Foreign Direct Investment and Inequality in Productivity across Countries[*]

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Abstract: Using data for 93 countries for a period from 1970 to 2000, this paper examines the effects of foreign direct investment (FDI) on cross-country differences in productivity. We construct a spatial Gini coefficient of labor productivity across countries, and weighted indices of FDI and gross domestic investment (GDI). We then examine their time series properties to explore the relations of FDI and GDI with productivity. Although we find little evidence of FDI flows – which have increased manifold in last three decades – reducing inequality in productivity for the entire sample, our analysis shows that these three variables are cointegrated for developed, high and middle income developing countries, indicating existence of a long-run equilibrium relationships between FDI, GDI and productivity. FDI seems to reduce inequality in productivity among high and middle income developing countries while it widens productivity gaps among developed countries in the long-run though these effects are statistically significant only for high income developing countries. In middle income developing countries, higher GDI seems to have significant effect in reducing productivity differences. Granger causality tests further suggest that FDI causes productivity differences among petroleum exporting countries. Furthermore, GDI granger causes FDI in high income countries and productivity differences Granger cause FDI into the middle income developing countries.

Key Words: Foreign Direct Investment, Spatial Gini Coefficient, Inequality in Productivity, Cointegration, Granger Causality

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1. Introduction

The growth literature emphasizes the importance of capital accumulation and technological progress for long-run economic growth. In this context, foreign direct investment (FDI) assumes special significance for its role in augmenting domestic capital stock and as a conduit for technology transfer.[1] One immediate implication of the existing growth theories is a rise in productivity in the FDI recipient countries. However, whether FDI helps these countries – presumably at different levels of economic growth – reduce the differences in productivity is not clear and theoretical predictions could be varied and contradictory.[2]

The empirical literature on FDI has mainly focused on the causal relationship between FDI and growth, and has not directly addressed its effects on cross-country productivity differences. For example, using cross-country regression results to test a hypothesis based on new growth theory, Balasubramanyam et al. (1996) finds that the growth enhancing effects of FDI are stronger in countries with more liberal trade regimes. de Mello (1999) examines time series and panel data evidence for a sample of OECD and non-OECD countries to investigate the impact of FDI on capital accumulation and productivity growth. He finds that foreign investment increases productivity in recipient countries and that FDI is often a catalyst for domestic investment and technological progress. Using panel causality tests technique, Nair-Reichert and Weinhold (2001) find no uniformity among countries in the effects of FDI on growth but the efficacy of FDI in raising future growth rates seems to be higher in more open

[1] In the literature, the role of FDI in transferring technology has received much attention and spurred intense debate. For a recent survey, see Saggi (2002)

[2] By productivity, we mean labor productivity which is measured by gross domestic product per worker.

economies. Basu et al (2003), on the other hand, use a panel co-integration framework to demonstrate that there exists long-run bi-directional causality between growth and FDI for more open economies and unidirectional causality that runs from growth to FDI for relatively closed economies.

While the above studies examine the causal relationship between FDI and growth in different trade environments, Borensztein et al (1998) investigate the growth enhancing role of FDI in the context of purely domestic environments in the recipient countries. They find that FDI contributes relatively more to growth than does domestic investment when sufficient absorptive capability in the form of a minimum stock of human capital is available in the host country. Choe (2003) employs a panel VAR model framework to examine the Granger-causality between growth, FDI flows and gross domestic investment (GDI) for 80 countries over 1971—1995. The findings are, however, inconclusive about the direction of causality especially between FDI and growth though for GDI, it seems to run from growth to GDI.

Another stream of empirical literature relevant for the issue we address in the current study is the convergence literature that started with the testing of one of the implications of Ramsey-Solow-Cass-Koopmans type growth models: per capita incomes of countries converge to one another in the long-run. This literature finds overwhelming empirical evidence against absolute convergence (see Romer (1986), Lucas (1988) and Barro (1991)) while some influential works on convergence (e.g. Barro (1991), Mankiw et al. (1992) and Barro and Sala-i-Martin (1995)) provide evidence in support of conditional convergence: that countries with similar structural characteristics converge in per capita income. Durlauf and Johnson (1995) and Quah (1996) provide supporting evidence for the club convergence hypothesis that emphasizes similarities in initial conditions in addition to structural similarities. Baumol (1986) and Li (1999), on the other hand, find mixed evidence of convergence clubs. They find that per capita incomes converge in the high income countries while they diverge in low income countries.

To the best of our knowledge, few of the existing studies have addressed the question of whether increased FDIs have contributed to the convergence among countries, that is, to closing the gap between countries in labor productivity. [3,4] This question is important and has assumed particular significance for the following reasons. *First*, according to Fortanier and Maher (2001), the FDI stock has increased from a mere 5 percent of world GDP in 1980 to 14 percent in 1998. The decade of the nineties has witnessed a more than quadruple growth in FDI. *Second*, some developing countries in Asia and Latin America (Argentina, Brazil, Chile, China, Colombia, India, Indonesia, Malaysia, Philippines, Thailand,Venezuela—to name a few) have seen significant growth in FDI. According to Maddison (2001), over the second half of the 20th century the flow of foreign capital to Africa, Latin America and Asia (excluding Japan) went up so high that the stock of foreign capital rose from 4 to 22 percent of their GDP. On the other hand, in the OECD countries, - mostly developed countries - there has been down sliding of FDI flows in last few years with major noticeable fall in the U.S. and U.K. [5] *Third*, some of the countries receiving FDI have also experienced high productivity growth and

[3] Since most growth models do not make a distinction between labor and population in the economy there is no difference between income per worker (which is the measure of productivity used in current study) and income per capita and convergence literature focuses on convergence in per capita income.
[4] Silvestriadou and Balasubramanyam (2000) is an exception. They find that in countries pursuing export-promoting trade policies, FDI promotes growth and convergence.
[5] See OECD International Investment Perspectives (September 2003)

growth in real GDP per capita during this period.[6] *Finally*, this question has important policy implications for the growth of productivity in developing countries.

It is in this context that this paper examines the relationship between FDI and labor productivity. More specifically, it addresses the question if increased FDI flows have reduced the differences in productivity among countries that have received FDIs over last three decades. In order to capture productivity differences across countries it first calculates a measure of inequality in productivity among 93 countries, and also for different groups of countries within this sample, for each year over a period from 1970 to 2000. It also constructs an index of FDI (a weighted average of FDI per worker across countries in our sample) for the sample period. Furthermore, we construct a weighted index of GDI so that (i) we can control for the effects of domestic capital formation on productivity, and (ii) we can explore the relationship between FDI and GDI. We then use multivariate time series techniques to determine the nature of the relationship between FDI and the inequality measure.[7]

This study finds evidence of a long-run equilibrium relationship between FDI and productivity differences for developed, and high and middle income developing countries. There is some evidence that FDI Granger causes productivity differences among petroleum exporting countries. In middle income developing countries, inequality in productivity Granger causes FDI while in high income developing countries GDI seems to Granger cause FDI. There is little evidence of any systematic relationships among productivity differences, FDI and GDI for the full sample as well as for low

[6] Especially, the growth rate of GDP, and of GDP per capita for 16 East Asian countries over 1973-98 have been 5.09 percent and 3.3 percents respectively (see Maddison (2001)).
[7] In a similar study, Bhatta (2002) examines the effect of openness to trade on reducing global inequality. Our methodology is very similar though we apply it to subgroups of countries and thereby try to investigate if there are differences in the relationship among various groups.

income developing countries, major exporters of manufactures, heavily indebted poor countries, LDCs and landlocked countries.

The rest of the paper is organized as follows. Section 2 briefly outlines the intuition (or lack of it!) from theoretical models that motivate the current research. In Section 3, we discuss the data. Section 4 presents the results and their analysis. Section 5 concludes with remarks on obvious omissions and on further research extension.

