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Panel Data Modelling: A Case Study On Determinants Of Fdi In Developing Countries.

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Abstract::-Panel Data modelling is a major advancement in econometric analysis of financial and economic data. It has several advantages over Ordinary Least Square Method. In this paper an attempt is made to study the determinants of FDI in developing countries using Panel Data Framework. The model hypothesised that the factors affecting FDI in developing countries are the market size, external debt, trade openness, exchange rate and inflation. The study used fixed effects and random effects models and the selection of these models was made using Hausman and Breusch-Pagen tests. The study also used Wald and F-test to estimate the joint significance of time dummies. Data used for the present study ranges between 1994-2009 and all major developing countries including India have been included in panel. The study has many interesting results and can have far reaching implications to the economic policies of developing countries. The results of the study will be of much use to India as we are in process of fine tuning our policy towards FDI.

Keywords: Determinants of FDI , econometric analysis , model hypothesised ,economic policies .

INTRODUCTION

Panel data models in Macroeconomics have become increasingly popular in the past decade with the increased availability of cross country data sets that span 20 years or more. There are several key advantages of using panel data over a single time series or cross section data set. In cases where there is limited time series data available for each country there may be insufficient power of tests of hypotheses. If it is possible to impose some homogeneity conditions upon the parameter across countries then a panel data model will afford additional power and may allow the detection of relationships not apparent from the individual time series. Unlike cross section models, with a panel model it is possible to control for the country-specific, time invariant characteristics through the use of country-specific intercepts or "fixed effects." (Weinhold, 1999)

Hsiao, (1986) points out that panel data sets for economic research possess several major advantages over conventional cross-sectional or time-series data sets. Mainly, panel data usually provide a large number of data points, increasing the degrees of freedom and reducing the collinearity among explanatory variables, hence improving the efficiency of econometric estimates. Furthermore, panel data are better able to study the dynamics of adjustment and are better able to identify and measure effects that are simply not detectable in pure cross-sections or pure time-series data (Baltagi, 1995).

PANEL DATA REGRESSION MODEL

The panel data regression model based on OLS estimates are expressed in following way

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + U_{it}$$

$$i = 1,2 \ldots\ldots\ldots N$$

$$t = 1,2, \ldots\ldots\ldots N$$

where, i stands for i th cross-sectional unit and t for the t th time period. In this type of estimation the intercept term ($\beta 0$) is assumed to be constant across the cross sectional units. Panel data regression models can be classified into fixed effect and random effect model.

The Fixed Effects Model

Model assumes that individual specific factors are correlated with the regressors. Fixed-effects are intended to capture broad geographic differences that are either permanent or unobservable, such as urbanization, weather, religiosity and social customs, national policies, political system, etc., In order to detrend the data and focus on cross-sectional differences, a country-specific time trend is included for each of the country and estimated jointly with the other model coefficients. When only country-specific is included in the fixed effect model it is called one way effect model. The timed effect-two way modeling allows for time effect, For example, the trade in services determinant function shifts over time because of factors such as technological changes, changes in government regulatory and /or tax policies, changes in EXIM policy, foreign trade, liberalization policies, etc. Such time effects can be easily

accounted for if we introduce the time dummies, one for each year.

If the two way effects are significant it only means that the time is affecting trade in services of different countries included in the income group, in other words it would mean that the unobserved variables accounted for by using country specific dummies vary not only across the countries but also over the time periods included in the study. If two way effect model are rejected in favour of one way effect models it only means, for example that the trade in service function varies over the country specific effect but is constant over time. The selection of a particular model is based on the joint significance of F-test.

The one way fixed effect model in terms of regression equation is expressed as follows

$$Y_{it} = \beta_i + \beta_1 X_{1it} + \beta_2 X_{2it} + U_{it}$$

The subscript i on the intercept terms suggest that the intercept of the countries included in a particular income group may be different, the number of dummies to be included in the model are always one less then number of cross sectional units included in the study. The common intercept in the model represent the intercept of country for which, dummy is not included. If we introduce explicit intercept for each country then we need to run the regression through the origin. This is done to avoid dummy variable trap.

