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# FDI and ICT effects on productivity growth in Middle East countries

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**Abstract**

Economic growth theories predict that economic growth is driven by investments in Information and Communication Technology (ICT). In this paper we studied the effects stemming from Foreign Direct Investment (FDI) and Information and Communication Technologies (ICT) on productivity growth. The analysis is based on panel data covering Middle East countries during the period 1990–2010. The growth accounting results indicate that the growth contribution of ICT and FDI was quite low this countries. The econometric results showed a positive and significant impact of ICT and FDI in these countries.

**Keywords:** FDI, ICT, growth, productivity, economic development.

## 1. Introduction

The rapidly rising level of economic integration, stimulated by advances in Information and Communication Technology (ICT), renders technology adoption, coming from foreign developed countries, a matter of great importance for economic growth and productivity improvement. As economic theory suggests, learning through international economic activity might be particularly important for all countries, especially for those lagging behind the most developed ones. Foreign Direct Investment (FDI) is considered, among others, an important channel for technology diffusion, which in turn raises the host country's productivity growth. On the other hand, the new 'information economy' of the past decades is associated with increased diffusion of ICTs, which are expected to deliver higher productivity gains and enhanced growth (Dimelisa, and Papaioannou, 2010).

Most empirical studies in the FDI and ICT growth literature have been conducted at the firm or industry level with mixed evidence regarding their relationship with economic growth and productivity. Fewer studies have been conducted at the macro or international level given the lack of long time-series data on FDI, ICT and other relevant country characteristics. Thus, as richer data are becoming available for longer periods and more countries, the macroeconomic effects of technology transfer through FDI and ICT become appealing.

An emerging body of empirical literature is concerned with how FDI affects labor productivity and economic growth in host economies. Most studies in this literature have been conducted at the micro-level using firm-level or industry data and are usually limited to manufacturing industry. The existing empirical evidence is mixed, depending on the type of data examined (cross-sectional versus panel data), the level of development of the FDI recipient country, the econometric analysis employed and the research design.

Evidence is provided for a positive and significant impact of FDI on productivity growth in both developing and developed countries. A uniform positive and significant innovation effect from FDI on growth was established for all countries, while divergent results between developing and developed countries were obtained for ICT and the interaction effects of FDI. These results are robust to possible endogeneity and omitted variable problems. They also suggest that the level of development matters in estimating such impacts.

In this paper, we intend to examine the relationship between FDI and ICT effects on productivity growth according to Dimelisa, and Papaioannou, (2010) article.

The rest of this article is organized as follows. The next section discusses several theoretical issues and the 'Economic Approach' section introduces the econometric specification. In the penultimate section, the econometric results are shown and discussed. Finally, the last section concludes.

**2. Theoretical Background**

The existing theoretical models imply that FDI is beneficial for host country's economic growth. According to traditional economic theory (law of diminishing returns), FDI will tend to concentrate in less developed countries, where there exist greater opportunities to achieve higher returns. However, there exist several prerequisites in order for FDI to become productive in developing countries. The existence of a minimum threshold level of human capital (Borensztein et al, 1998), of improved domestic infrastructures (de Mello, 1999), as well as of developed local financial systems (Alfaro et al, 2004) seem to be of high importance in order for FDI to flow in less developed countries and have a measurable impact on economic growth. Indeed, lack of these preconditions in several developing countries has resulted to unequal distribution across countries, with several developing countries facing difficulties to attract foreign investors.

We should point out that FDI is considered as an important channel for direct technology diffusion. Particularly, in developing countries, FDI is probably the most important channel for technology transfer because of the scarcity of financial resources and the urgent need for reconstruction. Within this framework it is expected that FDI will contribute to economic growth, indirectly, by accelerating the diffusion of general purpose technologies (GPTs). The most prominent and up-to-date example of a GPT is ICT. ICT is a technology with wide reach in many sectors and has created a range of complementary products (for example software products, communication networks and so on), which further enhance its productivity. Some essential characteristics of ICT include: (a) trade of goods and services at low cost, which lead to gains through specialization, scale economies and realization of comparative advantage (Harris, 1995); (b) low transaction costs and efficient management of information; (c) network effects implying higher effects as the number of users grows; (d) efficient control of distribution channels and reduced inventory holdings; and (e) faster and more efficient reallocation of factor inputs. Over time, such major developments in ICTs are expected to raise productivity and lead to accelerated economic growth (Dimelisa, and Papaioannou, 2010).