2. The Theoretical Background

The literature (see Findlay (1978), Blomström (1991), Tsai (1994), Balasubramanyam et al. (1996), Barrell and Pain (1997), Manzocchi (1999), Ramirez (2000)) that investigates the role of FDI in economic growth suggests that there are two channels through which foreign direct investments contribute to economic growth: first, they augment the stock of domestic capital and second, they facilitate diffusion of technology across borders. This technology diffusion could lead to a permanent shift in productivity through human capital accumulation and technological progress.

As mentioned in the beginning, the roles played by capital accumulation and technological progress in long-run growth have been stressed in the growth literature. In the earlier growth models (Ramsey (1928), Solow (1956), Cass (1965), Koopmans (1965) the assumption of diminishing marginal product of capital has an important implication: countries at different points of growth trajectory will eventually converge in labor productivity independently of initial conditions and current disturbances – which have no long-run effect on the level of output and consumption. This prediction came to be known as the absolute or unconditional convergence hypothesis and was subject to extensive empirical investigation.

The empirical rejection of the absolute convergence hypothesis led to two important developments in growth literature: modifications of the empirically testable convergence hypotheses, and development of new growth theories (e.g. Romer (1986)) as an alternative framework for the study of economic growth. Since the long-run equilibrium of an economy depends on its structural characteristics such as preferences, technologies, population growth, government policy etc. convergence among countries similar in these characteristics is more plausible than is absolute convergence. This type of convergence is known as conditional convergence, and as persuasively argued by Barro (1991), Mankiw et al. (1992) and Barro and Sala-i-Martin (1995), it is consistent with growth models in neoclassical tradition. Conditional convergence is based on the notion that each economy is characterized by a unique, globally stable non-trivial steady-state equilibrium, and therefore, does not require countries with similar characteristics to have similar initial conditions.

However, if we admit multiple locally steady-state equilibria, the convergence among countries would require not only similar structural characteristics but also similar initial conditions. Thus, further refinement of conditional convergence hypothesis yields what came to be known as club convergence. As Galor (1996) argues, the neoclassical growth paradigm is consistent with all three convergence hypotheses. He also shows that the viability of club convergence as a competing hypothesis with conditional convergence is strengthened by inclusion of empirically significant variables such as human capital, income distribution, and fertility in conventional growth models, along with capital market imperfections, externalities and non-convexities. In the light of these interpretations of the conventional growth models, FDI is likely to achieve some form of convergence in labor productivity across the recipient countries through capital accumulation and diffusion of advanced technologies.

The growth and productivity enhancing role of FDI is also discussed in the context of the other development that followed the empirical rejection of absolute convergence hypothesis, namely the development of the new growth theory.[8] The basic tenet of the new growth theory is endogenization of technological progress. In such models (e.g. Romer (1986) and Lucas (1988)), various types of knowledge spillover effects and externalities lead social rate of return to investment to exceed the private rate of return - a mechanism that prevents unbounded decline in return to the capital stock in aggregate. The new growth theory thus emphasizes the role of research and development (R&D), human capital accumulation and externalities. FDI facilitates transfer of knowledge created in developed countries with their relatively high endowments of human capital. Moreover, knowledge and technology could spill-over from the foreign firms to the domestic firms through the training of labor and management and through links between foreign firms and local suppliers of components. In addition, increased competition may compel domestic firms to invest in R&D and human capital. In sum, FDI will contribute to higher productivity in the recipient countries.

Studies that use new growth theory paradigm to examine the effects of FDI on growth take two different routes. For example, extending a hypothesis advanced by Jagdish Bhagwati (1973), Balasubramanyam et al (1996) were able to show that the

[8] New growth theory is also known as the endogenous growth theory as the stimuli for growth is endogenous and therefore growth is endogenous in this framework.

growth enhancing effects of FDI would be stronger in countries with more liberal trade regime. Using the new growth theory framework they argue that a liberal trade regime is likely to provide an appropriate environment conducive to learning that must go along with the human capital and new technology infused by FDI. Others (e.g., Borensztein et al. (1998)) rely on absorptive capability of the recipient country in the form of stock of human capital for technological progress that is assumed to take place through a process of 'capital deepening' in the form of new varieties of capital goods introduced by FDI.

The role of GDI in growth and in attracting FDIs has been discussed in the literature (see Feldstein and Bacchetta (1991), Choe (2003)). A country that is economically growing and having higher GDI offers better prospects for production opportunities. Also, physical capital formation via GDI along with human capital acquisition creates necessary conditions conducive to the inflow of FDIs that embody higher level of technology (see Borensztein et al (1998), Das and Powell (2001) and Das (2002)).

The new growth theory, however, does not necessarily imply convergence in productivity among countries. In particular, if the countries receiving FDI have different levels of productivity to start with, the endogenous technological progress may, in fact, widen the productivity gap because there will be a sustained rise in productivity in all those countries and there will be no bridging of the gap. In this paper, we adopt rather an agnostic approach, and try to answer the following: is there any empirical evidence of FDI having systematic effects on productivity differences among the recipient countries? Additionally, we also investigate how GDI influences productivity and FDI flows.

3. Data and variables

3.1 Data Sources

The main sources of data for this study are the *Penn World Tables* (PWT, Mark 6.0), compiled at the Center for International Comparisons (CIC) by Summers and Heston et al., and the *Foreign Direct Investment* database compiled and made available online by the United Nations Conference on Trade and Development (UNCTAD). We use real GDP per worker (*RGDPPW*) from the PWT as a measure of productivity. Data on the number of workers are obtained by dividing real GDP by *RGDPPW* for each country and for each year. We also obtain data on gross fixed investment from PWT. Finally, we obtain the data on net FDI inflows[9] for 93 countries for a period from 1970 to 2000 from the UNCTAD. Note that all these series are in 1996 constant US dollars.[10] Although the PWT provide data for 152 countries, in order to make our sample compatible for both data sources we use the data only for 93 countries.[11] The countries for which data are not available for a reasonable length of time have been excluded from the sample. Furthermore, we subtract the foreign direct investment from gross fixed investment to obtain the domestic components – which we call GDI - in each country for the sample period.

3.2. A Measure of Inequality in Productivity

The Gini coefficient is the most widely used aggregate measure of income

[9] FDI inflows in the recipient economy 'comprise capital provided (either directly or through other related enterprises) by a foreign direct investor to an enterprise resident in the economy.' 'FDI flows are recorded on a net basis (capital account credits less debits between direct investors and their foreign affiliates) in a particular year.' (see UNCTAD: Foreign Direct Investment database, Sources and Notes)

[10] UNCTAD reports the FDI flows in current US dollars but they are converted to 1996 US dollars by using an implicit deflator for investment from PWT. It may be noted that the purchasing power parity (PPP) adjusted data series reported in PWT are in international dollars which are at the aggregate level same as U.S. dollars.

