)				
N1	3.470398	.7858768	4.42	0.000	1.925066	5.015729
N2	5.372715	.7894049	6.81	0.000	3.820446	6.924984
N3	5.94564	.7880352	7.54	0.000	4.396064	7.495216
N4	6.848992	.8308631	8.24	0.000	5.215201	8.482784
N5	6.636346	.7973793	8.32	0.000	5.068397	8.204296
N6	6.864608	.7929836	8.66	0.000	5.305302	8.423914
N7	6.953098	.77264	9.00	0.000	5.433795	8.472401
N8	4.158714	.7709994	5.39	0.000	2.642637	5.674791
N9	2.17991	.7339439	2.97	0.003	.7366979	3.623121
N10	7.609164	.8162555	9.32	0.000	6.004097	9.214232
N11	5.719068	.7730097	7.40	0.000	4.199038	7.239097
N12	5.826367	.7683274	7.58	0.000	4.315545	7.33719
N13	5.171584	.7598309	6.81	0.000	3.677469	6.665699
N14	5.540393	.7684034	7.21	0.000	4.029421	7.051365
N15	5.289287	.7638754	6.92	0.000	3.787219	6.791356
N16	5.435066	.7728741	7.03	0.000	3.915303	6.954829

N17	5.993167	.7742886	7.74	0.000	4.470622	7.515711
N18	5.872836	.7722548	7.60	0.000	4.354291	7.391382
N19	5.533766	.7491392	7.39	0.000	4.060674	7.006857
N20	0	(omitted)				
_cons	-6.830051	.833723	-8.19	0.000	-8.469466	-5.190635

FEM

GROWTH	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
FDI	.0686646	.0325111	2.11	0.035	.0047242	.1326051
DLIQLIA	.0164157	.0155603	1.05	0.292	-.0141871	.0470185
c.FDI#c.DLIQLIA	-.0022503	.0011853	-1.90	0.058	-.0045815	.0000809
DCO2	.7387289	.1761954	4.19	0.000	.3922007	1.085257
TECH	-.0834657	.014409	-5.79	0.000	-.1118043	-.0551271
TRAOPE	.0067511	.0061141	1.10	0.270	-.0052737	.0187758
DPOPGO	-.0836512	.3054336	-0.27	0.784	-.6843555	.517053
DGOVEXP	-.0930458	.0453625	-2.05	0.041	-.1822614	-.0038303
GCF	.1060689	.0317054	3.35	0.001	.0437131	.1684247
N0	0	(omitted)				
N1	.4414187	1.038359	0.43	0.671	-1.60075	2.483587
N2	2.360206	1.010573	2.34	0.020	.3726849	4.347727
N3	2.990779	.9839126	3.04	0.003	1.055692	4.925866
N4	4.047966	.9849091	4.11	0.000	2.110919	5.985012
N5	3.992164	.9332368	4.28	0.000	2.156742	5.827585
N6	4.352725	.9075619	4.80	0.000	2.567799	6.13765
N7	4.7888	.8558227	5.60	0.000	3.105631	6.471969
N8	2.155613	.8523798	2.53	0.012	.4792156	3.832011
N9	.3426677	.7774455	0.44	0.660	-1.186355	1.87169
N10	5.784053	.8404873	6.88	0.000	4.131045	7.437062
N11	4.139489	.7862246	5.27	0.000	2.593201	5.685778
N12	4.504063	.7685915	5.86	0.000	2.992454	6.015672
N13	3.967198	.7494317	5.29	0.000	2.493271	5.441125
N14	4.366771	.7332971	5.95	0.000	2.924576	5.808965
N15	4.378004	.7059803	6.20	0.000	2.989534	5.766474
N16	4.679676	.6941533	6.74	0.000	3.314467	6.044886
N17	5.298239	.689939	7.68	0.000	3.941318	6.65516
N18	5.351093	.68209	7.85	0.000	4.009608	6.692577
N19	5.172181	.6511311	7.94	0.000	3.891585	6.452778
N20	0	(omitted)				
_cons	-.7024446	1.481464	-0.47	0.636	-3.616078	2.211189

