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The last two decades have witnessed a triumph of free market policies in many developing countries and thus an increase in trade and financial openness. While economic theory provides a solid justification of the fact that trade and financial openness for a small economy with perfectly competitive markets improve resource allocation and thus national welfare, empirical evidence shows that financial openness does not necessarily boost the economic growth. Intuition suggests that there should be certain preconditions or thresholds for developing countries to benefit from financial openness.

By applying Data Envelopment Analysis, robust OLS regressions and threshold analysis, we examine whether the effect of Foreign Direct Investment (FDI) on country's productivity is dependent upon different levels of financial openness. Our paper uses three measures of financial openness, namely, the value of total shares traded divided by market capitalization, the ratio of liquid liabilities to GDP and market capitalization. The empirical analysis shows that FDI has a positive effect on host country productivity based on a sample of 45 countries covering the period from 1980 through 2006. We also found that relationship between FDI and productivity is not monotonic and there exist threshold levels of financial openness at which productivity gain from FDI can be maximized.

Foreign Direct Investment and Productivity: Financial Openness Thresholds

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Does finance make a difference . . .?
Raymond Goldsmith (1969, p. 408)

1. Introduction

The last two decades have witnessed a triumph of free market policies in many developing countries and thus an increase in trade and financial openness. Whether financial openness of a country contributes to its productivity improvement and economic growth is one of the most interesting and controversial macroeconomic questions of the last decade. While economic theory provides a solid justification of the fact that trade and financial openness for a small economy with perfectly competitive markets improve resource allocation and thus national welfare, empirical evidence shows that financial openness does not necessarily boost economic growth. Intuition suggests that there should be certain preconditions or thresholds for developing countries to indeed benefit from financial openness.

The last two decades have also been marked by a dramatic growth of FDI, far outpacing the growth of trade and income. In 2007 world FDI inflows rose to a record level of $1.8 trillion. In developing countries FDI inflows reached $500 billion – their highest level ever and a 21% increase over 2006. The least developed countries (LDCs) attracted $13 billion worth of FDI in 2007. [1]

FDI can contribute to the productivity growth of a country via various channels, which can be generalized into two main groups – factor accumulation (physical and human capital) and improvements in Total Factor productivity (TFP). However, the empirical literature on the relation between FDI and productivity growth shows mixed results. Moreover, no consensus has been reached as to which of the channels – factor accumulation or a TFP improvement is more important for productivity growth.

Despite ambiguous empirical evidence, several recent studies, focusing on the issues of financial openness and FDI separately, argue that absorptive capacity plays an important role in defining whether a country benefits or loses because of financial openness and FDI.

[1] World Investment Report 2008, UNCTAD

The concept of absorptive capacity was originally defined by Cohen and Levinthal (1990) from a micro prospective as a form of organizational learning that characterizes a firm's ability to apply received information for achieving business goals. According to the World Bank's definition, absorptive capacities are macroeconomic management (specified under inflation and trade openness), infrastructure (telephone lines and paved roads), and human capital (share of labor force with secondary education and percentage of population with access to sanitation). However, financial markets are not mentioned.

In the current study we use the term "absorptive capacity" as a country's ability to benefit or lose from FDI depending on the level of financial openness threshold variables. The research question we ask is whether there is a certain level of financial openness beyond or under which countries that receive FDI tend to gain more/less in terms of productivity. We are also interested in whether this threshold effect varies with different regions (in the current paper we use Latin America, Eastern Europe, East Asia and Pacific and MENA regions) and different income groups of countries (high income, upper middle income, lower middle income). We also explore how the threshold effects change for 3 and 5 year periods, and whether the interaction effects of financial openness and FDI have positive or negative effects on productivity.

The results of the current study have a large practical value since they might provide an insight for policy makers on the issue of financial liberalization policies. In other words, they help answer the question how intensively a government should pursue financial openness policies that attract FDI to ensure gains in productivity.

The paper is constructed as follows: Section 2 gives a brief review of empirical studies linking FDI, financial openness and productivity growth. In Section 3 we present the methodology of productivity measurement and threshold analysis, as well as the model specification. Section 4 describes the database construction and the basic characteristics of the data. The main empirical findings and discussion are presented in Section 5. And finally Section 6 concludes the paper with a discussion of the results.

2. Review of Literature

The recent empirical literature provides mixed evidence on the existence of positive effects of FDI on productivity. Moreover, there is also a diversity of opinion regarding the effects of financial liberalization on economic growth. The main reason for that comes from the fact that relationship FDI-Productivity-Financial openness is complex and can be viewed from different angles. In the literature review section we look at various aspects of this relationship and focus on the recent developments made in the research area.

2.1 Financial Openness and Productivity

The importance of financial entrepreneurship was described by Joseph Schumpeter as early as in 1912. Modern empirical research on the relationship between finance and growth began with Raymond Goldsmith (1969). In his famous book "Financial Structure and Development" Goldsmith emphasizes the effect of financial superstructure of an economy on the acceleration of economic growth through the migration of funds to the best projects available. Ronald McKinnon (1973) and Edward Shaw (1973) argue that restriction of competition in the financial sector with government regulations (so called financial repression) discourages both saving and investment.

As many developing countries began to liberalize their financial sectors, there has been an extensive body of research on the issue of financial openness and economic growth, however, only few studies mentioned productive efficiency. Gourinchas and Jeanne (2002) conduct a theoretical study which resulted in the conclusion that financial liberalization brings benefits only in the short run. McKinnon and Pill (1997) introduce the phenomenon of "overborrowing," which causes a high rate of growth in the short run, however, might lead to a financial crisis and recession in the long-run. Stiglitz (2000) has pointed out the existence of market distortions such as asymmetric information that might lead to welfare-deteriorating effects from openness. Rodrik (1998) analyzes whether countries that had been open for a relatively longer part of the period 1975–89 also experienced faster economic growth and found that there is a lack of positive effect of openness on growth.

Bonfiglioli (2007) and Kose, Prasad and Terrones (2008) are the only two empirical macro studies that we are aware of that analyze the impact of overall financial openness on TFP growth.

Bonfiglioli analyzes the sample of 70 countries between 1975 and 1999 using both de facto and de jure measures of financial openness and found that financial integration has a positive direct effect on productivity growth mainly in developed countries with no direct effect on capital accumulation. In the discussion part of her study Bonfiglioli also suggests that as in trade models openness generates gains from specialization and increasing varieties which raise efficiency of the capital allocation, and thus lead to productivity growth.

Kose, Prasad and Terrones (2008) work is complementary to the work of Bonfiglioli (2007). They define de jure capital account openness as the absence of restrictions on capital account transactions and de facto financial integration as stocks of foreign assets and liabilities relative to GDP. The authors use a more comprehensive and updated dataset, a dynamic panel regression framework and various measures of productivity and financial openness for a large sample of countries and found that de jure capital account openness has a strong positive effect on TFP growth, while the effect of de facto measure is ambiguous.

2.2 FDI and Productivity

Just as there is no common agreement on the effects of financial openness, there is no general consensus whether there is a positive correlation between FDI and productivity. In the theoretical literature the relationship between FDI and productivity is often explored through the technology spillover channel (Findlay (1978), Romer (1993)). Blomstrom and Kokko (1998) argue that countries attract FDI today with the goal to acquire modern technology through important positive externalities that increase the productivity of local firms, and help to improve the comparative advantage of the economy over time.

Empirical literature on FDI and productivity can be divided into aggregate level and plant/firm level studies. Studies of plant/firm level FDI in specific countries provide mixed evidence, however in general the majority of them do not imply that FDI accelerates growth. Kokko et al. (1996) using FDI data from Uruguayan manufacturing plants in 1988 examines whether differences in the technology gap between locally-owned plants and foreign affiliates influence the relationship between local plants productivity and foreign investment. He finds a positive and statistically significant spillover effect only in a sub-sample of locally-owned plants with moderate technology gaps. Aitken and Harrison (1999) show for panel data on Venezuelan plants that FDI is positively correlated with plant productivity (the 'own-plant' effect), however FDI negatively affects the productivity of domestically owned plants. Thus, considering these two effects that offset each other, the authors find that the net impact of FDI is quite small and FDI seems to benefit only joint ventures. Haddad and Harrsion (1993) using firm level data find that there is no evidence of large positive effects of FDI on productivity of domestic firms in Moroccan manufacturing industries.

In the last several years models with heterogeneous firms are becoming popular in exploring the relationship between FDI and productivity. Melitz (2003) develops a dynamic industry model with heterogeneous firms to show that only the more productive firms will enter the export market while some less productive firms continue to operate only at the domestic market, and the least productive firms would exit. The paper also shows how the aggregate industry productivity growth generated by the reallocations contributes to a welfare gain, thus highlighting a benefit from trade that has not been examined theoretically before. Melitz extends Krugman's (1980) trade model that includes firm level productivity differences. Firms with different productivity levels coexist in an industry because each firm faces initial uncertainty concerning its productivity before making an irreversible investment to enter the industry. Entry into the export market is also costly, but the firm's decision to export occurs after it gains knowledge of its productivity.