[11] Countries included in our sample are listed in Appendix

inequality among the population in an economy. Since this paper examines inequality in labor productivity among countries, it uses a spatial Gini, *GS*, that is based on spatial units.[12] The underlying assumption is that every worker in a country has the same labor productivity, which is defined as real gross domestic product per worker in that country. GS_t, the spatial Gini of labor productivity across countries in period t, is derived by using a trapezoidal approximation for the area under the Lorenz curve as follows:

$$GS_t = 1 - \sum_{i=0}^{n-1} \left(\frac{Y_{i,t}^S + Y_{i+1,t}}{Y_t} \right) \left(\frac{L_{i+1,t}^S - L_{i,t}^S}{L_t} \right) \qquad (1)$$

where n is the number of countries in the sample, $Y_{i,t}$ is the real GDP in country i in period t and $Y_t = \sum_{i=1}^{n} Y_{i,t}$. $Y_{i,t}^S$ is the aggregate real GDP of all countries with $RGDPPW \leq RGDPPW_i$ in period t. L_t is the total number of workers in the sample countries. $L_{i,t}^S$ is the total number of workers in countries with $RGDPPW \leq RGDPPW_i$ in period t. We take $L_0 = Y_0 = 0$. Note that GS_t can take values only between 0 and 1, 0 indicating complete equality and 1 indicating extreme inequality.[13]

3.3. Aggregate Measures of FDI and GDI

To capture the changes in FDI and GDI, we construct two weighted indices for each year. The FDI index ($FDIX_t$) reflects flows of foreign capital into the countries in the sample. The GDI index ($GDIX_t$), on the other hand, reflects accumulation of domestic capital per worker across countries. Thus

[12] For a discussion, see Cowell (1995)

[13] One major drawback of this measure is that because it is a measure of aggregate inequality, it fails to adequately take into account certain changes in the underlying distribution of productivity. Following discussion in Bhatta (2002), we construct another measure of inequality by taking the ratio of total income going to the most and the least productive 20% of the workforce in the countries in our samples. However, the time series properties are not very different from those of GS and, therefore, the results are not reported in this paper.

$$FDIX_t = \sum_{i=1}^{n} \frac{FDI_{i,t}}{L_{i,t}} \times \frac{L_{i,t}}{L_t} \qquad (2)$$

where $FDI_{i,t}$ is the inflow of foreign direct investment in country i in period t, $L_{i,t}$ is the number of workers in country i and L_t is as described before. Thus, we use the share of country *i*'s workers in the aggregate of workers of all countries in the sample as the weight for calculating the FDI weighted index.[14] Similarly, we calculate the GDI weighted index as follows:

$$GDIX_t = \sum_{i=1}^{n} \frac{GDI_{i,t}}{L_{i,t}} \times \frac{L_{i,t}}{L_t} \qquad (3)$$

where $GDI_{i,t}$ is the gross domestic investment in country i in period t.

4. Empirical Results

We examine the relationship between FDI and productivity for the full sample of countries, and also for several groups within this sample based on the classification and grouping schemes of the UNCTAD. These classifications and groupings are based on different criteria that include income level – measured by per capita GDP, major export items, indebtedness, special designation by the Economic and Social Council (ECOSOC) and special geographic location. In total, we have nine groups of countries: Developed Countries, High Income Developing Countries, Middle Income Developing Countries, Low Income Developing Countries, Major Exporters of Petroleum, Major Exporters of

[14] By weighing FDI per worker in country i with the country's labor share in the sample we control for the effect of differential growth in the work force on productivity. Thus for a country that experiences higher growth in its work force, a relatively higher weight will be assigned to FDI per worker thus offsetting for relatively smaller (larger) increase (decrease) in productivity as a result of higher growth in work force. In some other related studies (e.g. Bhatta, 2002), the ratio between population in the rich 50% and the poor 50% of countries has been included to control for effect of population growth on income per capita.

Manufactures, Highly Indebted Poor Countries, Least Developed Countries (LDCs[15] as designated by ECOSOC), and Landlocked Countries.[16] There are overlaps among these groups. Our objective is to investigate if increased FDI has contributed to the closing of productivity gap in a particular group of countries, if not worldwide. In other words, we examine effects of FDI on absolute as well as on conditional convergence.

Table 1 presents summary statistics of the variables for the full sample as well as for different groups. Also, in Figure 1 we plot the three series for the period 1970 – 2000 for each group of countries. As we can see from the table, the FDI per worker increased almost 16 times during the sample period whereas GDI per worker increased by about one and half times for the full sample. There was a steady rise in the inequality measure until mid-1970s, then it remained somewhat stable for the decade of 1980s and rose again during most of the 1990s. Among various groups the following patterns are observed: inequality in productivity has been almost steadily decreasing among developed, and middle income developing countries. In high income developing and least developed countries, inequality first declined until around mid-1980s and then it rose. We observe similar patterns in major petroleum exporting countries. Low income countries have experienced steady rise in inequality in productivity. Major exporters of manufactures first experienced increase, and then significant steady decline since 1979. Thus, decrease in inequality can be purported to be evidence of convergence in labor productivity among developed and middle income developing countries. Low income developing countries, on the other hand, witnessed divergence in labor productivity during the sample period.

[15] Note that this acronym is, in general, used to refer to the less developed countries.

[16] The countries included in these groups and the criteria used for their classifications are discussed in Appendix.

These results are in accordance with the findings of Li (1999).[17] For other groups including the full sample the evidence is mixed.

FDI per worker has been steadily rising for developed, high and middle income developing countries, major exporters of manufactures and for landlocked countries. In low income developing countries and petroleum exporting countries, FDI decreased during the decade of 1970s and then it steadily increased. In heavily indebted poor countries and least developed countries FDI increased during the 1970s, fell significantly during the 1980s and rose again during the 1990s.

Among the developed, low income developing countries and major exporters of manufactures, GDI per worker has been steadily increasing during the sample period. In high income developing countries, it increased substantially during the 1970s, declined slightly during the 1980s and then increased again. It increased substantially during the 1970s, declined during the 1980s and then increased slightly during the decade of 1990s in middle income and petroleum exporting countries. In least developed and heavily indebted poor countries it steadily declined during the early part of the sample period. For landlocked countries, on the other hand, GDI declined steadily over the sample period.

4.1 Unit Root Test

Before we investigate the exact nature of the relationships among *GS, FDIX* and *GDIX*, we first need to examine the time series properties of the individual series so that we can use appropriate technique for multivariate analysis. We conduct Augmented Dickey-Fuller (ADF) tests to find out the order of integration for each of the three

[17] One has to be careful in interpreting these results as evidence in support of convergence club hypothesis because the groupings by income are based on the per capita income in 1996. Whether similar behavior will be observed if the countries are classified according to the per capita income in the beginning of the sample period is an empirical question. Here we strictly adhere to the UNCTAD classification scheme.

series[18]. First, we conduct the test in levels and then in first differences for the full sample as well as for various groups of countries.[19] For each series we start with the most flexible specification of the test equation that includes an intercept and a trend:

$$\Delta x_t = \alpha_o + \alpha_1 t + \gamma x_{t-1} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + \varepsilon_t \qquad (4)$$

where x is the variable of interest (e.g. *GS, FDIX, GDIX*), α_0 represents the intercept term, t is the deterministic time trend, Δx's are the augmented terms, p is the appropriate lag length of the augmented terms and ε is the white noise error term. The ADF test is essentially the test of significance of the coefficient γ in the above equation. In order to select the lag length p, we start with a maximum lag of 4 and pare it down to the appropriate lag by looking at the Schwartz Information Criterion (SIC).[20] If we do not find the intercept and trend – both or one of them – to be statistically significant at 10% significance level, we drop the insignificant term(s) and re-estimate the test statistics.

The results of these ADF tests are reported in Tables 2, 3 and 4. In Panel A we report the ADF test results for the variables in level and in Panel B we report them in first difference. As we can see from Table 2, for the full sample the Gini coefficient and GDI index are integrated of order 1 (i.e. I(1)), and FDI index is integrated process of order 2

[18] Given the scale differences among the variables, one would be tempted to apply these test procedures to logarithmic values of the variables: *FDIX* and *GDIX* in particular. We resist this temptation for two reasons. First, for some groups of countries the FDIX is negative for some years (which is not surprising because we consider net FDI inflows!). Second, there have been debates over the appropriateness of data transformation in models with unit roots and cointegration (for recent discussion see Corradi and Swanson (2003)).