REM

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0811729	.0311523	2.61	0.009	.0201156	.1422302
DLIQLIA	.0188394	.0159215	1.18	0.237	-.0123661	.050045
c.FDI#c.DLIQLIA	-.0021859	.0012031	-1.82	0.069	-.0045439	.0001721
DCO2	.6995176	.1794597	3.90	0.000	.3477831	1.051252
TECH	-.0501866	.0086146	-5.83	0.000	-.0670709	-.0333022
TRAOPE	.0003015	.0030968	0.10	0.922	-.0057682	.0063712
DPOPGO	-.0474295	.3073873	-0.15	0.877	-.6498976	.5550386
DGOVEXP	-.0730676	.0460948	-1.59	0.113	-.1634117	.0172764
GCF	.1400584	.0263858	5.31	0.000	.0883431	.1917737
N0	0	(omitted)				
N1	2.423925	.8153874	2.97	0.003	.825795	4.022055
N2	4.279374	.807118	5.30	0.000	2.697452	5.861296
N3	4.855734	.7969236	6.09	0.000	3.293792	6.417675
N4	5.825265	.8212364	7.09	0.000	4.215671	7.434859
N5	5.674736	.7839441	7.24	0.000	4.138234	7.211238
N6	5.94653	.7723924	7.70	0.000	4.432669	7.460392
N7	6.195319	.7426431	8.34	0.000	4.739765	7.650873
N8	3.504792	.7392186	4.74	0.000	2.05595	4.953634
N9	1.538027	.6933123	2.22	0.027	.17916	2.896894
N10	6.948352	.7629195	9.11	0.000	5.453057	8.443647
N11	5.182149	.7186887	7.21	0.000	3.773545	6.590753
N12	5.419123	.7101588	7.63	0.000	4.027237	6.811008
N13	4.807725	.6989194	6.88	0.000	3.437868	6.177582
N14	5.144783	.6993135	7.36	0.000	3.774153	6.515412
N15	4.984678	.6886411	7.24	0.000	3.634967	6.33439
N16	5.144929	.6903609	7.45	0.000	3.791847	6.498012

N17	5.71897	.6901266	8.29	0.000	4.366346	7.071593
N18	5.675657	.6870128	8.26	0.000	4.329137	7.022178
N19	5.382394	.6628377	8.12	0.000	4.083255	6.681532
N20	0	(omitted)				
_cons	-3.761171	1.096495	-3.43	0.001	-5.910261	-1.61208

2. Model selection test

N10	5.784053	6.948352	-1.164299	.3526652
N11	4.139489	5.182149	-1.042659	.3188035
N12	4.504063	5.419123	-.9150592	.2939514
N13	3.967198	4.807725	-.8405266	.2704802
N14	4.366771	5.144783	-.778012	.2206471
N15	4.378004	4.984678	-.6066746	.1555046
N16	4.679676	5.144929	-.4652528	.0724619
N17	5.298239	5.71897	-.420731	.
N18	5.351093	5.675657	-.3245648	.
N19	5.172181	5.382394	-.2102124	.

b = Consistent under H0 and Ha; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