Helpman, Melitz and Yeaple (2004) construct a multi-country, multi-sector general equilibrium model that explains the decision of heterogeneous firms to serve foreign markets either through exports or local subsidiary sales (FDI). They conclude using data from data of US affiliate sales and US exports in 38 different countries and 52 sectors that in equilibrium, only the more productive firms choose to serve the foreign markets and the most productive among this group will further choose to serve the overseas market via FDI. The authors also confirm the predictions of earlier studies (Brainard 1997), that country specific transport costs and tariffs have a strong negative effect on export sales relative to FDI.

National level studies of FDI and economic growth relationship also provide controversial results; however, the majority of them suggest a positive role of FDI in economic growth. Borensztein et al. (1998) using cross-country regressions and data from industrial countries in 69 developing countries over the last two decades, examine the role of FDI in economic growth. Their results show that FDI plays an important role in technology transfers, contributing relatively more to growth than domestic investment. However, they also find that the higher productivity of FDI holds only when the host country has a minimum threshold stock of human capital.

Carkovic and Levine (2005) use simple OLS regression with one observation per country over 1960-1995 and a dynamic panel procedure with data averaged over five year periods to improve on previous efforts to examine FDI-growth relationship. They estimate the effects of FDI inflows on economic growth after controlling for other growth determinants, endogeneity biases and country-specific effects. They find that FDI inflows do not have a robust and independent influence on economic growth. Moreover, an extensive sensitivity analysis with a variety of alternative samples and specifications (limiting the sample of developing countries, using natural logarithm of FDI, exchange rate volatility, change in terms of trade in the regression, various combinations of the conditioning information set, etc.) show that these factors do not change the major conclusion.

2.3 Financial Openness, FDI and Productivity

Few recent empirical studies that we are aware of connect together financial openness, FDI & productivity. Moreover, we could not find any study that would explore the issue of absorptive capacity of the country as a certain threshold to benefit from FDI through the increase in productivity.

Noy and Vu (2007) study the relationship between capital account openness and FDI using an annual panel dataset of 83 developing and developed countries for 1984-2000. They conclude that other country characteristics (here the level of corruption and political risk) seem to determine FDI inflows instead of capital account policies. They find that capital account openness is positively but only very moderately associated with the amount of FDI inflows after controlling for other macroeconomic and institutional measures.

Alfaro et al. (2004) connect financial markets, FDI and productivity to answer the question whether countries with better financial systems can use FDI more efficiently. They conduct an empirical analysis, using cross-country data between 1975 and 1995 and find that FDI alone plays an ambiguous role in contributing to economic growth. However, countries with well-developed financial markets gain significantly from FDI. The results are robust to different measures of financial market development, the inclusion of other determinants of economic growth, and consideration of endogeneity. The valuable extension of this study is recent work of Alfaro et al. (2009) that investigates whether financial development in the host-country influences productivity through factor accumulation and/or improvements in TFP. They find that countries with well-developed financial markets gain significantly from FDI mainly via TFP improvements.

2.4 Absorptive Capacity and Methods of Threshold Regressions

The issue of absorptive capacity and benefits from FDI has received proper attention only recently. Several studies state that the domestic firms' ability to respond successfully to new entrants, new technology and new competition contribute to how much in fact they benefit from FDI. The World Bank's report on Global Development Finance (2001) discusses the role of country's "absorptive capacities" with respect to FDI. Under "absorptive capacities" the listed are macroeconomic management (specified under inflation and trade openness), infrastructure (telephone lines and paved roads), and human capital (share of labor force with secondary education and percentage of population with access to sanitation). However, financial markets are not mentioned.

Girma (2005) applies threshold regression techniques recently developed by Hansen (2000), Caner & Hansen (2004) to investigate if the effect of FDI on productivity growth is dependent on absorptive capacity. The author uses firm-level data from the U.K. manufacturing industry over the period 1989–99 to show the presence of nonlinear threshold effects: the productivity benefit from FDI increases with absorptive capacity until some threshold level beyond which it becomes less pronounced. The important result of this work is that it also points to the existence of a minimum absorptive capacity threshold level below which productivity spillovers from FDI are very small or even negative.

To examine if the effect of FDI on economic growth is dependent upon different absorptive capacities Wu and Hsu (2008) also use threshold regression techniques developed by Caner and Hansen (2004) to study a sample of 62 countries covering the period from 1975 through 2000. As threshold variables they use three absorptive capacities: initial GDP, human capital and the volume of trade. Their results show that FDI itself plays an ambiguous role in contributing to economic growth, while with the threshold regression, the initial GDP and human capital are important factors in explaining FDI. Thus, the authors conclude that FDI has a positive and significant impact on growth when host countries have better levels of initial GDP and human capital.

Our research is focused on the impact of financial openness on productivity change, rather than on the output growth, which is a different angle of growth-openness issue. It contributes to the existing body of literature by using the Malmquist productivity index as a measure of productive efficiency which is distinct from the previous works since it accounts for X –inefficiency – an efficiency loss caused by the failure of the firms/countries to produce on the lowest possible average and marginal cost curves. Also, we apply threshold analysis to determine the minimum level of threshold variable such as financial openness that would define "minimum absorptive capacity" beyond which a country would benefit from FDI.

3. Methodology

Our analysis proceeds in four steps. The first step involves the application of Data Envelopment Analysis (DEA) techniques to calculate the Malmquist productivity index (MPI) to obtain productivity changes in the country over time. In the second step we apply a least squares regression analysis with different specifications to test the relationship between FDI and obtained MPI. The third step applies the Bayesian information criterion (BIC) to select the specification with the best fit. And in the final step of the analysis we conduct grid search by obtaining the sum of squares of residuals (SSR) and selecting the smallest one that would indicate a tight fit of the model to the data and comparing it with different levels of financial openness. All steps are described below in detail.

3.1 Productivity Measurement

3.1.1 The DEA Approach

In a broad set of literature the economic performance of a country has usually been closely associated with the country's GDP growth rate, which reflects the increase in the value of all final goods and services produced within a nation in a given year. However, growth ignores how efficiently or productively a country uses its inputs to produce output.

By productivity of the country we mean the ratio of its output to its inputs. The variation in productivity across countries and different periods represents an important piece of information about a country's economic development. It can be characterized as the residual attributed to different sources such as variations in production technology, operative efficiency and environment, etc.

Fried, Lovell and Schmidt (2008) define efficiency as the difference between observed and optimal values of producers' output and input. They divide efficiency into two parts. If we compare the observed output (input) to maximum (minimum) potential output (input) obtainable from the input, the efficiency is technical.

However, Fried, Lovell and Schmidt also mention that it is possible to define the optimum in terms of behavioral goal of the producer. This type of efficiency when the optimum is defined in value terms is referred as economic.

In the current study we apply the nonparametric method for the estimation of production frontiers called DEA which is used to empirically measure productive efficiency of decision making units when the production process consists of multiple inputs and outputs.

The work "Measuring The Efficiency Of Decision Making Units" by Charnes, Cooper & Rhodes (1978) was one of the first applications of linear programming to estimate an empirical production technology frontier. Currently DEA is widely applied in various studies for various sets of problems since this approach provides a wide range of advantages such as it does not require the specification of a certain a mathematical functional form for the production function, does not depend on measurement units, and can be used with multiple inputs and outputs.

Charnes, Cooper and Rhodes (1978) define efficiency as a weighted sum of outputs to a weighted sum of inputs, where the weights structure is calculated by means of mathematical programming and assumes Constant Returns to Scale (CRS). In the literature DEA is now a well-known approach for efficiency measurement. Here we use the DEA model that estimates “best practice” frontiers in the manner of Charnes et al. (1978), Färe et al.(1996). In other words, we calculate output-oriented measures of efficiency assuming CRS.

We assume that at each time period t= 1, . . . ,T there are n = 1, . . . , N countries that use k = 1, . . . , K inputs to produce *m* = 1, . . . , *M* outputs . We describe the CRS technology at period *t* as follows:

$$S^t = \{(x^t y^t) : y_m^t \leq \sum_{n=1}^{N} z^{n,t} y_m^{n,t}, m = 1,..., M \quad (1)$$

$$\sum_{n=1}^{N} z^{n,t} x_k^{n,t} \leq x_k^t, k = 1,..., K \quad (2)$$

$$z^{n,t} \geq 0, n = 1,..., N\} \quad (3)$$

where $z^{n,t}$ is the intensity variable for each observation. We interpret intensity variables as the relative importance of each observation while constructing the frontier.