The existing empirical evidence shows the importance of FDI in fostering investment in ICTs in developing economies. While developed countries are expected to adopt more quickly GPTs, the developing countries tend to imitate them with lower costs because of learning and experience effects. Furthermore, ICT is expected to have a positive impact on FDI as it creates opportunities, especially for developing countries that are located away from technologically advanced countries, to free themselves from geographical limitations and become more attractive to foreign investors.

## 3. Econometric Approach

### *3.1. The Model*

To capture FDI and ICT effects on productivity growth, a production function is specified with several types of inputs. The present study considers the accumulation of FDI or ICT as special types of knowledge and technology capital introduced in the production process. Consequently, the regression analysis will be carried on by decomposing the overall effect of total capital to that of its individual domestic, foreign and ICT components.

Thus, following the paradigm of Dimelisa, and Papaioannou (2010), an aggregate Cobb-Douglas production function is specified, which incorporates four inputs, domestic capital (K), labor (L), foreign capital (F) and ICT capital:

$$Y_{it} = A_{it}e^{ct}(K_{it})^{\alpha}(L_{it})^{\beta}(F_{it})^{\gamma}(ICT_{it})^{\delta}e^{u_{it}} \qquad (1)$$

Where the subscripts of i and t denote country and year, respectively; Y measures gross output of each country; A is an index of technical progress; while K and F are taken to represent non-ICT capital. Parameters $\alpha, \beta, \gamma$ and $\delta$ are the elasticities of domestic capital, labor, foreign capital and ICT with respect to output and finally $u_{it}$ is the error term capturing unobserved variations between countries and over time. After taking logarithms and following the assumption of constant returns to scale, the level of output per worker can be expressed as a function of domestic, foreign and ICT capital to labor ratios (Dimelisa, and Papaioannou, 2010):

$$\ln(y_{it}) = ct - \ln(A_{it}) + \alpha \ln(k_{it}) + \gamma \ln(f_{it}) + \delta \ln(ict_{it}) + u_{it} \quad (2)$$

Where small case letters denote figures per worker. Writing (2) in first differences we obtain the following growth regression:

$$\Delta \ln(y_{it}) = ct + \ln(\Delta A_{it}) + \alpha \ln(\Delta k_{it}) + \gamma \ln(\Delta f_{it}) + \delta \ln(\Delta ict_{it}) + \varepsilon_{it} \quad (3)$$

Following common practice in the growth literature, equation (3) is further augmented by the lagged level of the dependent variable (lagged level of output per worker in its logarithmic scale) to capture convergence effects among countries (Barro, 1991). According to the neoclassical growth model, a negative impact is expected, implying that more developed economies are closer to their steady state equilibrium and display lower growth rates.

A problem encountered in most cross-country growth regressions is that technical progress ($\Delta \ln A_{it}$) in each country is unobservable, while its omission would introduce bias in the parameter estimates. We implement (3) by including a number of widely used policy and environmental variables (transparency (TI), government consumption (GOV), openness of trade) that have been proposed by Barro (1991). These variables are expected to affect economic growth through their impact on TFP. We expect that the effect of omitting relevant variables is mitigated by including such additional covariates, which have been widely used in the empirical growth literature (Temple, 1999). Particularly, the transparency indicator reflects an assessment by business people and institutions of the degree of corruption in each country5 and the general idea for using this indicator is to proxy for institutional effects on economic growth. Modern economic theory suggests that policies and institutions affect each country's attractiveness to investment, which, in turn, affects long-run economic growth. It is expected that several key determinants of economic growth (for example investment, technology, innovation and so on) are largely affected by institutions, so that a country with efficient public sector, low corruption and protection of legal rights will grow more rapidly. Regarding GOV (as a share of GDP), economic theory has not come to definite conclusion about its impact on economic performance. Proponents of government presence argue that if government spending is low, there will be slow economic growth because operation of the rule of law and providence of public infrastructures will be very difficult.