chi2(27) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 21.64
Prob > chi2 = 0.7556
(V_b-V_B is not positive definite)

```
. hausman F R

Note: the rank of the differenced variance matrix (27) does not equal the number of coefficients being tested
      (28); 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) F	(B) R	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
FDI	.0686646	.0811729	-.0125082	.0093011
DLIQLIA	.0164157	.0188394	-.0024237	.
c.FDI#				
c.DLIQLIA	-.0022503	-.0021859	-.0000644	.
DCO2	.7387289	.6995176	.0392112	.
TECH	-.0834657	-.0501866	-.0332791	.0115502
TRAOPE	.0067511	.0003015	.0064496	.0052718
DPOPGO	-.0836512	-.0474295	-.0362217	.
DGOVEXP	-.0930458	-.0730676	-.0199782	.
GCF	.1060689	.1400584	-.0339895	.017579
N1	.4414187	2.423925	-1.982506	.6429104
N2	2.360206	4.279374	-1.919169	.6081273
N3	2.990779	4.855734	-1.864954	.5770587
N4	4.047966	5.825265	-1.777299	.5437064
N5	3.992164	5.674736	-1.682573	.5063226
N6	4.352725	5.94653	-1.593806	.4765275
N7	4.7888	6.195319	-1.406519	.4253396
N8	2.155613	3.504792	-1.349179	.4243904
N9	.3426677	1.538027	-1.19536	.3517662

3. Matching model results

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0811729	.0311523	2.61	0.009	.0201156	.1422302
DLIQLIA	.0188394	.0159215	1.18	0.237	-.0123661	.050045
c.FDI#c.DLIQLIA	-.0021859	.0012031	-1.82	0.069	-.0045439	.0001721
DCO2	.6995176	.1794597	3.90	0.000	.3477831	1.051252
TECH	-.0501866	.0086146	-5.83	0.000	-.0670709	-.0333022
TRAOPE	.0003015	.0030968	0.10	0.922	-.0057682	.0063712
DPOPGO	-.0474295	.3073873	-0.15	0.877	-.6498976	.5550386
DGOVEXP	-.0730676	.0460948	-1.59	0.113	-.1634117	.0172764
GCF	.1400584	.0263858	5.31	0.000	.0883431	.1917737
N0	0	(omitted)				
N1	2.423925	.8153874	2.97	0.003	.825795	4.022055
N2	4.279374	.807118	5.30	0.000	2.697452	5.861296
N3	4.855734	.7969236	6.09	0.000	3.293792	6.417675
N4	5.825265	.8212364	7.09	0.000	4.215671	7.434859
N5	5.674736	.7839441	7.24	0.000	4.138234	7.211238
N6	5.94653	.7723924	7.70	0.000	4.432669	7.460392
N7	6.195319	.7426431	8.34	0.000	4.739765	7.650873
N8	3.504792	.7392186	4.74	0.000	2.05595	4.953634
N9	1.538027	.6933123	2.22	0.027	.17916	2.896894
N10	6.948352	.7629195	9.11	0.000	5.453057	8.443647
N11	5.182149	.7186887	7.21	0.000	3.773545	6.590753
N12	5.419123	.7101588	7.63	0.000	4.027237	6.811008
N13	4.807725	.6989194	6.88	0.000	3.437868	6.177582
N14	5.144783	.6993135	7.36	0.000	3.774153	6.515412
N15	4.984678	.6886411	7.24	0.000	3.634967	6.33439
N16	5.144929	.6903609	7.45	0.000	3.791847	6.498012
N17	5.71897	.6901266	8.29	0.000	4.366346	7.071593
N18	5.675657	.6870128	8.26	0.000	4.329137	7.022178
N19	5.382394	.6628377	8.12	0.000	4.083255	6.681532
N20	0	(omitted)				
_cons	-3.761171	1.096495	-3.43	0.001	-5.910261	-1.61208

Appendix 8: Defect testing of the model

1. Autocorrelation in the non-seasonal adjustment model

```
. xtserial GROWTH FDI DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      19) =      5.791
           Prob > F =      0.0265
```

2. Heteroscedasticity in the non-seasonal adjustment model

```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        GROWTH[COUNTRYmh,t] = Xb + u[COUNTRYmh] + e[COUNTRYmh,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                  GROWTH |     11.5674       3.401088
                       e |    5.435712       2.331461
                       u |    .8674814       .9313868

        Test: Var(u) = 0
                                  chibar2(01) =    83.76
                              Prob > chibar2 =   0.0000
```

3. Autocorrelation in the seasonal adjustment model

```
. xtserial GROWTH FDI DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF N0 N1 N2 N3 N4 N5 N6 N7 N8 N9 N10 N11 N12 N13
>  N14 N15 N16 N17 N18 N19 N20

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
    F(  1,      19) =      8.552
           Prob > F =      0.0087
```

4. Heteroscedasticity in the seasonal adjustment model

```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        GROWTH[COUNTRYmh,t] = Xb + u[COUNTRYmh] + e[COUNTRYmh,t]

        Estimated results:
                     |       Var      SD = sqrt(Var)
             ---------+------------------------------
              GROWTH |     11.5674        3.401088
                   e |     3.64484        1.909146
                   u |     .957025        .9782766