To construct the Malmquist productivity index between periods *t* and *t+1* and given our technology function, we need to find output distance functions by solving the following linear programming problems:

$$\left[D_o^{t+i}(x^{n,t+j}, y^{n,t+j})\right]^{-1} = \max \lambda^n, \qquad (4)$$

subject to

$$\lambda^n y_m^{n,t+j} \le \sum_{n=1}^{N} z^{n,t+i} y_m^{n,t+i}, m = 1,..., M \qquad (5)$$

$$\sum_{n=1}^{N} z^{n,t+i} x_k^{n,t+i} \le x_k^{n,t+j}, k = 1,..., K \qquad (6)$$

$$z^{n,t+i} \ge 0, n = 1,..., N, \qquad (7)$$

where (*i,j*)=(0,0) when solving for $D_o^t(x^{n,t} y^{n,t})$;

(*i,j*)=(0,1) when solving for $D_o^t(x^{n,t+1} y^{n,t+1})$;

(*i,j*)=(1,0) when solving for $D_o^{t+1}(x^{n,t}, y^{n,t})$;

(*i,j*)=(1,1) when solving for $D_o^{t+1}(x^{n,t+1} y^{n,t+1})$ [2]

[2] For setting up the non-parametric problem I referred to Guillaumont, Hua and Liang.,"Finanicial development, Economic Efficiency and Productivity Growth: Evidence from China", The Developing Economies, XLIV-1 (March 2006): 27–52

3.1.2 Malmquist Productivity Index

Malmquist productivity index was first initiated by Caves, Christensen, and Diewert (1982) and further developed by Färe (1988), Färe *et al*. (1994), and others (e.g., Färe *et al* . 1996; Färe, Grosskopf, and Russell 1997).

The building blocks of Malmquist index are distance functions. In the current study we use the output –oriented form of Malmquist index that is defined as the geometric mean of the two ratios of a pair of output distance functions. The output distance functions consider the maximum proportional expansion of the output vector given the input vector.

The output-oriented distance function for each time period *t*= 1, . . ,*T,* following Shephard (1970) and Färe (1988), can be defined on the output set S^t as:

$$\begin{aligned} D_o^t(x^t, y^t) &= \inf[\theta : (x^t, y^t/\theta) \in S^t] \\ &= \{\sup[\theta : (x^t, \theta y^t) \in S^t]\}^{-1}, \end{aligned} \qquad (8)$$

where x^t is the inputs vector (in our case Capital and Labor) at time period *t,* y^t is the outputs vector (in our case GDP), *t* stands for the time period of reference technology, and S^t is the technology set with $S^t = \{(x^t, y^t) : x^t \mathit{can\ produce}\ y^t\}$ that models the transformation of inputs ($x^t \in R_N^+$) into outputs ($y^t \in R_M^+$). The technology S^t being closed, bounded, convex, and satisfies strong disposability properties. The output distance function reflects the distance of an individual economy to the production frontier in relation to benchmark technology. $D_o{}^t(x^t y^t) \le 1$ if the output vector y^t is an element of the feasible production set S^t . The distance function will take the value 1 if y^t is located on the outer boundary of the feasible production set and will be greater than 1 if y is located outside of the feasible production set.

Following Caves, Christensen, and Diewert (1982), the Malmquist index is defined as follows:

$$M_o^t = \frac{D_o^t(x^{t+1}y^{t+1})}{D_o^t(x^t y^t)} \tag{9}$$

$$M_o^{t+1} = \frac{D_o^{t+1}(x^{t+1}y^{t+1})}{D_o^t(x^t y^t)} \tag{10}$$

We use Malmquist indexes to measure the productivity changes from period *t* to *t+1* by calculating the ratio of the distances of the observation of each period under the same reference technology. Following Färe *et al*. (1994) we calculate the Malmquist productivity index as the geometric mean of these two indices:

$$M_o^{t+1,t}(x^{t+1}y^{t+1}x^t y \ ) = \left[\left(\frac{D_o^t(x^{t+1}y^{t+1})}{D_o^t(x^t y^t)}\right)\left(\frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t y^t)}\right)\right]^{1/2} \tag{11}$$

The value of $M_o > 1$ reflects positive productivity growth from period t to period t+1 while the value of $M_o < 1$ indicates a decline.

We also calculate the Malmquist productivity index decomposition into efficiency change and technical change:

$$M_o^{t+1,t}(x^{t+1}y^{t+1}x^t y^t) = \frac{D_o^t(x^{t+1}y^{t+1})}{D_o^t(x^t y^t)}\left[\left(\frac{D_o^t(x^{t+1}y^{t+1})}{D_o^{t+1}(x^{t+1}y^{t+1})}\right)\left(\frac{D_o^t(x^t y^t)}{D_o^{t+1}(x^t y^t)}\right)\right]^{1/2} \tag{12}$$

where the term outside of the brackets measures the degree of "catching up" with the best frontier between periods of *t* and *t+1* (efficiency change). The component in brackets denotes technical change and shows the shift of the frontier itself between these two periods. Decomposition of the Malmquist productivity index into efficiency change and technical change allows us to identify the contributions from above mentioned changes to the overall TFP change.

In the current study we also calculate cumulative productivity change using the following formula:

$$M_o = \prod_{t=1}^{T} M_o(x^{t+1}y^{t+1}x^t y^t) \tag{13}$$

Cumulative productivity change shows the trend in productivity change in different countries and regions over the period 1980-2006. To estimate Malmquist indexes we use the Onfront® software.

3.2 Productivity and FDI: Financial Openness Thresholds

3.2.1 Model Specification

The next step of our analysis is the application of OLS regressions to test the relationship between FDI and MPI. The baseline specification of our model includes our predictor variable FDI, outcome variable MPI and vector of controls X_{it}:

(I)

$$\Delta MPI_{it} = \beta' X_{it-1} + \delta FDI_{it-1} + \varepsilon_{it} \qquad (14)$$

where ΔMPI_{it} is a productivity change in country *i* in period *t*, FDI_{it-1} is FDI inflows to the host country in the period *t-1*, X_{it-1} is a vector of conditional information set that includes the following variables: ENERGY, TEL, LAND and HC. We use lagged variables in our model due to the assumption that the effect from FDI inflows is more pronounced in the next period after FDI took place in the country. Application of lagged variables also helps to mitigate the endogeneity issue when FDI is correlated with the error term. However, in order to completely avoid endogeneity problem we would have to apply the instrumental threshold regression by Caner and Hansen (2004), which we plan to do in the future as the extension of the current study.

Finally, we assume that the random error ε_{it} is distributed independent of the explanatory variables.

By including regional and income dummies we create 3 additional specifications of the model.

Second specification includes dummy variables for four regions: Latin America, Middle East and North Africa, Eastern Europe, and East Asia and Pacific as a reference region.

(II)

$$\Delta MPI_{it} = \beta^{'} X_{it-1} + \delta FDI_{it-1} + \varphi_1 D(LATIN) + \varphi_2 D(MENA) + \varphi_3 (EASTEUROPE) + \varepsilon_{it} \quad (15)$$

The third specification includes income dummies for high income and upper middle income countries, using lower middle income countries as a reference group:

(III)

$$\Delta MPI_{it} = \beta^{'} X_{it-1} + \delta FDI_{it-1} + \mu_1 D(HIGHINCOME) + \mu_2 (UPMINCOME) + \varepsilon_{it} \quad (16)$$

Specification (IV) combines specifications (II) and (III):

(IV)

$$\Delta MPI_{it} = \beta^{'} X_{it-1} + \delta FDI_{it-1} + \varphi_1 (LATIN) + \varphi_2 (MENA) + \varphi_3 (EASTEUROPE) + \mu_1 D(HIGHINCOME) + \mu_2 D(UPMINCOME) + \varepsilon_{it} \quad (17)$$

Before conducting the detailed threshold analysis we estimate an additional specification with FO, FDI and the interaction term FDI*FO to investigate the possibility of a non-linear relation between FDI and productivity:

$$\text{(V)}\ \Delta MPI_{it} = \beta^{'} X_{it-1} + \delta FDI_{it-1} + \lambda FO_{t-1} + \gamma (FO_{it-1}) * (FDI_{it-1}) + \varepsilon_{it} \quad (18)$$

where FO denotes Financial openness.

We run additional eight specifications for 3 year and 5 year panels to test if the relationship between FDI and productivity growth changes with larger time periods. We expect the effect of FDI to “fade away” with larger time periods as technology spillovers get absorbed by the host country.

We include regional and income dummies to check if the effect of FDI on productivity is more or less pronounced in certain regions or income groups. We also estimate an additional regression for the period 1990-2006 to concentrate on the effects of FDI on productivity in the recent 16 years, which is particularly important for Eastern European countries.

We expect to find a positive relationship between productivity and FDI (coefficient δ>0), as well as a positive sign for the interaction term of FO and FDI

($\gamma > 0$). We also expect that the δ coefficient will be greater for low middle income countries than for high income countries due to the fact positive effects of FDI inflows on productivity are more pronounced in the countries at the lower level of development. This can be explained by the fact that developing countries have larger technology gaps and large supply of relatively cheap labor force, thus initial FDI that comes to the country has to bridge wider gaps in developing low income countries than in developed countries which makes the effects of FDI more pronounced.