[19] If we find evidence of a unit root in first difference of a series we further conduct ADF test on the second difference of that series. However, we do not report the detailed results of this ADF test.

[20] There is no general rule as to how one chooses the maximum lag length to start with. Enders (1995) suggests 'to start with a relatively long lag length…' (pp.227). Some researchers use the following rule of thumb: start with a maximum lag length equal to the cube root of the number of observation which is 3.14 ($=\sqrt[3]{31}$) in our case.

(i.e. I (2)).[21] Even for developed and high income developing countries, and for major exporters of manufactures Gini and GDI index are I (1) but FDI index is integrated process of higher order. For middle income developing and least developed countries, all three series are I (1) processes. For low income developing countries, *GS* is I (2) and for heavily indebted poor countries it is I (0). Both FDI and GDI indices are I (1) processes for low income developing and heavily indebted poor countries. For major exporters of petroleum and LDCs, FDI index is I (0) but Gini and GDI index are I (1) processes. FDI and GDI index for landlocked countries, on the other hand, are found to be I (0) while Gini is I (1).

For those cases in which the AIC selects 4 to be the appropriate lag length, we increase the maximum lag length and re-examine AIC to select the appropriate lag length for the augmented terms in the test equation. The most important result from this experiment is that *FDIX* in first difference is now found to be I (0) for developed countries, thus making it an I (1) process.

Augmented Dickey-Fuller test procedure is often criticized for the assumptions of statistical independence and constant variance of the underlying distribution of the errors. Phillips and Perron (1988) develop a nonparametric test procedure that allows fairly mild assumptions regarding the distribution of the errors. We therefore use Phillips-Perron methodology as a cross-check on the results suggested by the ADF tests about the orders of integration of the variables of interest. The results are summarized in Table 5. As we can see, though for most series they confirm the results obtained from ADF tests, for a few others Phillips-Perron test suggests different orders of integration. We find that even

[21] As one can see from the MacKinnon's approximate p-values, the results are based on conventional 5 percent significance level (a p-value of 0.05 or less).

for high and low income developing countries, all three series are I (1) according to Phillips-Perron test procedure.

Now that we know the time series properties of the individual series we may turn to multivariate analysis in order to shed light on the relationships among these variables.

4.2 Cointegration Test

In a seminal paper, Engle and Granger (1987) define cointegration as a long-run equilibrium[22] relationship among variables that are integrated of the same order. Although ADF tests suggest that GS, FDIX and GDIX are all integrated of same order (i.e. I (1)) only for the developed and middle income developing countries, Phillips-Perron test results further indicate that all three series are I(1) for high income and low income developing countries as well. [23] Therefore, we conduct Johansen's Cointegration Test[24] for these four groups of countries. Note that Johansen's test procedure involves estimation of the following model:

$$\Delta \boldsymbol{x}_t = \sum_{i=1}^{p-1} \boldsymbol{\pi}_i \Delta \boldsymbol{x}_{t-i} + \boldsymbol{\pi} \boldsymbol{x}_{t-p} + \boldsymbol{\varepsilon}_t \tag{5}$$

where $\boldsymbol{x}_t = (GS_t, FDIX_t, GDIX_t)'$. The test for cointegration is based on the rank of the matrix $\boldsymbol{\pi}$.[25]

The results of the cointegration test are presented in Table 6. In panel A, B, C and D, we report the results for developed countries, high income, middle income and low income developing countries respectively. We report both trace statistics and max-

[22] Not necessarily in the strictest sense of economics. '….the equilibrium relationship may be causal, behavioral, or simply a reduced-form relationship among similarly trending variables.' (see Enders, 1995, pp 359)
[23] For developed countries, it is so after increasing the maximum lag length to 8
[24] Note that Engle-Granger Cointegration Test procedure involves testing for stationarity of the error term in a hypothesized long-run relationship between the variables of interests. Johansen's procedure extends the concept and generalizes to multivariate case.
[25] Note that bold face is used to denote vector or matrix.

eigenvalue statistics.[26,27] As we can see from the table, for both developed and middle income developing countries there exists a cointegrating relationship between Gini coefficient, FDI and GDI index. There is evidence of two cointegrating relationships among the variables for high income developing countries. For low income developing countries, these variables are not cointegrated.

The normalized cointegrating coefficients suggest that FDI has a positive effect and GDI has a negative effect on inequality in productivity among the developed countries although the effects seem to be statistically insignificant.[28] For high income developing countries, however, FDI has a significant negative impact on inequality and GDI seems to have a negative but statistically insignificant effect.[29] The two cointegrating equations reported in Panel B suggest that GDI decreases inequality and FDI flows though these effects are found to be statistically insignificant. For middle income developing countries, both FDI and GDI seem to reduce inequality in productivity. However, this effect is statistically significant only for GDI. The time trend in the cointegrating equation is statistically significant for both developed and middle income developing countries. For low income developing countries there is no evidence of long-run equilibrium relationships among these three variables.

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[26] For a discussion on these test statistics, see Enders (1995)

[27] We fit an equal lag length VAR to *GS, FDIX* and *GDIX* in levels for each group and use the system-wide SIC (alternatively, Akaike Information Criterion (AIC)) to determine the appropriate lag length. We then choose the selected lag length *minus* 1 to be the lag length of the differenced terms in equation (7).

[28] The cointegrating equation with normalized coefficients for the developed countries is: GS_t =7.81e-07 $FDIX_t$ - 1.39e-07 $GDIX_t$ – 0.0015 t and for high income developing countries is: $GS_t = -0.0004FDIX_t - 2.08e\text{-}06GDIX_t + 0.452$. The cointegrating equation for the middle income developing countries is: GS_t =-0.0002 $FDIX_t$ – 0.0001 $GDIX_t$ – 0.0048 t.

[29] It is difficult to interpret the estimated coefficient. Roughly, it suggests that an average (weighted) increase of $100 in FDI per worker reduces the Gini by 0.04 (=0.0004 × 100) among the high income developing countries.

4.3 Granger Causality Test

We conduct Granger Causality Tests to further investigate the relationships among *GS, FDIX* and *GDIX*. We use the multivariate generalization of Granger Causality Test, which is also called 'block causality' test. The objective is to determine whether lags of one variable Granger cause any other of the variables in the system.[30] A likelihood ratio test is used to test the cross equation restrictions on the lags of the variables of interest. For the groups for which there is no evidence of cointegrating relationship among the variables, the results are reported in Table 7. Note that the test statistics are estimated from a VAR model of the three variables in their stationary forms.[31,32]

For the full sample as well as for most other groups of countries there is no evidence of Granger causality among the variables. For major exporters of petroleum, FDIX Granger causes changes in GS. Since three countries: Venezuela, Indonesia and Nigeria, receive most of the FDI flows into petroleum exporting countries, this skewed distribution of FDI flows may help explain productivity differential among those countries.

Because we find these variables to be cointegrated at least for three groups of countries, we use Vector Error Correction (VEC) Model for those countries. Note that the VEC model is represented by:

$$\Delta x_t = \delta_0 + \delta_1 \left(\hat{e}_{t-1}\right) + \sum_{i=1}^{p-1} \lambda_i \Delta x_{t-i} + \varepsilon_t \qquad (6)$$

[30] For a discussion, see Enders (1995) pp. 315-16

[31] As suggested by Fomby (1998), for the full sample, for example, we first fit a equal lag length VAR to ΔGS, $\Delta^2 FDIX$ and $\Delta GDIX$, and determine the appropriate lag length using system-wide SIC and then conduct block causality tests.