On the other hand, opponents of government presence suggest that high government spending undermines economic growth by transferring resources from the productive sector of the economy to government, which uses them less efficiently. They further support that government spending regularly reduces long-term growth owing to the imposition of taxes, which in turn lower the incentives to work, save and invest in capital and technology (Dimelisa, and Papaioannou, 2010). We also use the variable of trade openness (OPEN), defined as the ratio of total imports and exports to GDP. Higher trade volumes allow countries to specialize and gain comparative advantage that in turn lead to scale economies and higher efficiency. International trade is, also, considered as an important channel of technology transfer through imports of intermediate inputs and capital equipment. Furthermore, trade induces local firms to become more innovative and productive in order to compete efficiently with foreign firms. The expected sign of this variable is positive.

## 4. Econometric Methods – Endogeneity Issues

When dealing with panel data growth regressions, the standard practice is to use either the fixed or the random effect estimator, depending on the correlation between the cross section effect and the explanatory variables. Nevertheless, their use might not always provide precise estimates in the presence of endogenous variables. Although the basic motivation of most of the existing theoretical and empirical work is the potential effect of FDI or ICT on economic growth, their association with GDP growth does not mean that causality runs from one direction (Chowdhury and Mavrotas, 2006). The inclusion of the lagged level of the dependent variable in the empirical specification of model 3 may also create endogeneity problems through its relation to the dependent variable, causing correlation with the error term (Dimelisa, and Papaioannou, 2010).

It seems therefore that the traditional panel data estimation methods (either the fixed or the random effect estimator) are likely to produce biased and inconsistent results (Wooldridge, 2002). For this reason we employ the system GMM panel data estimator as econometrically more appropriate whenever the explanatory variables are correlated with past or even current realizations of the error term (Roodman, 2006). Furthermore, this estimator is useful for panel data with relatively small time dimension, as compared to the number of cross sections (Roodman, 2006).

The system GMM estimator is an augmented extension of the Arellano and Bond (1991) first difference GMM estimator. This estimator has been proposed by Arellano and Bover (1995) and is based on a system of two equations, one equation in first differences and one equation in levels. The variables in the equation in levels are instrumented with lags of their own first differences, while the variables in the equation in first differences are instrumented with lags of their own levels. The allowance of more instruments in this system GMM estimator can improve the efficiency of the obtained estimates (Dimelisa, and Papaioannou, 2010).

In this study, we will employ the two-step variant of the system GMM estimator, as it is considered more efficient. The problems caused with downward bias in the standard errors are mitigated by the inclusion of a finite sample correction to the two-step covariance matrix, as it was derived by Windmeijer (2005). The system GMM estimator reports two diagnostic tests. The Hansen J test tests the validity of the instruments used for the endogenous covariates. The hypothesis being tested is that the chosen instruments are uncorrelated with the residuals. If the null hypothesis is not rejected, the instruments pass the test and they are valid by this criterion. This estimator also reports a test for serial correlation, which is applied to the first differenced residuals. If the null of no serial correlation is rejected then the test indicates that lags of the used instruments are in fact endogenous and thus bad instruments.

### 5. Factor Contributions: A Growth Accounting Approach

Given the construction of ICT stocks, it would be interesting to perform a preliminary growth accounting exercise and analyze the relative contribution of each production factor. In this way, the growth accounting analysis can motivate the econometric analysis that constitutes the main part of this study. We start with the production function specified in (1). In growth accounting we assume that constant returns to scale are present, so that $\alpha + \beta + \gamma + \delta = 1$. After taking logarithms, differentiating both sides of equation (1) and accepting the hypothesis of constant returns to scale, we obtain (Dimelisa, and Papaioannou, 2010):

$$\hat{y}_t = \hat{a}_t + a\hat{k}_t + \gamma\hat{f}_t + \delta\widehat{ict}_t + (1 - a - \gamma - \delta)\hat{l}_t \qquad (4)$$

where the hats above letters denote variables in logarithmic differences. In the above equation, output growth is decomposed to TFP growth ($\hat{a}$), and a weighted average of domestic ($\hat{k}$), foreign ($\hat{f}$ ), ict ($\widehat{ict}$) capital and labor ($\hat{l}$) growth.