The two way time effect model in terms of regression equation is expressed as follows

$$Y_{it} = \beta_{it} + \beta_1 X_{1it} + \beta_2 X_{2it} + U_{it}$$

The subscript it on the intercept term suggest that it varies across cross sectional units and time. The intercept in this model is assumed to be time variant.

Random Effect Model

The Random Effects Model or Error Components Model assumes that the individual specific factors are uncorrelated with the regressor. The rationale behind using this model is that the lack of knowledge about the true model should be expressed through the disturbance term uit. In this model, the individual differences in the intercept values of each country are reflected in the error term. The error term in random effect model is also called composite error term, as it comprises of two parts. The one representing cross section or individual-specific error component and the other is the combined time series and cross section error component. The country specific error component is not directly observable, and is also known as unobservable variable.

The equation representing random effect model is expressed in following way

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \varepsilon_i + U_{it}$$

$$= \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + w_{it}$$

where,

$$w_{it} = \varepsilon_i + U_{it}$$

The composite error term W consists of two components, εi , which is the cross-section, or country specific error component and U it, which is the combined time series and cross-section error component.

Fixed effect is generally more appropriate than a random effect model for many macroeconomic datasets for mainly two reasons. First, if the individual effect represent omitted variables, it is highly likely that these country specific characteristics are correlated {(Gujarati, 2003), (Wooldridge, 2000)}

Hausman's Specification (H) Test

Hausman's Specification Test helps to select fixed effect estimate over random effect estimates. If the effects are uncorrelated with the explanatory variables, then the random effect estimator is consistent and efficient. If the effects are correlated with the explanatory variables, the fixed effects estimator is consistent and efficient but the random effect is now inconsistent.

Hausman test is defined as

$$H = \frac{[\beta_{RE} - \beta_{FE}]^2}{var(\beta_{FE}) - var(\beta_{RE})} \sim \chi_1^2$$

The Hausman test (H) statistics will be distributed asymptotically as $\chi 2$ with K degrees of freedom under the null hypothesis that the random effects estimator is correct. If computed H-value is less than the table ($\chi 2$) value for appropriate degrees of freedom and level of significance, then the null hypothesis (of individual effects are uncorrelated with other regressors) cannot be rejected. (i.e. accepted). In this case, the Random Effect model is relevant (not the Fixed Effect Model). Larger H favors for Fixed effect model and lower value for random effect model (Dinardo & Johnston, 1997).

Breuch and Pagan's Lagrangian Multiplier Test

This test help to choose between OLS and Random Effect estimates. It is based on the OLS residuals. The null hypothesis suggests that OLS estimator is consistent. Rejection of null hypothesis suggests the use of random effect estimates.

Null Hypothesis: $s^2_v = 0$
Alternate Hypothesis: $s^2_v \neq 0$

Let e'e be the RSS from OLS

LMc = [nT/(2(T-1)] = [(T e'e/e'e)-1] ~^{2} (1)

If LM$_c$ > LM$_t$ reject the null hypothesis and choose the random effect model (Dinardo & Johnston, 1997).

BACKGROUND OF THE STUDY

Systematic review of literature is highly important for research activity because it gives relatively inclusive information concerning the problem and provides an improved and better insight of it. Many studies in literature have dealt with the issue of FDI and their potential benefits for developing countries in terms of job creation opportunities, technology transfers, and growth and development. There have also been several studies on the determinants of FDI in developed countries and developing countries although all developed countries or all developing countries cannot be grouped together given their different economic conditions.