[32] For some groups, the appropriate lag length chosen by SIC is 0 which indicates that there may not be any causal relationship among the variables. However, for those cases we conduct the tests using a lag of 1 period.

where $\boldsymbol{x}_t$ is as before. $\boldsymbol{\delta}_0$ is a 3 × 1 vector of constants, $\boldsymbol{\delta}_1$ is a 3 × 1 vector of parameters that represent the *speed of adjustment* of the variables to a deviation from the long-run relationship represented by the cointegrating equation, and $\hat{e}_{t-1}$ is the error-correction term. $\boldsymbol{\lambda}_i$ is a 3 × 3 matrix of parameters that represent how the lagged values of the variables at lag *i* affect each of the variables. We can investigate long-run and short-run (Granger) causality by examining the estimated $\boldsymbol{\delta}_1$ and $\boldsymbol{\lambda}_i$ respectively. The results are reported in Table 8. As we can see from the speed of adjustment parameters, a deviation from the long-run relationship in period *t-1* has significant positive effects on the change in *FDIX* between period *t* and *t-1* for developed and high income developing countries indicating convergence in FDI in those countries to its long-run equilibrium path. For middle income developing countries, on the other hand, all three variables seem to be significantly affected by such deviations but only FDI has a convergent path.

The bottom part of each panel reports the χ^2 test statistics that tell us if the exclusion of lagged values of the variables in the left column is statistically significant for explaining movements in the variables in the first row of the table in a VEC Model framework. In other words, we are testing for block causality among different variables. The figures within parentheses are the p-values associated with the estimated test statistics. Note that SIC selects a lag length of zero for the differenced terms in the VEC model for developed countries. From the results in Panel B, we find that changes in *GDIX* Granger causes changes in *FDIX* in high income developing countries. For middle income developing countries, changes in *GS* seems to Granger cause changes in *FDIX*.

Overall, there is little evidence of increased FDI affecting productivity differences for the entire sample. Most studies using data for a large sample of countries (e.g. Choe

(2003)) reach similar conclusions. Most developing countries receive a very small amount of FDI inflows and in most cases they are concentrated in only a few sectors. It is difficult to expect a significant impact of FDI on overall labor productivity in those countries. As results indicate, for high and middle income developing countries there is some evidence of FDI reducing productivity differences while it seems to worsen inequality among developed countries in the long-run. The relationship is statistically significant only for high income developing countries and it seems to be consistent with the findings of Blomström et al. (1994). Furthermore, in middle income developing countries GDI seems to play a pivotal role in achieving convergence in productivity. For these countries FDI inflows seem to constitute a small part of overall capital formation, and therefore likely to have relatively less significant effect on productivity. FDI Granger causes inequality in productivity in petroleum exporting countries. For low income developing countries, exporters of manufactures, heavily indebted poor countries, LDCs and landlocked countries, there is no evidence of Granger causality among these variables.

5. Concluding remarks

Using data for 93 countries this paper examines if foreign direct investments help countries catch up with each other in labor productivity. We construct spatial Gini coefficient of labor productivity across countries, and aggregate indices of FDI and GDI, and examine their time series properties to explore the relationship of FDI and GDI with productivity. Although we find no clear evidence of FDI flows – which have increased manifold in last three decades – reducing inequality in productivity for the entire sample, our analysis shows that these three variables are cointegrated for developed, high and middle income developing countries, indicating long-run equilibrium relationships between FDI, GDI and productivity. FDI seems to reduce inequality in productivity among high income developing countries in the long-run. Moreover, GDI plays a significant role in reducing productivity differences among middle income developing countries.

The Granger causality test results suggest that for the entire sample there is no systematic relation of FDI and GDI with productivity differences. In petroleum exporting countries, FDI Granger causes inequality in productivity. GDI Granger causes FDI in high income developing countries and *GS* Granger causes FDI in middle income developing

As we can see from the data, for most countries FDI constitutes a small part of total investment. Moreover, these FDI flows may be concentrated in a few sectors in the recipient countries. Thus, the results of this study should be interpreted and used with utmost care. Furthermore, we are using data only for 31 years which may not be long enough to examine the long-run effects of FDI on productivity. In this paper, we narrowly focus on the effect of FDI on productivity differences. Although we control for domestic capital accumulation, as previous studies have shown, it would be interesting to take into account the effects of trade regime and factors like human capital accumulation to evaluate and fully appreciate the contributions of FDI to productivity differences. [33] With these caveates, the current study however gives a broad overview of the relationship between FDI and productivity differences across countries.

[33] Using a trade liberalization index (a weighted index of exports *plus* imports per worker) we re-did our analyses. Since we did not find any significant qualitative difference in the effects of FDI on productivity differences we have not reported the results here to save space.

Table 1: Summary Statistics of Gini Coefficient, Foreign Direct Investment Aggregate Index, and Domestic Investment Aggregate Index (Sample Period: 1970 – 2000)

Statistics	Full Sample			Developed Countries			High Income Developing Countries			Middle Income Developing Countries			Low Income Developing Countries		
	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient *(GS)*	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient *(GS)*	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient *(GS)*	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient *(GS)*	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*
1970	0.727	38.420	2658.792	0.480	90.495	6561.587	0.481	41.547	2470.199	0.660	28.012	1292.135	0.355	1.891	275.828
1980	0.724	83.843 (118.23)	3335.323 (25.45)	0.458	221.696 (144.98)	8006.435 (22.02)	0.425	112.501 (170.78)	4262.36 (72.55)	0.601	33.365 (19.11)	2032.584 (57.30)	0.366	0.583 (-69.17)	325.201 (17.90)
1990	0.73	156.754 (86.96)	3662.305 (9.80)	0.446	489.255 (120.69)	10090.22 (26.03)	0.396	172.08 (52.96)	4152.954 (-2.57)	0.539	42.964 (28.77)	1964.744 (-3.34)	0.385	2.633 (351.63)	401.516 (23.47)
2000	0.732	612.377 (290.66)	3839.513 (4.84)	0.446	2041.337 (317.23)	11208.12 (11.08)	0.502	1057.046 (514.28)	4618.459 (11.21)	0.535	89.942 (109.34)	1983.697 (0.96)	0.397	9.884 (275.39)	606.834 (51.14)
Minimum	0.720	37.242	2658.792	0.441	90.495	6561.587	0.377	41.547	2470.199	0.516	9.296	1249.329	0.355	0.583	271.663
Maximum	0.732	612.377	4049.106	0.480	2041.337	11208.12	0.502	1057.046	5889.164	0.660	148.388	2365.12	0.397	13.606	606.834
Mean	0.727	133.217	3372.227	0.455	384.703	8797.125	0.440	216.799	4075.379	0.580	49.487	1845.657	0.377	5.300	378.788
Standard deviation	0.003	136.302	366.511	0.012	451.851	1445.837	0.037	247.866	873.697	0.042	35.432	307.428	0.014	3.514	88.644
No. of obs.	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31

Note: We report values of the variables at decennial interval. The numbers in parentheses represent decennial percentage growth rates of the respective variables

Table 1 (contd.): Summary Statistics of Gini Coefficient, Foreign Direct Investment Aggregate Index, and Domestic Investment Aggregate Index (Sample Period: 1970 – 2000)