Next we apply Bayesian Information Criterion (BIC) to estimate the best model using only an in-sample estimate. BIC is based on maximization of a log likelihood function:

$$BIC = -2 \log M_j (X_1, ..., X_N) + k_j \log N \qquad (19)$$

We assume that the model errors are normally distributed, thus BIC becomes:

$$BIC = n \ln(\frac{SSR}{n}) + k \ln(n) \qquad (20)$$

Since BIC is an increasing function of SSR and an increasing function of *k,* unexplained variation in the dependent variable and the number of explanatory variables will increase the value of BIC. Thus, the model with lower BIC will be the preferred one.

3.2.2 Threshold Analysis

The last stage of our analysis involves the estimation of selected regression equation (using BIC criteria) under the various levels of financial openness thresholds.

Due to the model structure and data availability we were not able to apply the threshold regression techniques developed by Hansen (2000) and Caner & Hansen (2004) based on conducting an endogenous test that defines the existence and significance of threshold levels of absorptive capacity rather than imposing arbitrary cut-off measures. Instead we use the “Grid Search” method to find the thresholds in the relationship between MPI and FDI technology spillovers conditional on country's financial openness level. The "Grid Search" method, creates a "grid" of all possible locations for different levels of the threshold variable, and tests the SSR at each one to find the best possible fit which occurs at the level where SSR value is minimized.

We apply three different measures of FO while conducting the grid search: the market capitalization ratio, the ratio of the value of total shares traded to average real market capitalization and the ratio of liquid liabilities to GDP.

We express the general relationship between changes in MPI, FDI and FO as:

$$MPI_{it} = \beta'_1 X_{it-1} + \delta_1' FDI_{it-1} + \varepsilon_{it} \quad \text{When } FO_{it-1} =< \alpha \qquad (21)$$

$$MPI_{it} = \beta'_2 X_{it-1} + \delta_2' FDI_{it-1} + \varepsilon_{it} \quad \text{When } FO_{it-1} > \alpha \qquad (22)$$

Equations (21) and (22) divide the FDI parameters (hence the observations) into two regimes depending on whether the FO is smaller or larger than the threshold level alpha.

Equations (1) and (2) can be modified to get:

$$MPI_{it} = L_{1t}\theta_1(FO_{it-1} \leq \alpha) + L_{2t}\theta_2(FO_{it-1} > \alpha) + \varepsilon_{it} \qquad (23)$$

Conditional on a threshold value, for example α_0, SSR from equations (21) and (22) is linear in parameters $\beta i'$ and δ_i' so that it can be minimized to yield the conditional OLS estimators $\hat{\theta}_i(\alpha_0)$.

$$\underset{\theta_1,\theta_2}{Arg \min} \frac{1}{n}\sum \varepsilon_{it}^2 = \frac{1}{n}\sum_{it}\left[\left(y_{it} - L_{it}\hat{\theta}_1\right)^2 1\left(s_{t-1} \leq \alpha\right) + \left(y_{it} - L_{it}\hat{\theta}_2\right)^2 1\left(s_{t-1} > \alpha\right)\right] \qquad (24)$$

$$Arg \min \frac{1}{n}\sum_{sit-1=<\alpha}\left[\left(y_{it} - L_{it}\hat{\theta}_1\right)^2\right] \qquad (25)$$

$$Arg \min \frac{1}{n} \sum_{sit-1>\alpha} \left[\left(y_{it} - L_{it} \hat{\theta}_2 \right)^2 \right] \tag{26}$$

Of all possible values of financial openness as thresholds, the estimator of the threshold corresponds to the value of α that yields the smallest SSR.

The next step of analysis is to create a grid from the financial openness variables such as market capitalization, turnover ratio and the ratio of liquid liabilities to GDP and conduct the search by plotting $\frac{1}{n}\sum \hat{\varepsilon}_{it}^2$ against α . From the plot we expect to see a non-monotonic pattern and identify a global minimum, if exists, and thus the threshold.

4. Database Construction and Sample Characteristics

We study the empirical link between financial openness thresholds and productivity growth using a large sample of developing countries that have recently liberalized their capital accounts. To construct our dataset we used the latest version of the World Development Indicators database (2007) by the World Bank and supplement it with data from various other sources, including the Barro-Lee database on education and labor, United Nations Conference on Trade and Development (UNCTAD) database of Inward FDI Inflows, the Worldwide Governance Indicators (WGI) database, a new database on financial development and structure by Beck et al. (2000).

All data are in constant (2000) international prices. Our dataset comprises annual data over the period 1980–2006 for 45 countries, 13 high-income, 16 upper middle income and 15 lower middle income countries and one low income[3]. The countries are divided into 4 regional groups: Latin America, MENA, East Asia and Pacific and Eastern Europe. The table summarizing country information is presented in the Appendix (Table A1).

We selected these particular regions for our study due to the recent financial account liberalization efforts in the countries belonging to these regions. The Latin American region was the earliest to "open up" in 1970s with further retrenchment during the debt crises of the early 1980s. However, it took much longer for Middle Eastern countries to open up. Only during the 1990s, the MENA capital markets became more accessible. In contrast, Eastern Europe removed the restrictions most rapidly after 1990.

Overall we have constructed three datasets including yearly data, and 3 and 5 year aggregate datasets created from the yearly data by means of arithmetic averages and aggregation.

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[3] World Bank classification is used: Economies are divided according to 2007 GNI per capita, calculated using the World Bank Atlas method. The groups are: low income, \$935 or less; lower middle income, \$936 - \$3,705; upper middle income, \$3,706 - \$11,455; and high income, \$11,456 or more.

4.1 Core Variables

In the first stage of the Malmquist productivity estimation we use GDP as output and CAPITAL and LABOR as input core variables. Our goal is to measure the productivity change in the country's output (GDP) through its efficient/inefficient use of capital and labor inputs.

CAPITAL variable is represented by gross fixed capital formation which is defined by the European System of Accounts (ESA) and consists of resident producers' acquisitions, less disposals, of fixed assets during a given period plus certain additions to the value of non-produced assets realized by the productive activity of producer or institutional units[4]. Fluctuations in this indicator are often considered to show the trend of future business activity and the pattern of economic growth.

LABOR variable is proxied by the total labor force in millions of people, or currently active population, that comprises all persons who fulfill the requirements for inclusion among the employed or the unemployed during a specified brief reference period.[5]

The GDP variable represents Gross domestic product calculated in constant 2000 US $ and is taken from World Development Indicators database.

To implement threshold regressions in the second part of our estimations we construct the MPI variable which represents the change in Malmquist productivity in the specific year as an arithmetic mean of two Malmquist Indices for the two consecutive periods t and $t+1$. Due to the fact Malmquist input and/or output variables are not available for all the periods, we interpolated missing MPI data points per country within the range of a discrete set of known data points. Estimated MPI takes values between 0 and ∞ reflecting the productivity change, if the value of index is greater than 1 we observe a positive shift in productivity, if the value is less than 1, then we observe a decrease in productivity and in case it is 1, there is stagnation.

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[4] OECD: Glossary of Statistical terms: Gross Fixed Capital Formation

[5] International Labour Organization (ILO) Resolutions Concerning Economically Active Population, Employment, Unemployment and Underemployment Adopted by the 13th International Conference of Labour Statisticians, October 1982, para. 8.

FDI variable represents inward FDI flows to the host economy (billions of US dollars). UNCTAD defines FDI as:

> "An investment made to acquire lasting interest in enterprises operating outside of the economy of the investor. Further, in cases of FDI, the investor´s purpose is to gain an effective voice in the management of the enterprise."[6]

The literature on possible measures of financial openness is extensive. Bussière and Fratzscher (2008) summarize the existing literature and define two general approaches on measuring capital account openness: de jure and de facto. *De jure* openness is based on the removal of restrictions to capital account transactions as published in line E.2 of the International Monetary Fund (IMF)'s Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The common way to use this measure in openness-growth literature is to define it as a discrete 0–1 variable, which will position the country on the spectrum from fully open to close. Due to the issues of data availability we do not use this measure.

Following King and Levine (1993), Levine and Zervos (1998), and Levine et al. (2000) we construct several measures of *de facto* financial openness.

Levin and Zervos (1998) use six indicators and two conglomerate indexes of stock market development and find that stock markets tend to become larger and more liquid following the liberalization of restrictions on international portfolio flows. Considering this, we choose to use the following measures of financial openness: the market capitalization ratio, the turnover ratio and the ratio of liquid liabilities to GDP.

The market capitalization ratio equals the value of listed shares divided by GDP. This measure has been used in a broad set of literature as an indicator of the market size. Following Levine and Zervos (1998) we assume that stock market size and ability to quickly mobilize capital and diversify risks are positively correlated.