The bulk of growth accounting literature has adopted the Cobb Douglas production function, in which the share of physical capital in total output usually equals 1/3 and the share of labor equals 2/3. In our case this is not applicable owing to the decomposition of the capital input (ICT, foreign and remaining physical capital) on which no previous estimates of their shares exist. Because of national income data constraints (especially in developing countries), we follow the econometric method and calculate the shares of labor and physical capital by estimating a Cobb Douglas production function. We do this by employing the fixed effect panel data estimator and having imposed the necessary restriction of constant returns to scale.

The growth accounting method is more direct than the econometric method to obtain the relative contribution of each factor of production. However, the assumptions in the growth accounting are relatively restrictive in allowing to fully capturing the effect of each factor. As Barro and Sala-i-Martin (1995) indicate, the growth accounting method is less able to fully catch the impact of production factors, as it mistakenly assigns a part of output growth, which should be attributed to technological progress (TFP), to the growth of capital. On the other hand, the econometric analysis is more flexible, does not impose that the returns of capital accumulation are direct on growth and can allow for the existence of endogenous inputs. Nevertheless, the results from the growth accounting analysis provide a useful framework that motivates the econometric analysis that follows and constitutes the main part of this study.

## 6. Econometric Results – Discussion

### *6.1. Presentation of the Results*

Labor productivity growth regressions are performed according to equation (3) using a panel data set of Middle East countries for the 1990–2010 period, while separate regressions are estimated for the groups of developing and developed countries.8 As mentioned above, endogeneity problems, arising from a possible correlation between the regressors and the error term, may introduce bias and inconsistency in the estimates. In our sample, a positive correlation between productivity and FDI is, in principle, just as likely to mean that foreign capital is attracted to high-productivity countries, as it is to mean that foreign capital raises host country's productivity. In addition, the ICT investment series is derived from original spending data containing expenses for government or consumption purposes. Thus, it is possible that the derived capital stock data be affected by ICT consumption, in which case a part of the final ICT series will not be orthogonal to the error term of the regression. Finally, the variables of OPEN and GOV might, also, be treated as endogenous because higher GDP growth might increase imports or government spending.

The system GMM panel data estimator applied in our samples is expected to mitigate such problems, as explained in the section 'Econometric Methods – Endogeneity Issues', which describes in detail the econometric methodology applied. Baseline regressions are reported in Table 2, and include three forms of capital inputs: domestic, foreign and ICT capital per worker in growth rates (GKD, GKF, GICT), as well as the lagged level of output per worker {Y(1)}. As it is evident from the first column in Table 5 (entire panel of countries), the elasticity of ICT and domestic capital is highly positive and significant, while the impact of lagged output per worker $\{Y(-1)\}$ is significantly negative, as expected. The impact of FDI, however, although positive, is not statistically significant. It is interesting to notice the highly positive and significant ICT growth effect, something that had long been disputed in the empirical literature. When splitting the sample into the groups of developing and developed countries, the effect of FDI remains insignificant in developing countries, while the ICT effect remains positive and significant. By contrast, in the developed countries, the FDI impact dominates at the expense of both domestic and ICT capital stock whose impact becomes insignificant.

The results differentiate substantially when estimating the growth model augmented with the three policy and macroeconomic variables of TI, OPEN and GOV. As we can see from the results in Table 3, all three forms of capital (GKD, GKF and GICT) exert now a positive and significant impact on growth when using the panel of countries. The consistency of the GMM estimator is based on the validity of the instruments used and the absence of second-order serial correlation in the error term. Two lags of the dependent and endogenous variables were used as instruments in the system GMM regressions. As we can see, the reported Hansen J test and the test that examines for second-order serial correlation fail to reject their null hypotheses implying that the instruments used are valid and that the error term does not exhibit second-order serial correlation. Overall, these tests give further support to the estimated model and its implications.

Regarding the effects from ICT, the results provide significant evidence in favor of the 'new economy', especially in developing countries. Tiwari (2008) has stressed that ICT has the potential to play a positive role for economic development and poverty reduction in poor regions of the world, provided that information asymmetries related to demand factors for ICT will be eliminated. As discussed in the 'Theoretical Background' section, the new technologies tend to diffuse more rapidly and with lower costs in less developed countries because of learning and experience effects. The econometric evidence of this study trend to support this argument by establishing a highly positive and significant ICT effect in developing countries.