Statistics	Major Exporters of Petroleum			Major Exporters of Manufactures			Heavily Indebted Poor Countries			Least Developed Countries			Landlocked Countries		
	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*
1970	0.617	13.883	639.867	0.548	10.762	812.653	0.639	21.576	268.424	0.607	-10.069	199.651	0.618	-27.034	329.667
1980	0.521	-1.586 (-111.43)	1236.377 (93.22)	0.606	27.105 (151.86)	1416.05 (74.25)	0.641	35.142 (62.88)	233.230 (-13.11)	0.580	7.142 (170.93)	158.858 (-20.43)	0.648	7.779 (-128.77)	241.397 (-26.78)
1990	0.510	12.486 (887.26)	1020.303 (-17.48)	0.572	44.396 (63.79)	1687.224 (19.15)	0.630	18.432 (-47.55)	130.527 (-44.04)	0.572	1.763 (-75.32)	89.231 (-43.83)	0.629	7.894 (1.48)	190.318 (-21.16)
2000	0.547	11.882 (-4.84)	1054.785 (3.38)	0.554	229.702 (417.39)	1975.465 (17.08)	0.633	36.423 (97.61)	141.319 (8.27)	0.606	15.727 (792.06)	94.391 (5.78)	0.592	18.621 (135.89)	178.638 (-6.14)
Minimum	0.506	-2.990	609.512	0.548	10.636	812.653	0.630	17.975	112.169	0.555	-10.069	71.776	0.592	-27.034	178.638
Maximum	0.617	73.565	1564.177	0.608	229.702	2168.063	0.645	53.243	274.513	0.607	28.941	199.651	0.650	34.151	380.835
Mean	0.539	23.367	1077.386	0.579	51.063	1477.744	0.637	28.677	191.792	0.583	6.391	130.573	0.627	8.048	235.618
Standard deviation	0.033	17.344	227.438	0.016	52.392	388.670	0.004	8.117	56.135	0.017	6.429	42.364	0.013	10.021	62.360
No. of obs.	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31

Note: We report values of the variables at decennial interval. The numbers in parentheses represent decennial percentage growth rates of the respective variables

Table 2: Augmented Dickey-Fuller Test Results for Gini Coefficient, Foreign Direct Investment Aggregate Index, and Domestic Investment Aggregate Index (Sample Period: 1970 – 2000)

Statistics	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index (*FDIX*)	GDI Aggregate Index (*GDIX*)
Panel A: In levels			
ADF test statistics	0.491	1.713	-3.033
Lag length of the augmented terms	0	1	0
Is a time trend included in the test equation?	no	no	yes
Is an intercept term included in the test equation?	no	no	yes
Dickey-Fuller 5% critical value	-1.952	-1.952	-3.568
MacKinnon approximate p-value	0.815	0.976	0.140
Number of obs. used in the test equation	30	29	30
Panel A: In first differences			
ADF test statistics	-5.084	-2.531	-4.737
Lag length of the augmented terms	0	0	0
Is a time trend included in the test equation?	no	yes	no
Is an intercept term included in the test equation?	no	yes	no
Dickey-Fuller 5% critical value	-1.953	-3.574	-1.953
MacKinnon approximate p-value	0.000	0.312	0.000
Number of obs. used in the test equation	29	29	29

Notes: To select the lag length of the augmented terms in the test equation, we start with a maximum lag length of 4 and pare it down by looking at the Schwartz Information Criterion (SIC). *FDIX* in second difference is found to be an I(0) process.

Table 3: Augmented Dickey-Fuller Test Results for Gini Coefficient, Foreign Direct Investment Aggregate Index, and Domestic Investment Aggregate Index (Sample Period: 1970 – 2000)

Panel A: In levels

Statistics	Developed Countries			High Income Developing			Middle Income Developing			Low Income Developing		
	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*
ADF test statistics	-2.535	2.068	-3.544	-1.410	5.484	-2.573	-2.337	-2.053	-2.009	-2.117	-1.002	2.785
Lag length of the augmented terms	0	4	1	0	1	1	0	0	0	0	1	0
Is a time trend included in the test equation?	no	no	yes	yes	no	yes	yes	yes	no	yes	no	no
Is an intercept term included in the test equation?	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	no	yes
Dickey-Fuller 5% critical value	-2.964	-1.954	-3.574	-3.568	-2.968	-3.574	-3.568	-3.568	-2.964	-3.568	-1.953	-1.952
MacKinnon approximate p-value	0.118	0.989	0.053	0.837	1.00	0.294	0.402	0.550	0.282	0.516	0.912	0.998
Number of obs. used in the test equation	30	26	29	30	29	29	30	30	30	30	29	30

Note: To select the lag length of the augmented terms in the test equation, we start with a maximum lag length of 4 and pare it down by looking at the Schwartz Information Criterion (SIC).

Table 3(contd.): Augmented Dickey-Fuller Test Results for Gini Coefficient, Foreign Direct Investment Aggregate Index, and Domestic Investment Aggregate Index (Sample Period: 1970 – 2000)

Panel B: In first differences

Statistics	Developed Countries			High Income Developing			Middle Income Developing			Low Income Developing		
	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (*GS*)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*
ADF test statistics	-5.245	0.549	-4.465	-4.763	2.050	-3.488	-6.004	-5.525	-3.913	-2.425	-8.758	-6.857
Lag length of the augmented terms	0	4	0	0	2	0	1	0	0	4	0	0
Is a time trend included in the test equation?	yes	no	no	yes	no	no	yes	no	no	no	no	yes
Is an intercept term included in the test equation?	yes	no	no	yes	no	no	yes	no	no	yes	no	yes
Dickey-Fuller 5% critical value	-3.574	-1.955	-1.953	-3.574	-1.954	-1.953	-3.581	-1.953	-1.953	-2.986	-1.953	-3.574
MacKinnon approximate p-value	0.001	0.828	0.000	0.003	0.988	0.001	0.000	0.000	0.000	0.145	0.000	0.000
Number of obs. used in the test equation	29	25	29	28	27	29	28	29	29	25	29	29

Note: To select the lag length of the augmented terms in the test equation, we start with a maximum lag length of 4 and pare it down by looking at the Schwartz Information Criterion (SIC).

Table 4: Augmented Dickey-Fuller Test Results for Gini Coefficient, Foreign Direct Investment Aggregate Index, and Domestic Investment Aggregate Index (Sample Period: 1970 – 2000)
Panel A: In levels

Statistics	Major Exporters of Petroleum			Major Exporters of Manufactures			Heavily Indebted Poor Countries			Least Developed Countries			Landlocked Countries		
	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*
ADF test statistics	-2.865	-3.471	-2.534	-3.410	6.997	-2.373	-4.555	-2.692	-2.154	-2.209	-3.270	-2.656	-0.527	-4.365	-4.167
Lag length of the augmented terms	0	0	0	0	0	1	3	0	0	4	0	0	0	0	4
Is a time trend included in the test equation?	no	no	no	yes	no	yes	yes	no	yes	yes	no	yes	no	no	no
Is an intercept term included in the test equation?	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes
Dickey-Fuller 5% critical value	-2.964	-2.964	-2.964	-3.568	-2.964	-3.574	-3.588	-2.964	-3.568	-3.595	-2.964	-3.568	-1.952	-2.964	-2.981
MacKinnon approximate p-value	0.062	0.016	0.118	0.069	1.000	0.385	0.006	0.087	0.497	0.465	0.026	0.261	0.480	0.002	0.003
Number of obs. used in the test equation	30	30	30	30	30	29	27	30	30	26	30	30	30	30	26

Note: To select the lag length of the augmented terms in the test equation, we start with a maximum lag length of 4 and pare it down by looking at the Schwartz Information Criterion (SIC).