The turnover ratio equals the value of total shares traded divided by market capitalization. This measure complements market capitalization since there is a possibility that market might be large but inactive in terms of trade, and the turnover ratio reflects trading relative to the size of the stock market. High turnover on the

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[6] United Nations Conference on Trade and Development, Definitions and Sources: FDI

stock market is often used as an indicator of low transactions costs.

The ratio of liquid liabilities to GDP represents an overall measure of financial sector development. It equals the ratio of liquid liabilities of bank and non-bank financial intermediaries to GDP. This measure is used complementary to other financial openness measures to test whether under the threshold of overall financial system development, the host country benefits from FDI through productivity growth.

The sources and methods of calculation of financial openness measures as well as core variables and controls are presented in the Appendix, TableA2.

4.2 Controls

The vector of controls X_{it} includes ENERGY, TEL, LAND, HC, GOV and CORR.

ENERGY is GDP per unit of energy use in constant 2005 Purchasing Power Parity (PPP) $ per kg of oil equivalent and reflects the level of energy use in total production in the economy. TEL is the number of telephone mainlines per 1 million of population and LAND represents the area of arable land as a percentage of total land area. We expect positive signs for ENERGY and LAND coefficients since they serve as inputs and important conditions for productivity. However, we are not certain about the sign for TEL coefficient considering the diminishing importance of telephone mainlines and increasing importance of mobile networks. Due to data availability issues we were not able to include the number of mobile phone subscribers as well as the number of internet users in our analysis.

HC includes the measure of average years of higher schooling in the total population and average schooling years in the total population from the Barro-Lee dataset. HC measures are available only as two year averages, thus they were interpolated. We use both measures separately in different specifications; however the measure of overall average schooling years has more observations and thus, we believe, provides a better picture on the role of human capital in the productivity-FDI relationship. We expect HC coefficients to be positive illustrating the important contribution of human capital and education to productivity gains.

GOV, Governance Effectiveness, and CORR, Control of Corruption, measures are taken from the Worldwide Governance Indicator (WGI) database by Daniel Kaufman that includes six governance indicators (data for 1996-2007) which are measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance. The database is constructed by using the statistical reports by a number of survey institutes, think tanks, non-governmental organizations, and international organizations. In order to include GOV and CORR measures into our regressions, we normalize the values and create a scale ranging from 0 to 5, with higher values corresponding to better governance outcomes.

5. Results

5.1 Malmquist Estimation Results

At the first step of our analysis 1125 Malmquist indices are estimated. In the Appendix we present the Malmquist plots for 25 periods (1980-1981, 1981-1982, etc.) for four regions. Our comparative analysis shows that cumulative productivity of East Asian and Pacific countries (Hong Kong, Thailand, South Korea) for the period 1980-2006 has an increasing trend while cumulative productivity of Latin American economies, except Peru, Paraguay and Brazil presents a decreasing trend.

Since most of the data for Eastern European countries are available starting from 1990, our results of Malmquist productivity for this group of countries mostly refer to the period 1990-2006. Cumulative productivity growth in Eastern Europe also has a mostly stagnating trend except for Latvia, whose productivity increased from 1980 to 2006. Moreover, Bulgaria and Belarus show decreasing trends in productivity with a large downturn in the middle of 1990s.

MENA countries exhibit increasing trends in cumulative productivity change during 1980-2006 with the exception of Syria (decreasing trend) and United Arab Emirates (stagnation).

It is interesting to note that cumulative productivity of East Asian and Pacific countries was not significantly influenced by Asian financial crisis of 1998, and we can observe a very similar situation in the MENA region. Moreover, during this period and several subsequent periods cumulative productivity has increased. At the same time in case of Latin American economies, 1998 and several subsequent periods were marked with downward trends in cumulative productivity.

This paradox can be explained by the extent to which these two groups of countries were involved in international capital markets. Latin American economies have reaped a lot of benefits from their active participation in international capital markets; however they were also more exposed to high risks in times of financial crisis. The cumulative Malmquist graphs are presented in Appendix (Figure A1.1-A1.4)

5.2 Baseline Specification

Table 5.2 provides the results of estimations for four specifications described in the previous section. In all four specifications coefficient of FDI is positive and significant, as we expected. In the Specifications (1) and (2) coefficients are statistically significant at 1% level.

As we increase the FDI inflow in the host country by one billion dollars we will observe 0.0008 increase in MPI. Even though such an increase in Malmquist productivity does not seem to be significant, however when accumulated over several periods it presents a substantial number. A good example to illustrate this will be the calculation of accumulated productivity growth of 0.0008 for 25 years which will yield 1.02 [7].

Human capital is positive and significant in three of four specifications, showing that a 1 year increase in schooling in the total population leads to 0.14 or 14 % increase in MPI.

ENERGY and LAND have positive impact on productivity; however they are not significant or significant at the 10% level only. We obtained a negative sign for TEL coefficient which can be explained by the fact that the role of telephone mainlines is diminishing while mobile technology becomes increasingly important.

Inclusion of dummy variables in our analysis presents interesting results. Coefficient for Latin American dummy is negative and statistically significant in the Specification 4 implying that Latin American region has experienced a decrease in productivity during 1980-2006 which is confirmed by our cumulative Malmquist estimation results.

Coefficient for high income countries dummy is negative and significant, implying productivity is lower in high income countries in contrast to low income countries.

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[7] $(1+0.0008)^{25} = 1.02$

Table 5.2. MPI and FDI: OLS Robust Regressions, 1980-2006

	(1)	(2)	(3)	(4)
FDI	0.0008***	0.0007***	0.0004*	0.0002*
	(0.0002)	(0.0002)	(0.0002)	(0.0001)
ENERGY	0.081*	0.015	0.007	-0.036
	(0.047)	(0.059)	(0.034)	(0.044)
TEL	-0.086***	-0.086***	-0.027	0.0038
	(0.016)	(0.012)	(0.011)	(0.009)
LAND	0.012*	0.0219*	0.0165	-0.011
	(0.007)	(0.012)	(0.007)	(0.009)
HC	0.142***	0.168***	0.092**	0.053
	(0.039)	(0.051)	(0.03)	(0.035)
LATIN		0.156		-1.58***
		(0.218)		(0.365)
EASTEUROPE		-1.122*		0.063
		(0.404)		(0.669)
MENA		-0.429**		-1.90***
		(0.215)		(0.384)
HIGHINCOME			-1.91***	-2.74***
			(0.42)	(0.479)
UPMINCOME			0.036	-0.293
			(0.088)	(0.128)
N	331	317	331	317
R^2	0.24	0.28	0.39	0.49

(i)***Significant at 1% level, **significant at 5 % level, * significant at 10% level

Inclusion of the interaction term *FDI*FO* in the regressions gives us positive coefficient for the interaction term when we use market capitalization and turnover ratio, however it is significant at 1% level for turnover ratio only. It is important to note that coefficient of FO variable is negative for both market capitalization and turnover ratio. The results tell us that financial openness alone can have ambiguous effect on productivity, while in the interaction with FDI it has a positive effect on productivity growth. (Table A4, Appendix).

Based on the minimum BIC criteria, Specification 4 from the first regression is selected since it has the lowest BIC and thus obtains the best fit. The results of BIC estimations are provided in Table A5 of Appendix.

We have also separately estimated all four specifications of the model for the period 1990-2006 (Table A6, Appendix). Year 1990 is taken as a benchmark since majority of Eastern European countries opened up their economies in 1990s. The coefficient for FDI is positive in all four specifications, however significant at the 5 and 10 % levels only in specifications (1) and (3), respectively. Coefficient for Eastern European regional dummy is negative and statistically significant in two specifications implying the decrease in productivity in the region since 1990.

Results for 3 and 5 year period regressions are presented in the Appendix (Table A7 and A8). Initially GOV and CORR variables were included in these panels; however they do not yield statistically significant estimates and are therefore not reported. In the 3 year specification, the coefficients for the regional dummy for MENA and high income countries are negative and significant on 10% level implying productivity decline. In 5 year aggregate periods, FDI variable for the first time becomes negative yet insignificant. The lack of observations (125 and 63 observations for 3 and 5 year panels accordingly) does not allow us to make robust conclusions about the effect of FDI on productivity changes over longer time periods.

We use panel data in our study, which is characterized by many panels and fewer periods. Namely, we have 45 countries and 25 years. Though using feasible generalized least squares method with a panel-heteroscedastic variance-covariance matrix would give more efficient estimates, we cannot apply it in our analysis because the method involves estimating variance parameters for each panel (or covariances between panels; thus the estimates would require many periods per panel for consistency.