The increasingly significant role of FDI in the growth dynamics of countries has created much research interest among scholars and much research has been focused on the determinants of FDI and has generally identified the following factors namely comparative labour costs, country size, economic openness nature of exchange rate regime return on investment and political factors. Studies by Crespo, Fontura and Khondoker ,Mottaleb (2007) acknowledge the above facts by stating that foreign direct investment produces economic benefits to the recipient countries by providing capital, foreign exchange, technology, competition and by enhancing access to foreign markets. So also by bridging the gap between domestic savings and investment and bringing the latest technology and management know-how from developed countries, foreign direct investment (FDI) can play important role in achieving rapid economic growth in the developing countries. In view of above this study aims to analyze those factors which determine the inflow of foreign direct investment in developing countries during the study period with the help of panel data analysis.

Dunning (1993), introduced an Ownership-Location-Internalisation (OLI) paradigm to explain factors that determine FDI by Multinational Enterprises. The location advantage theory provides a framework to identify important variables that influence FDI using three main categories: (a) economic, (b) social or cultural factors, and (c) the political environment. With the help of theory the author concludes that a large and growing market, a high gross domestic product, low production costs, and political stability help countries in attracting investment from multi-national companies. Asiedu (2002) applying Least Square techniques for all estimations in the study and found that openness, return on investment and GDP as proxy variable for market size, are significant variables for FDI fostering and infrastructure and political risk found insignificant.

Quazi and Mahmud (2004) investigated that it is either economic or non-economic, drive the flow of FDI into South Asia and found that economic freedom, openness, prosperity, human capital and lagged FDI significantly increase FDI inflow into South Asia, while political instability depresses it.

Naeem, Ijaz, and Azam (2005) used time series data from 1970-71 to 1999-2000 for Pakistan and found the main economic factors are market size, domestic investment, trade openness, indirect taxes, inflation, and external debt.

Chowdhury and Mavrotas (2005) in their study tried to examine the causal relationship between FDI and economic growth. They used time-series data covering the period 1969-2000 for three developing countries, namely Chile, Malaysia and Thailand, all of them major recipients of FDI with a different history of macroeconomic episodes, policy regimes and growth patterns. Their empirical findings clearly suggested that it is GDP that causes FDI in the case of Chile and not vice versa, while for both Malaysia and Thailand, there is a strong evidence of a bi-directional causality between the two variables.

Tanna and Topaiboul (2005) tried to investigate the causal links between human capital, openness through trade and FDI, and economic growth using quarterly data for Thailand over the period 1973:2- 2000:4. A number of hypotheses have been investigated including, in particular, FDI-led growth and export-led growth, as well as the reverse linkages from growth to FDI and exports. The importance of human capital is highlighted as complementary to trade and FDI inflows, underlying the importance of technology adoption. The study found that, after controlling for domestic investment, government expenditure and imports, support for FDI-led growth was not as strong as export-led growth, although allowing for the joint interaction of FDI and human capital revealed a positive FDI effect above a minimum threshold of human capital, estimated to be around 4.5 years of average secondary schooling attainment. The study using multivariate causality tests conducted within a vector error correction framework, found a significant effects of domestic investment and trade openness, providing support for import-led growth, but direct support for FDI-led growth as well as growth-led FDI was again relatively weak, reinforcing the conclusion that trade openness had played a more significant role than FDI in influencing Thai economic growth. But the results revealed a subtle role for technology transfer through the complementary effect of trade on FDI, and FDI on government expenditure, which thereby influences human capital development with spillovers onto domestic investment and growth. This lead the authors to argue that there was a potential role for FDI interacting with human capital in influencing the future development of the Thai economy, given its recently active policy of FDI promotion.