Table 4 (contd.): Augmented Dickey-Fuller Test Results for Gini Coefficient, Foreign Direct Investment Aggregate Index, and Domestic Investment Aggregate Index (Sample Period: 1970 – 2000)
Panel B: In first differences

Statistics	Major Exporters of Petroleum			Major Exporters of Manufactures			Heavily Indebted Poor Countries			Least Developed Countries			Land-locked Countries		
	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*	Spatial Gini Coefficient (GS)	FDI Aggregate Index *(FDIX)*	GDI Aggregate Index *(GDIX)*
ADF test statistics	-5.420	-9.447	-5.433	-4.777	-2.208	-3.645	-5.510	-8.091	-5.794	-4.437	-7.768	-7.454	-3.753	-8.271	-6.339
Lag length of the augmented terms	0	0	0	0	0	0	4	0	0	4	0	0	3	0	3
Is a time trend included in the test equation?	yes	no	no	yes	yes	no	no	no	no	yes	no	no	yes	no	yes
Is an intercept term included in the test equation?	yes	no	no	yes	yes	no	no	no	no	yes	no	yes	yes	no	yes
Dickey-Fuller 5% critical value	-3.574	-1.953	-1.953	-3.574	-3.574	-1.953	-1.955	-1.953	-1.953	-3.603	-1.953	-2.968	-3.595	-1.953	-3.595
MacKinnon approximate p-value	0.001	0.000	0.000	0.003	0.468	0.001	0.000	0.000	0.000	0.009	0.000	0.000	0.036	0.000	0.000
Number of obs. used in the test equation	29	29	29	29	29	29	25	29	29	25	29	29	26	29	26

Note: To select the lag length of the augmented terms in the test equation, we start with a maximum lag length of 8 and pare it down by looking at the Schwartz Information Criterion (SIC).

Table 5: Summary of Phillips-Perron Unit Root Tests

	Spatial Gini Coefficient (GS)	FDI Aggregate Index (*FDIX*)	GDI Aggregate Index (*GDIX*)
Full sample	I(1)	I(2)	I(1)
Developed countries	I(1)	I(2)	I(1)
High income developing countries	I(1)	I(1)*	I(1)
Middle income developing countries	I(1)	I(1)	I(1)
Low income developing countries	I(1)*	I(1)	I(1)
Major exporters of petroleum	I(1)	I(0)	I(1)
Major exporters of manufacturing	I(0)*	I(2)	I(1)
Heavily indebted poor countries	I(0)	I(1)	I(1)
Least developed countries	I(1)	I(0)	I(1)
Landlocked countries	I(1)	I(0)	I(1)*

Note: * indicates that the order of integration suggested by Phillips-Perron Unit Root Test is different from the one suggested by ADF test

Table 6: Johansen Cointegration Test for GS_t, $FDIX_t$ and $GDIX_t$

Panel A: Developed Countries

Trend and intercept specifications: linear deterministic trends in data; intercept and trend in cointegrating equation
Lag interval in first differences: No lags
Included observations: 30

Null Hypothesis	Eigenvalue	Trace Statistics	5 percent critical value	Maximum Eigenvalue Statistics	5 percent critical value
No CE	0.69	56.37	42.44	35.33	25.54
At most 1 CE	0.36	21.05	25.32	13.32	18.96
At most 2 CE	0.23	7.72	12.25	7.72	12.25

Normalized cointegrating coefficients: (t-statistics are in parentheses)

GS_t	$FDIX_t$	$GDIX_t$	Trend
1.00	-7.81e-07	1.39e-07	0.0015
	(-0.355)	(0.126)	(8.829)

Panel B: High Income Developing Countries

Trend and intercept specifications: no deterministic trends in data; intercept in cointegrating equation
Lag interval in first differences: 1 to 1
Included observations: 29

Null Hypothesis	Eigenvalue	Trace Statistics	5 percent critical value	Maximum Eigenvalue Statistics	5 percent critical value
No CE	0.68	52.84	34.91	32.90	22.00
At most 1 CE	0.43	19.94	19.96	16.55	15.67
At most 2 CE	0.11	3.39	9.24	3.39	9.24

Normalized cointegrating coefficients: (t-statistics are in parentheses)

1 Conintegrating Equation

GS_t	$FDIX_t$	$GDIX_t$	Intercept
1.00	0.0004	2.08e-06	-0.452
	(2.135)	(0.109)	(7.760)

2 Cointegrating Equations

GS_t	$FDIX_t$	$GDIX_t$	Intercept
1.000	0.000	1.46e-06	-0.410
		(0.183)	(12.684)
0.000	1.000	0.002	-115.557
		(0.086)	(1.431)

Table 6 (contd.): Johansen Cointegration Test for GS_t, $FDIX_t$ and $GDIX_t$

Panel C: Middle Income Developing Countries

Trend and intercept specifications: linear deterministic trends in data; intercept and trend in cointegrating equation
Lag interval in first differences: 1 to 2
Included observations: 28

Null Hypothesis	Eigenvalue	Trace Statistics	5 percent critical value	Maximum Eigenvalue Statistics	5 percent critical value
No CE	0.61	43.80	42.44	26.04	25.54
At most 1 CE	0.39	17.76	25.32	13.73	18.96
At most 2 CE	0.13	4.03	12.25	4.03	12.25

Normalized cointegrating coefficients: (t-statistics are in parentheses)

GS_t	$FDIX_t$	$GDIX_t$	Trend
1.000	0.0002	0.0001	0.0048
	(0.703)	(3.970)	(4.069)

Panel D: Low Income Developing Countries

Trend and intercept specifications: linear deterministic trends in data; intercept in cointegrating equation
Lag interval in first differences: 1 to 1
Included observations: 29

Null Hypothesis	Eigenvalue	Trace Statistics	5 percent critical value	Maximum Eigenvalue Statistics	5 percent critical value
No CE	0.41	25.15	29.68	15.26	20.97
At most 1 CE	0.26	9.89	15.41	8.58	14.07
At most 2 CE	0.04	1.32	3.76	1.32	3.76

Table 7: Pairwise Granger Causality Test

Panel A: Full Sample
Lag length of the differenced variables = 1
Observations = 28

		Dependent Variables		
		ΔGS_t	$\Delta^2 FDIX_t$	$\Delta GDIX_t$
χ^2 test statistics for exclusion of:	ΔGS_t		0.255 (0.614)	0.250 (0.619)
	$\Delta^2 FDIX_t$	0.008 (0.929)		0.017 (0.897)
	$\Delta GDIX_t$	1.894 (0.169)	0.235 (0.628)	
	All	2.205 (0.332)	0.290 (0.865)	0.265 (0.876)

Panel B: Low Income Countries
Lag length of the differenced variables = 1
Observations = 28

		Dependent Variables		
		$\Delta^2 GS_t$	$\Delta FDIX_t$	$\Delta GDIX_t$
χ^2 test statistics for exclusion of:	$\Delta^2 GS_t$		0.369 (0.544)	0.411 (0.521)
	$\Delta FDIX_t$	0.005 (0.942)		0.852 (0.356)
	$\Delta GDIX_t$	1.179 (0.278)	0.067 (0.796)	
	All	1.185 (0.553)	0.436 (0.804)	1.088 (0.580)

Panel C: Major Exporters of Petroleum
Lag length of the differenced variables = 1
Observations = 29

		Dependent Variables		
		ΔGS_t	$FDIX_t$	$\Delta GDIX_t$
χ^2 test statistics for exclusion of:	ΔGS_t		0.167 (0.682)	0.210 (0.647)
	$FDIX_t$	3.178 (0.075)		0.219 (0.640)
	$\Delta GDIX_t$	0.006 (0.941)	2.325 (0.127)	
	All	3.200 (0.202)	2.395 (0.302)	0.395 (0.821)

Panel D: Major Exporters of Manufactures
Lag length of the differenced variables = 1
Observations = 28

		Dependent Variables		
		ΔGS_t	$\Delta^2 FDIX_t$	$\Delta GDIX_t$
χ^2 test statistics for exclusion of:	ΔGS_t		0.312 (0.577)	0.115 (0.735)
	$\Delta^2 FDIX_t$	0.557 (0.455)		1.003 (0.317)
	$\Delta GDIX_t$	0.149 (0.699)	1.495 (0.221)	
	All	1.092 (0.579)	2.942 (0.230)	1.112 (0.574)