        Test: Var(u) = 0
                                 chibar2(01) =    142.22
                              Prob > chibar2 =    0.0000
```

Appendix 9: Regression model by FGLS methods

1. Regression in the non-seasonal adjustment model

```
. xtgls GROWTH c.FDI##c.DLIQLIA DCO2 TECH TRAOPE DPOPGO DGOVEXP GCF,panels(h) corr(ar1)

Cross-sectional time-series FGLS regression

Coefficients:  generalized least squares
Panels:        heteroskedastic
Correlation:   common AR(1) coefficient for all panels  (0.4053)

Estimated covariances      =        20          Number of obs     =       400
Estimated autocorrelations =         1          Number of groups  =        20
Estimated coefficients     =        10          Time periods      =        20
                                                Wald chi2(9)      =    367.09
                                                Prob > chi2       =    0.0000
```

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0651315	.0315785	2.06	0.039	.0032389	.1270242
DLIQLIA	-.0272246	.0129613	-2.10	0.036	-.0526283	-.0018209
c.FDI#c.DLIQLIA	-.0008999	.0012563	-0.72	0.474	-.0033622	.0015623
DCO2	.8410599	.1918895	4.38	0.000	.4649635	1.217156
TECH	-.0308665	.0052327	-5.90	0.000	-.0411225	-.0206106
TRAOPE	.0013596	.0026976	0.50	0.614	-.0039277	.0066469
DPOPGO	.2457695	.3235755	0.76	0.448	-.3884268	.8799657
DGOVEXP	-.2766439	.0359525	-7.69	0.000	-.3471095	-.2061784
GCF	.2263119	.0248122	9.12	0.000	.1776808	.274943
_cons	-2.027311	.8110056	-2.50	0.012	-3.616853	-.437769

2. Regression in the seasonal adjustment model

GROWTH	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
FDI	.0663244	.0279284	2.37	0.018	.0115858	.121063
DLIQLIA	.0092035	.0098635	0.93	0.351	-.0101285	.0285355
c.FDI#c.DLIQLIA	-.0006693	.0009272	-0.72	0.470	-.0024866	.001148
DCO2	.3675812	.1618392	2.27	0.023	.0503821	.6847803
TECH	-.029477	.0057942	-5.09	0.000	-.0408333	-.0181206
TRAOPE	-.0003822	.0024232	-0.16	0.875	-.0051316	.0043672
DPOPGO	.0404245	.3042914	0.13	0.894	-.5559757	.6368246
DGOVEXP	-.0810315	.0347871	-2.33	0.020	-.1492129	-.01285
GCF	.2234152	.0226852	9.85	0.000	.1789531	.2678773
N0	0	(omitted)				
N1	3.615748	.6308338	5.73	0.000	2.379336	4.852159
N2	5.177432	.6234048	8.31	0.000	3.955581	6.399283
N3	5.433506	.6173697	8.80	0.000	4.223484	6.643529
N4	6.385031	.6308055	10.12	0.000	5.148675	7.621388
N5	6.080579	.6073734	10.01	0.000	4.890149	7.271009
N6	6.133773	.6039556	10.16	0.000	4.950042	7.317504
N7	6.086187	.594819	10.23	0.000	4.920364	7.252011
N8	4.027878	.5783436	6.96	0.000	2.894346	5.161411
N9	1.840773	.5610466	3.28	0.001	.7411414	2.940404
N10	6.608177	.6072906	10.88	0.000	5.417909	7.798444
N11	5.417598	.5802019	9.34	0.000	4.280424	6.554773
N12	5.398434	.5734567	9.41	0.000	4.274479	6.522388
N13	4.882706	.5758146	8.48	0.000	3.75413	6.011281
N14	4.929517	.5746356	8.58	0.000	3.803251	6.055782
N15	4.966543	.5650418	8.79	0.000	3.859081	6.074005
N16	4.99135	.5635712	8.86	0.000	3.886771	6.09593

N17	5.551699	.5493771	10.11	0.000	4.47494	6.628458
N18	5.704254	.5189127	10.99	0.000	4.687203	6.721304
N19	5.034144	.4315759	11.66	0.000	4.188271	5.880017
N20	0	(omitted)				
_cons	-6.914743	.9425181	-7.34	0.000	-8.762044	-5.067441