With respect to FDI, the estimates indicate that the accumulation of FDI contributes positively and significantly to the productivity growth of developed countries only. The insignificant growth effect of FDI in developing countries can also be explained by several insufficiencies that act as barriers to FDI and hinder its impact on economic growth. The macro empirical literature indicates that local structures, institutions and capital endowments are important for a host country to take advantage of FDI (Alfaro et al, 2006). In particular, there is evidence that FDI contributes to host country's productivity when technology gap is not large and when a sufficient level of absorptive capacity exists in the host country (Dimelisa, and Papaioannou, 2010). Other recipient country's conditions for the growth effect of FDI include the level of financial development, local credit constraints and OPEN.

Overall the econometric results indicate that less developed countries have the potential to benefit from ICT. With respect to FDI, Lall and Narula (2004) note that FDI cannot drive long-run economic growth of the host county without the existence of local capabilities and without the assistance of governments in promoting policies favorable for FDI. Such policies might be oriented to OPEN and financial development. Further policies will lead to the increase of competition in the high-technology sector, the increase of Internet diffusion, the development of telecommunications infrastructure, and the establishment of an adequate legal and regulatory framework. Furthermore, special focus should also be placed to high-level specialized training, without, however, overlooking basic education because the encouragement of training is more effective when basic skills are already available.

 

## 7. Conclusion

This article investigates for possible effects on productivity growth generated by the accumulation of FDI, together with any impacts stemming from the employment of ICT. Such effects were estimated by applying a growth accounting framework as well as by using recent panel data econometric techniques. A sample of Middle East countries over the period 1990–2010 was used and the system GMM panel data estimator was employed to estimate the model.

The growth accounting results indicate that the contribution of ICT and FDI was quite low for this countries. The econometric results confirm that the growth impact of ICT is positive and significant in these countries, the effect being larger among developing countries. A positive and significant effect was also found for FDI in the panel of countries.

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Table 1: Correlation matrix

| | GY | GKD | GKF | GICT | GOV | OPEN | TI |
|---|---|---|---|---|---|---|---|
| GY | 1 | - | - | - | - | - | - |
| GKD | 0.31 | 1 | - | - | - | - | - |
| GKF | 0.15 | -.17 | 1 | - | - | - | - |
| GICT | 0.38 | 0.28 | 0.13 | 1 | - | - | - |
| GOV | -0.10 | -0.31 | 0.11 | 0.02 | 1 | - | - |
| OPEN | 0.04 | -0.15 | -0.06 | -0.08 | -0.09 | 1 | - |
| IT | -0.05 | -0.29 | 0.06 | -0.04 | 0.56 | 0.20 | 1 |

Note: GY=Growth rate of output per worker, GKD=Growth rate of domestic capital per worker, GKF=Growth rate of foreign capital per worker, GICT=Growth rate of ICT capital per worker, GOV= Government consumption (as a share of GDP), OPEN=Openness of trade (imports plus exports as a share of GDP), TI=Transparency index (1–10).

 

Table 2: System GMM estimates: Baseline model

| Explanatory variables | constant | Y(-1) | GKD | GKF | GICT | Hansen J test (P-value) |
|---|---|---|---|---|---|---|
| coefficient | 0.30 | -0.02 | 0.08 | 0.01 | 0.02 | 0.08 |
| | (4.72) | (-5.21) | (6.03) | (1.93) | (3.12) | |

Table 3: System GMM estimates: Augmented model

Dependent variable: Growth rate of output per worker

| Explanatory variables | constant | Y(-1) | GKD | GKF | GICT | TI | OPEN | GOV | Hansen J test (P-value) |
|---|---|---|---|---|---|---|---|---|---|
| coefficient | -0.05 | -0.11 | 0.21 | 0.02 | 0.03 | 0.011 | 0.01 | 0.01 | 0.53 |
| | (-2.32) | (-2.21) | (5.11) | (0.98) | (2.56) | (1.85) | (1.82) | (1.34) | |