We perform Breusch-Pagan / Cook-Weisberg test and detect heteroscedasticity (chi2(1) = 442.57), which means that among all the unbiased estimators, OLS does not provide the estimate with the smallest variance. In addition, the standard errors are biased when heteroskedasticity is present, which leads to bias in test statistics and confidence intervals. To correct for heteroscedasticity we apply commonly used heteroscedasticity – robust standard errors estimator introduced by White (1980):

$$\hat{V}_{robust}(\hat{\beta}) = (X'X)^{-1}\left(\frac{N}{N-k}\sum_i \hat{\varepsilon}_i^2 x_i x_i'\right)(X'X)^{-1}$$

Though under the presence of even large multicollinearity OLS estimates are still unbiased, with high multicollinearity confidence intervals for coefficients tend to be very wide and t statistics tend to be very small, that is why accounting for multicollinearity is important. We apply collinearity diagnostics, the results of which are provided below:

Table 5.2.1 Multicollinearity diagnostics

Variable	*VIF*	$\sqrt{VIF}$	*Tolerance*	R^2
Mo	1.31	1.14	0.7638	0.2362
FDI	1.14	1.07	0.8769	0.1231
ENERGY	1.21	1.1	0.8252	0.1748
TEL	2.33	1.52	0.43	0.57
LAND	1.09	1.04	0.9207	0.0793
HC	2.18	1.48	0.4587	0.5413
Mean VIF	1.54			

$\sqrt{VIF}$ tells how much larger the standard error is compared with what it would be if that variable were uncorrelated with the other independent variables in the equation. $\sqrt{VIF}$ is not a large number for the majority of our variables.

We conduct autocorrelation diagnostics and detect a large autocorrelation with original Durbin-Watson statistic of 0.036494. In the presence of autocorrelation the OLS estimates of the β_i s are unbiased and consistent but inefficient. In addition, the standard errors will tend to be underestimated, and the confidence intervals too narrow. Applying Prais Winston estimation that corrects for first order autocorrelation is not sufficient in this case, since the transformed Durbin-Watson statistic of 0.984 still shows the presence of autocorrelation. When we tried to apply Newey -West estimation that assumes heteroscedastic and correlated up to some lag error structure, the previous results received from robust regressions were not altered a lot. The coefficients are still significant, keep their signs and there was almost no change in standard errors.

5.3 Threshold Analysis Results.

Specification 4 of the baseline model is used for conducting grid search analysis with financial openness measures. The first step is to determine the number of intervals for grid search by estimating model allowing for zero, one, two and more thresholds on the three financial openness variables.

Since all three measures represent ratios with their own specifics, we do not create unified system of intervals, and thus present the results of grid search separately for each measure.

The intervals are determined by conditioning upon the trend of the financial openness measure. We start from the smaller number of observations in each interval and then increase the number of observations in the interval if the trend of SSR is increasing. By doing it this way we can guarantee that no global minimum would be missed in the larger intervals with many observations.

The tables with grid search results are presented below. We first look at the market capitalization measure. The SSR is minimized when the value of market capitalization lies in the interval 0.15-0.2. This can be referred as the medium measure of market size. Assuming that the stock market size and ability to quickly mobilize capital and diversify risks are positively correlated, we can infer from our results that a medium market size is required for a country to achieve maximum gain in productivity. Additional increase in stock market capitalization will have less effect on productivity.

Table 5.3.1 Market Capitalization Thresholds

Intervals	N	SSR
<0.02	118	534.5
0.02-0.05	74	639.3
0.05-0.09	72	566.2
0.09-0.15	69	948
0.15-0.2	**55**	**360**
0.2-0.3	94	484.9
0.3-0.4	57	684.7
0.4-0.6	54	529.4
>0.6	77	404.1

The gains from productivity are maximized at 0.1 -0.2 values of turnover ratio which equals the value of total shares traded divided by market capitalization (Table5.3.2). Turnover ratio reflects trading relative to the size of the stock market. Results show that maximum marginal benefit from FDI is attained at 0.1-0.2 level of turnover ratio. Also, turnover on the stock market is often used as an indicator of low transactions costs which implies that certain minimum level of this ratio that reduces transactions costs on the stock market is required to benefit from FDI.

Table 5.3.2 Turnover Ratio Threshold

Intervals	N	SSR
<0.02	36	512.4
0.02-0.05	58	546.4
0.05-0.07	50	504.8
0.07-0.1	59	547
0.1-0.2	**120**	**385.4**
0.2-0.3	85	1343
0.3-0.4	58	5527.2
0.4-0.5	49	79438
0.5-0.7	49	865.2
0.7-1	35	28791
>1	45	632

The ratio of liquid liabilities to GDP represents an overall measure of financial sector development and we use it in the current study as a complimentary measure to financial openness. As we see from the Table 5.3.3 a financial system with at least 0.5-0.6 level of liquid liabilities to GDP ratio which reflects the size of financial intermediaries to the overall economy size, benefits the most from FDI in terms of productivity growth. Moreover, there is a second threshold as the ratio reaches 1.5 level, however due to the lack of observations we cannot consider it reliable.

Table 5.3.3 Liquid Liabilities Threshold.

Intervals	N	SSR
0-0.2	8	626.1
0.2-0.3	145	737.4
0.3-0.4	145	443.9
0.4- 0.5	128	357.1
0.5-0.6	**84**	**312.6**
0.6-0.7	66	572.4
0.7-0.8	54	523.8
0.8-1	42	743.1
1-1.5	25	466.5
>1.5	**15**	**279.9**

In all three cases the results point to the presence of nonlinear threshold effects: the productivity benefit from FDI increases with financial openness (SSR decreases) until some threshold level beyond which it becomes less pronounced. Thus, it may be concluded that the relationship between FDI and productivity is not monotonic and there exist threshold levels of financial openness at which productivity gains from FDI can be maximized.

6. Conclusion and Discussion

As a final result of our work we expected to confirm the hypothesis that a country's absorptive capacity, under which we mean financial openness and overall financial sector development, is important in defining whether and how much a certain country would benefit from FDI through TFP improvements. Countries that have reached certain initial level of financial system openness (measured in this paper as liquid liabilities to GDP ratio, turnover ratio and market capitalization) would significantly benefit from FDI through TFP improvements, while the lack of financial openness can limit economy's ability to gain from potential technology spillovers that come from FDI.

The empirical analysis shows that FDI has a positive effect on host country productivity based on a sample of 45 countries covering the period from 1980 through 2006. We also find that relationship between FDI and productivity is not monotonic and there exist threshold levels of financial openness at which productivity gain from FDI can be maximized.

The policy implication of our results may have a big importance. The existence of financial openness thresholds to benefit from FDI may encourage policy- makers in developing countries to be more focused on eliminating "financial" barriers to reach the threshold absorptive capacity level to maximize benefits from foreign direct investment.

However, despite the promising results, one should be cautious to draw one – sided conclusions out of it. Productivity –FDI- Financial Openness relationship is complex and even though focusing on the policies aimed to improve and liberalize financial system might increase productive efficiency, there might be other local conditions that can substantially limit the benefits received due financial openness.

Overall, the findings from this analysis suggest that it is essential to allow for differences in country -level financial openness in order to assess accurately the extent of productivity gains from FDI. The grid search method of estimation is just a first step to find if the relationship between FDI and productivity might be contingent upon certain thresholds. The future analysis might proceed in the following directions:

i. Applying the threshold regression approach developed by Hansen (2000), which allows an endogenous test for the existence and significance of threshold levels of absorptive capacity, rather than imposing arbitrary data-splitting schemes or specific functional forms.

ii. Allow for differences in the type of FDI (vertical, horizontal) in order to assess more precisely the extent of technology spillovers from multinational enterprises.

iii. Using different measures of human capital and R&D in the country as threshold variables to determine minimum required level of these variables to benefit from FDI through productivity increase.