Vijayakumar, N., Sridharan P., & Rao, K. C. S (2010) examines the factors determining FDI inflows of BRICS countries using annual dataset from the period 1975 to 2007 (for Russia required data set is available from 1990 onwards). The study employs Panel data analysis and finds that the selected variables Market size, Labour cost, Infrastructure, Currency value and Gross Capital formation as the potential determinants of FDI inflows of BRICS countries. The Economic Stability and Growth prospects (measured by inflation rate and Industrial production respectively), Trade openness (measured by the ratio of total

trade to GDP) are seems to be the insignificant determinant of FDI inflows of the BRICS countries. The empirical results are robust in general for alternative variables determining FDI flows.

Narayanamurthy et al. (2010) examined the factors determining FDI inflows of BRICS countries using unbalanced panel annual dataset from the period 1975 to 2007. The analysis suggests that the variables like Market size, Labour cost, Infrastructure, exhange rate and Gross Capital formation are the potential determinants of FDI inflows, whereas economic stability and growth prospects, along with trade openness were found to be insignificant determinant of FDI inflows in BRICS countries.

Muhammad Azam. et al (2010) examined the different economic factors that influenced foreign direct investment (FDI) inflows into Pakistan, India and Indonesia during the study period ranging from 1971 to 2005. The study with the help of log linear regression model based on method of least square revealed that market size, external debt, domestic investment, trade openness, and physical infrastructure are the important economic determinants of FDI. The authors believe that in order to encourage more FDI into these three nations, the national government's would have to ensure sustainable economic and political stability, provide better infrastructure, maintain law and order, encourage domestic investment, curtail external debt, and effective functioning of monetary and fiscal policies.

METHODOLOGICAL FRAMEWORK

Panel Data modelling is a major advancement in econometric analysis of financial and economic data. It has several advantages over Ordinary Least Square Method. In this paper an attempt is made to study the determinants of FDI in developing countries using Panel Data Framework. The model hypothesises that the factors affecting FDI in developing countries are the market size, external debt, trade openness, exchange rate and inflation. The study expects positive signs for market size and trade openness while negative signs for inflation, exchange rate and external debt. The study used fixed effects and random effects models and the selection of these models is made using Hausman and Breusch-Pagen tests. The study also uses Wald test to estimate the joint significance of time dummies. The study uses time series data for seventeen developing countries for a period of 16 years i.e. from 1994 to 2009. The countries selected for the purpose of study are India, Indonesia, Brazil, China, S. Africa, Columbia, Costa Rica, Srilanka, Pakistan, Bangladesh, Greece, Malaysia, Paraguay, Turkey, Venezuela, Argentina, and Mexico. Data required for analysis has been collected from WTO annual reports, UNCTAD statistical database and World Bank development indicators. The Models studied for determining factors influencing Foreign Direct Investment Inflows are given below.

MODELS:

1.Pooled Data Model

$$\text{Model: } FDI_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 TO_{It} + \beta_3 INF + \beta_4 EX.RATE + \beta 5 EX.DEBT + U_{it}$$

2. One Way Effect Model

$$\text{Model : } FDI_{it} = \beta_i + \beta_1 GDP_{it} + \beta_2 TO_{it} + \beta_3 INF + \beta_4 EX.RATE + \beta_5 EX.DEBT + U_{it}$$

3. Two Way Effect Model

$$\text{Model : } FDI_{it} = \beta_{it} + \beta_1 GDP_{it} + \beta_2 TO_{it} + \beta_3 INF + \beta_4 EX.RATE + \beta_5 EX.DEBT + U_{it}$$

FDI = Foreign Direct Investment Inflows
GDP= Gross Domestic Investment (Proxy for market size)
TO = Trade Openness (X+M)/GDP
INF =Inflation
Ex.Rate = Exchange Rate
Ex. Debt = External Debt

The values of Foreign Direct Investment Inflows, Gross Domestic Investment and External Debt are expressed in million dollars. Exchange rate is expressed as value of national currency in terms of US dollar.