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APPENDIX

Figure A1.1 Cumulative Malmquist, Latin America

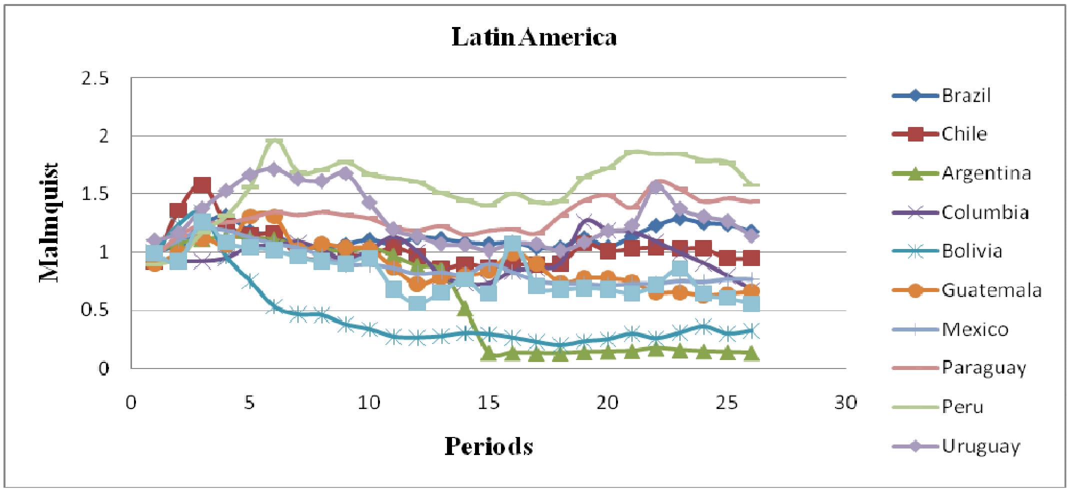

Figure A1.2 Cumulative Malmquist, Eastern Europe

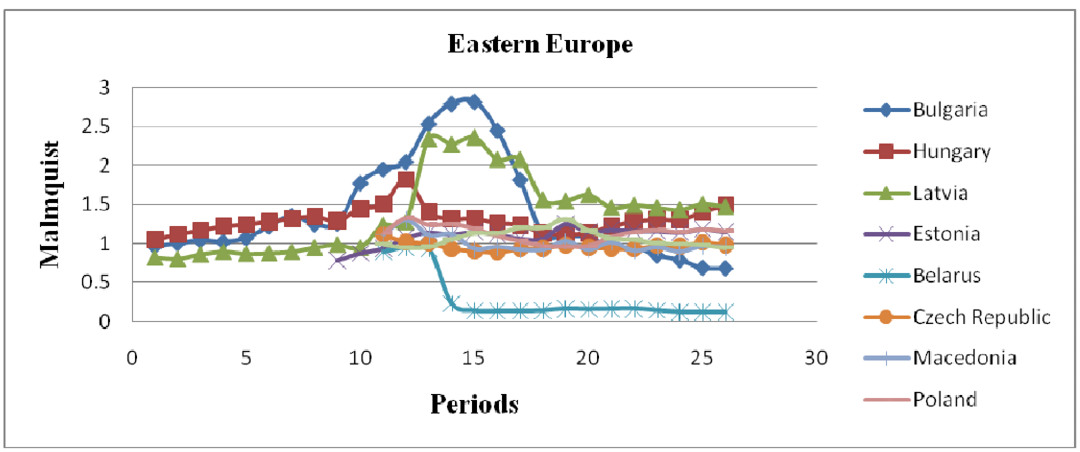

Figure A1.3 Cumulative Malmquist, Asian Tigers

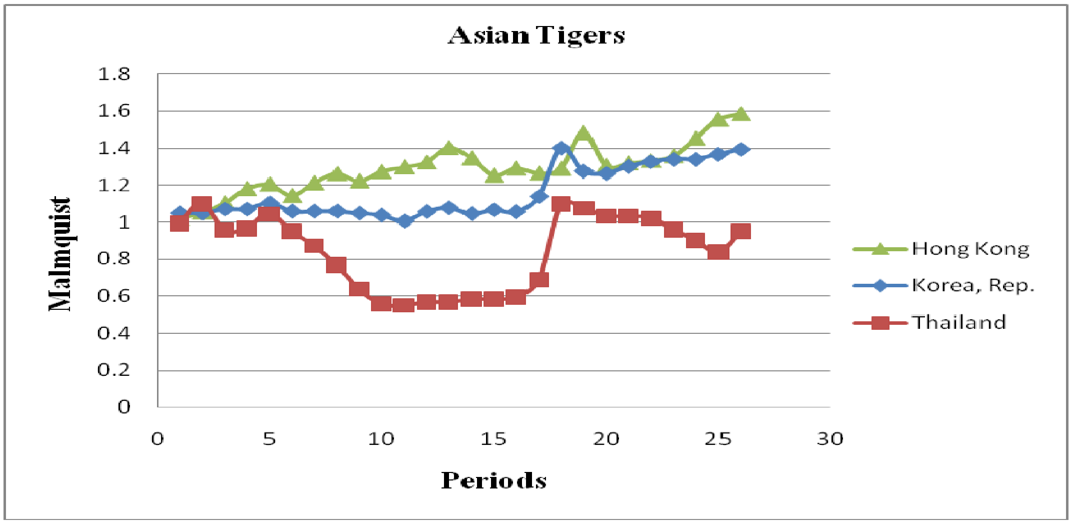

Figure A1.4 Cumulative Malmquist, MENA

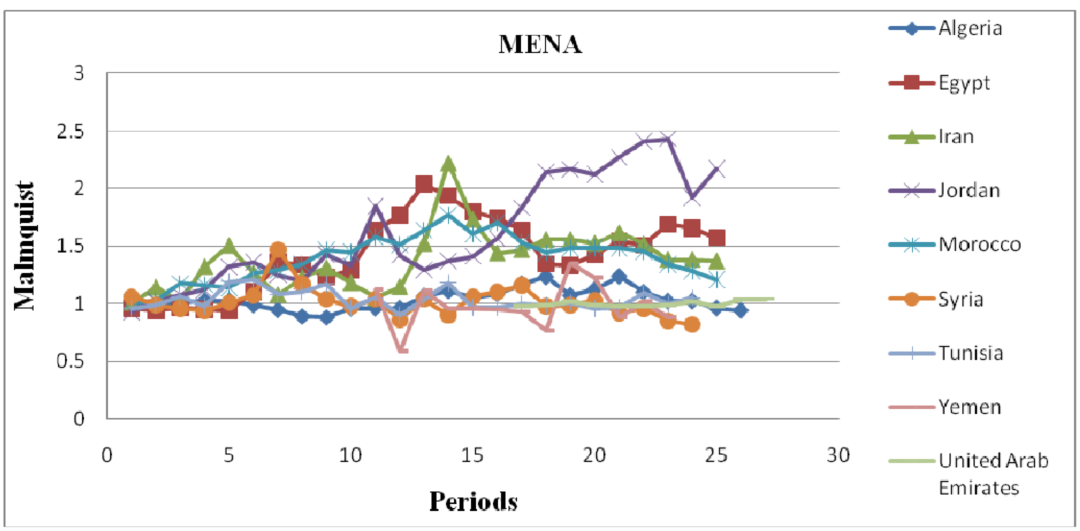

Table A1. Country Classification

Country	WB Region	WB Income group
Algeria	Middle East & North Africa	Lower middle income
Argentina	Latin America & Caribbean	Upper middle income
Belarus	Europe & Central Asia	Upper middle income
Bolivia	Latin America & Caribbean	Lower middle income
Bosnia and Herzegovina	Europe & Central Asia	Lower middle income
Brazil	Latin America & Caribbean	Upper middle income
Bulgaria	Europe & Central Asia	Upper middle income
Chile	Latin America & Caribbean	Upper middle income
Croatia	Europe & Central Asia	Upper middle income
Czech Republic	Europe & Central Asia	High income: OECD
Egypt, Arab Rep.	Middle East & North Africa	Lower middle income
Estonia	Europe & Central Asia	High income: non-OECD
Guatemala	Latin America & Caribbean	Lower middle income
Hong Kong, China	East Asia and Pacific	High income: non-OECD
Hungary	Europe & Central Asia	High income: OECD
Iran, Islamic Rep.	Middle East & North Africa	Lower middle income
Israel	Middle East & North Africa	High income: non-OECD
Jordan	Middle East & North Africa	Lower middle income
Korea, Rep.	East Asia and Pacific	High income: OECD
Kuwait	Middle East & North Africa	High income: non-OECD
Latvia	Europe & Central Asia	Upper middle income
Lebanon	Middle East & North Africa	Upper middle income
Lithuania	Europe & Central Asia	Upper middle income
Macedonia, FYR	Europe & Central Asia	Lower middle income
Mexico	Latin America & Caribbean	Upper middle income
Moldova	Europe & Central Asia	Lower middle income
Morocco	Middle East & North Africa	Lower middle income
Oman	Middle East & North Africa	High income: non-OECD
Paraguay	Latin America & Caribbean	Lower middle income
Peru	Latin America & Caribbean	Lower middle income
Poland	Europe & Central Asia	Upper middle income
Romania	Europe & Central Asia	Upper middle income
Russian Federation	Europe & Central Asia	Upper middle income
Saudi Arabia	Middle East & North Africa	High income: non-OECD
Serbia	Europe & Central Asia	Upper middle income
Slovak Republic	Europe & Central Asia	High income: OECD
Slovenia	Europe & Central Asia	High income: non-OECD
Syrian Arab Republic	Middle East & North Africa	Lower middle income
Taiwan, China	East Asia and Pacific	High income: non-OECD

Thailand	East Asia & Pacific	Lower middle income
Tunisia	Middle East & North Africa	Lower middle income
Ukraine	Europe & Central Asia	Lower middle income
United Arab Emirates	Middle East & North Africa	High income: non-OECD
Uruguay	Latin America & Caribbean	Upper middle income
Venezuela, RB	Latin America & Caribbean	Upper middle income
Yemen, Rep.	Middle East & North Africa	Low income

Table A2. Variables Description

Variable	Description, Units and Measurement	Source
MPI	Following Caves, Christensen, and Diewert (1982), the Malmquist productivity index is defined as follows: $M_o^t = \frac{D_o^t(x^{t+1} y^{t+1})}{D_o^t(x^t y^t)}$, $M_o^{t+1} = \frac{D_o^{t+1}(x^{t+1} y^{t+1})}{D_o^t(x^t y^t)}$ We use Malmquist indexes to measure the productivity changes from period t to t+1 under the same reference technology. Following Färe *et al*. (1994) we calculate the Malmquist productivity index as the geometric mean of these two indices: $M_o^{t+1,t}(x^{t+1} y^{t+1} x^t y \ ) = \left[\left(\frac{D_o^t(x^{t+1} y^{t+1})}{D_o^t(x^t y^t)}\right)\left(\frac{D_o^{t+1}(x^t}{D_o^{t+1}(}\right.\right.$	Estimated using OnFront software
GDP	Gross domestic product calculated in constant 2000 US $	World Development Indicators
CAPITAL	Gross capital formation in constant 2000 US$	World Development Indicators
LABOR	Total labor force	World Development Indicators
FDI	Inward FDI inflows (billions of US dollars)	UNCTAD
HC	Human capital is measured as average years of higher schooling in the total population and Average schooling years in the total population	Barro R. and J.W. Lee
ENERGY	GDP per unit of energy use (constant 2005 PPP $ per kg of oil equivalent)	World Development Indicators
TEL	Telephone mainlines (per 1 million people)	World Development Indicators
LAND	Arable land (percentage of land area)	World Development Indicators
GOV & CORR	The worldwide Governance Indicator (WGI) includes 6 dimensions of Governance: Voice and Accountability, Political Stability and	Daniel Kaufman (WGI Project)

	Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption (data for 1996-2007)	
LLGDP	Ratio of liquid liabilities to GDP, calculated using the following deflation method: {(0.5)*[Ft/P_et + Ft-1/P_et-1]}/[GDPt/P_at] where F is liquid liabilities, P_e is end-of period CPI, and P_a is average annual CPI	Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), "A New Database on Financial Development and Structure," World Bank Economic Review 14, 597-605.
MARCAP	Value of listed shares to GDP, calculated using the following deflation method: {(0.5)*[Ft/P_et + Ft-1/P_et-1]}/[GDPt/P_at] where F is stock market capitalization, P_e is end-of period CPI, and P_a is average annual CPI	Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), "A New Database on Financial Development and Structure," World Bank Economic Review 14, 597-605.
TURR	Ratio of the value of total shares traded to average real market capitalization, the denominator is deflated using the following method: Tt/P_at/{(0.5)*[Mt/P_et + Mt-1/P_et-1] where T is total value traded, M is stock market capitalization, P_e is end-of period CPI P_a is average annual CPI	Thorsten Beck, Asli Demirgüç-Kunt and Ross Levine, (2000), "A New Database on Financial Development and Structure," World Bank Economic Review 14, 597-605.

TableA3. Descriptive Statistics

Variable	Unit	N	Mean	Std. Dev.	Min	Max
MPI	Index	923	0.98	0.12	0.325	1.435
FDI	Billions $US	690	220.44	256.4	0	989
ENERGY	$ per kg of oil equivalent)	986	5.55	2.45	1.2	13.45
TEL	mainlines per 1 million people	1168	15.53	12.27	0.2	58.9
LAND	% of land area	960	16.55	15.74	0.056	57.58
LLGDP	ratio	786	0.487	0.32	0.045	2.6
MARKETCAP	value	599	0.325	0.513	0.00021	4.22
TURNOVER	ratio	644	0.391	0.927	0	16.78

Table A4. The OLS Robust Regressions: Financial openness interaction terms

	(1)	(2)	(3)
FDI	0.0014	-0.0002	0.0001
	(0.0005)	(0.00009)	(0.00009)
ENERGY	0.046	0.009	-0.017
	(0.036)	(0.018)	(0.012)
TEL	-0.066 ***	-0.032**	-0.025**
	(0.018)	(0.010)	(0.008)
LAND	0.005	-0.00001	-0.004
	(0.006)	(0.0036)	(0.0016)
HC	0.079**	0.048	(0.043)***
	(0.026)	(0.0156)	(0.013)
LLGDP	0.599		
	(0.293)		
LLGDP*FDI	-0.001		
	(0.0006)		
MARKETCAP			-0.339
			(0.272)
MARKETCAP*FDI			0.0002
			(0.0003)
TURNOVER		-0.731	
		(0.289)	
TURNOVER*FDI		0.0017***	
		(0.0005)	
N	208	185	174
R^2	0.21	0.33	0.26

(i)***Significant at 1% level, **significant at 5 % level, * significant at 10% level

Table A5. BIC estimation

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
Spec1	331	-538.5472	-493.9542	6	999.9085	1022.721
Spec2	317	-522.306	-471.0881	9	960.1762	994.0063
Spec3	331	-538.5472	-455.7091	8	927.4182	957.8352
Spec4	317	-522.306	-416.6891	11	855.3782	896.7261

TableA6. MPI and FDI: The OLS Robust Regressions, 1990-2006

	(1)	(2)	(3)	(4)
FDI	0.0002* **	0.00006	0.0001*	0.00003
	(0 .00008)	(0.00008)	(0.00008)	(0.00006)
ENERGY	0 .032	0.023	-0.0009	-0.004
	(0.021)	(0.022)	(0.013)	(0.021)
TEL	-0.027**	-0.034***	-0.0098	-0.0107*
	(0.008)	(0.009)	(0.006)	(0.006)
LAND	0.005	0.0103	0.0027	-0.003
	(0.003)	(0.007)	(0.003)	(0.004)
HC	0.048*	0.082*	0.026**	0.019
	(0.0178)	(0.032)	(0.013)	(0.019)
LATIN		-0.43*		-1.062***
		(0.163)		(0.248)
EASTEUROPE		-0.917*		-0.729
		(0.338)		(0.328)
MENA		-0.641***		-1.066***
		(0.195)		(0.257)
HIGHINCOME			-0.623*	-0.838
			(0.243)	(0.282)
UPMIINCOME			0.033	0.058**
			(0.072)	(0.135)
N	190	183	190	183
R^2	0.21	0.28	0.33	0.43

(i)***Significant at 1% level, **significant at 5 % level, * significant at 10% level

TableA7. MPI and FDI: The OLS Robust Regressions, 3 year periods.

	(1)	(2)	(3)	(4)
FDI	0.218	0 .196	0.147	0.084
	(0.095)	(0.085)	(0.083)	(0.066)
ENERGY	0.012	0.008	0.005	0.004
	(0 .008)	(0.010)	(0.006)	(0.008)
TEL	-115.23	-79.7	-52.36977	8.79
	(34.24)	(37.87)	(37.78)	(38.83)
LAND	(dropped)	(dropped)	(dropped)	(dropped)
HC	0.0022	-0.018	0.006	-0.015
	(0.010)	(0.016)	(0.0121)	(0.014)
LATIN		-0.081		-0.203
		(0 .059)		(0.100)
EASTEUROPE		0.043		0.028
		(0 .079)		(0.126)
MENA		-0.151		-0.255*
		(0.0645)		(0.096)
HIGHINCOME			-0.223	-0.323
			(0.115)	(0.115)
UPMINCOME			-0.003	-0.029*
			(0.039)	(0.036)
N	125	125	125	125
R^2	0.23	0.28	0.31	0.41

(i)***Significant at 1% level, **significant at 5 % level, * significant at 10% level

Table A8. MPI and FDI: The OLS Robust Regressions, 5 year periods.

	(1)	(2)	(3)	(4)
FDI	-0.0002	-0.0002	-0.0001	-.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
ENERGY	0.0108	-0.0034	0.015	0.0078
	(0.007)	(0.009)	(0.008)	(0.009)
TEL	-0.006	-0.003	-0.009	-0.007
	(0.004)	(0.004)	(0.005)	(0.005)
LAND	0.0006	-0.002	0.0009	-0.0004
	(0.0015)	(0.003)	(0.001)	(0.003)
HC	0.0082	-0.012	-0.007	-0.015
	(0.013)	(0.016)	(0.012)	(0.016)
LATIN		-0.178		-0.147
		0.112		(0.123)
EASTEUROPE		-0.059144		-0.116
		0.151		(0.161)
MENA		-0.267		-0.215
		(0.109)		(0.116)
HIGHINCOME			0.189	0.144
			(0.099)	(0.098)
UPMINCOME			0.104	0.074
			(0.047)	(0.053)
N	63	63	63	63
R^2	0.15	0.27	0.24	0.31

(i)***Significant at 1% level, **significant at 5 % level, * significant at 10% level