RESULTS AND DISCUSSION

The pooled data OLS estimates for developing countries shows that all the independent variables are statistically significant. All the variables have expected signs except external debt. The analysis in table 1 reflects that when GDP (market size) and Trade Openness increases by one unit Foreign Direct Investment Inflows increases by 0.24 and 1413 units respectively. The values of inflation and exchange rate as expected have negative signs. Hence, when inflation and exchange rate rises by one unit foreign direct investment falls by 6.38 and 0.36 units respectively. The model exhibit high R2 and statistically significant F value showing a good fit and overall significance of the model.

Table 1: Regression Results of Pooled Data Model: OLS Estimate

Constant	Coefficient (GDP)	Coefficient (TO)	Coefficient (INF)	Coefficient (EX.RATE)	Coefficient (EX.DEBT)
-1364	0.24	1413	-6.38	-0.36	0.20
(1.56)	(28.9)***	(1.72)*	(-2.29)**	(2.18)**	(2.42)**
R^2 = 0.86			F = 339		

Values in parenthesis are t-values: ***, **, * imply statistical significance at 1%, 5% and 10%level respectively

In the table 2, results of the one-way effect panel data model are shown. The statistical significance of LM value favours random effect model over pooled data analysis whereas statistically significant H-test value favours fixed

effect model over random effect analysis. The result shows that all the independent variables are statistically significant and have expected signs except external debt. The study shows that when GDP (market size) and trade openness increases by one unit foreign direct investment inflows increase by 0.14 and 6268.6 units respectively. When inflation and exchange rate rises by one unit foreign direct investment inflows fall by 3.48 and 0.61 units respectively. Statistically significant F-test value shows that one way effect model is better compared to pooled data model.

Table 2: Regression Results of One way effect Model: Fixed/Random effect Estimates

GDP	TO	INF	EX.RATE	EX.DEBT
0.14 (19.08)***	6268.6 (3.60)***	-3.48 (1.96)**	-0.61 (2.33)**	0.11 (8.66)***
F = 30.79	H= 29.19	LM= 251.89		

Values in parenthesis are t-values: ***, **, * imply statistical significance at 1%, 5% and 10% level respectively

Table 3:Regression Results of Two way effect Model: Fixed/Random effect Estimates

CONSTANT	GDP	TO	INF	EX.RATE	EX.DEBT
-6229 (4.11)***	0.01 (19.19)***	4671 (2.58)**	- 3.53 (2.05)**	-0.47 (1.78)*	0.12 (8.61)***
R^2 = 0.96		H= 32.96		Wald= 42.20	

values in parenthesis are t-values: ***, **, * imply statistical significance at 1%, 5% and 10% level respectively

In the table 3, results of the two-way time effect panel data model are shown. Statistically significant Wald-test value shows that two- way time effect model is better compared to one way time-effect panel data model. The statistically significant H-test value favours fixed effect model over random effect analysis. The result shows that all the independent variables are statistically significant and have expected signs except external debt. The study shows that when GDP (market size) and trade openness increases by one unit foreign direct investment inflows increase by 0.01and 4671 units respectively. When inflation and exchange rate rises by one unit foreign direct investment inflows fall by 3.53 and 0.47 units respectively. High R2 shows the good fit of the model.

CONCLUSION AND IMPLICATIONS OF THE STUDY

The model estimation has been done using panel data for a period of 16 years from 1994-2009 for a group of seventeen developing countries. The results of the Model that analyzed the relationship between foreign direct investment inflows as dependent variable and market size, trade openness, inflation, exchange rate and external debt as independent variable revealed that all these factors influence and determine foreign direct investment, though external debt variables did not have expected negative sign. The selection and application of fixed effect or random effect techniques over OLS estimates shows that the country specific effects did affect trade in services and also it varied over time. The study based on panel data regression analysis on different developing economies implies that growth in GDP that is market size, opening up of economy with respect to trade positively influences the FDI inflows whereas as expected whenever there is rise in domestic inflation FDI inflows fall, so also appreciation of national currency in terms of dollars leads to fall in FDI inflows.

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