Table 7 (contd.): Pairwise Granger Causality Test

Panel E: Heavily Indebted Poor Countries
Lag length of the differenced variables = 1
Observations = 29

		Dependent Variables		
		GS_t	$\Delta FDIX_t$	$\Delta GDIX_t$
χ^2 test statistics for exclusion of:	GS_t		0.020 (0.888)	0.377 (0.539)
	$\Delta FDIX_t$	1.264 (0.261)		0.032 (0.859)
	$\Delta GDIX_t$	1.543 (0.214)	2.295 (0.130)	
	All	4.005 (0.135)	2.313 (0.315)	0.433 (0.805)

Panel F: Least Developed Countries
Lag length of the differenced variables = 1
Observations = 29

		Dependent Variables		
		ΔGS_t	$FDIX_t$	$\Delta GDIX_t$
χ^2 test statistics for exclusion of:	ΔGS_t		0.738 (0.691)	1.446 (0.485)
	$FDIX_t$	1.991 (0.369)		1.552 (0.460)
	$\Delta GDIX_t$	2.457 (0.293)	1.595 (0.451)	
	All	3.731 (0.444)	2.506 (0.644)	3.951 (0.413)

Panel G: Landlocked Countries
Lag length of the differenced variables = 1
Observations = 29

		Dependent Variables		
		ΔGS_t	$FDIX_t$	$GDIX_t$
χ^2 test statistics for exclusion of:	ΔGS_t		0.040 (0.842)	0.983 (0.321)
	$FDIX_t$	1.569 (0.210)		0.027 (0.870)
	$GDIX_t$	0.834 (0.361)	0.161 (0.688)	
	All	2.539 (0.281)	0.239 (0.888)	0.986 (0.611)

Table 8: Vector Error Correction Model Pairwise Granger Causality Test

Panel A: Developed Countries
VEC Model
Lag length of the differenced variables =0
Observations =30

Speed of Adjustment Parameters	Dependent Variables ΔGS_t	$\Delta FDIX_t$	$\Delta GDIX_t$
δ_1 (t-statistics are in parentheses)	0.011 (0.094)	28871.61 (5.28)	4084.104 (0.19)

Panel B: High Income Developing Countries
VEC Model
Lag length of the differenced variables = 1
Observations = 29

Speed of Adjustment Parameters		Dependent Variables ΔGS_t	$\Delta FDIX_t$	$\Delta GDIX_t$
δ_1 (t-statistics are in parentheses)		-0.012 (-0.244)	835.192 (6.018)	-605.939 (-0.662)
χ^2 test statistics for exclusion of: (p-values in parentheses)	ΔGS_t		0.929 (0.335)	0.887 (0.346)
	$\Delta FDIX_t$	0.290 (0.590)		0.158 (0.691)
	$\Delta GDIX_t$	0.417 (0.518)	4.153 (0.042)	
	All	0.837 (0.658)	4.386 (0.112)	0.999 (0.607)

Panel C: Middle Income Developing Countries
VEC Model
Lag length of the differenced variables = 2
Observations = 28

Speed of Adjustment Parameters		Dependent Variables ΔGS_t	$\Delta FDIX_t$	$\Delta GDIX_t$
δ_1 (t-statistics in parentheses)		0.167 (2.909)	166.164 (1.794)	-2322.549 (-2.542)
χ^2 test statistics for exclusion of: (p-values in parentheses)	ΔGS_t		6.594 (0.037)	4.420 (0.110)
	$\Delta FDIX_t$	1.283 (0.527)		1.108 (0.575)
	$\Delta GDIX_t$	3.644 (0.162)	0.002 (0.999)	
	All	4.710 (0.318)	10.697 (0.030)	4.910 (0.297)

Figure 1: Spatial Gini, FDI Aggregate Index and GDI Aggregate Index: 1970 – 2000

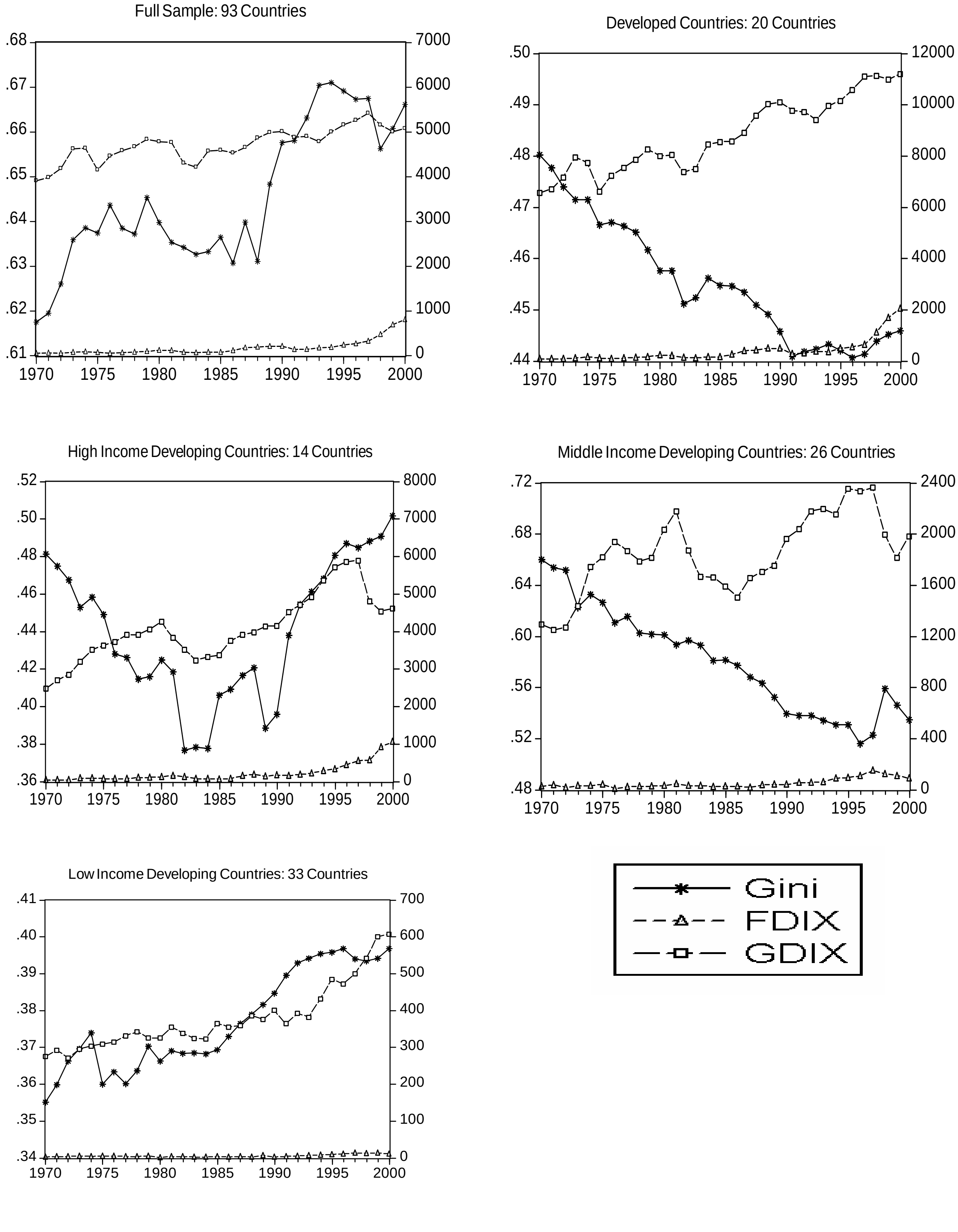
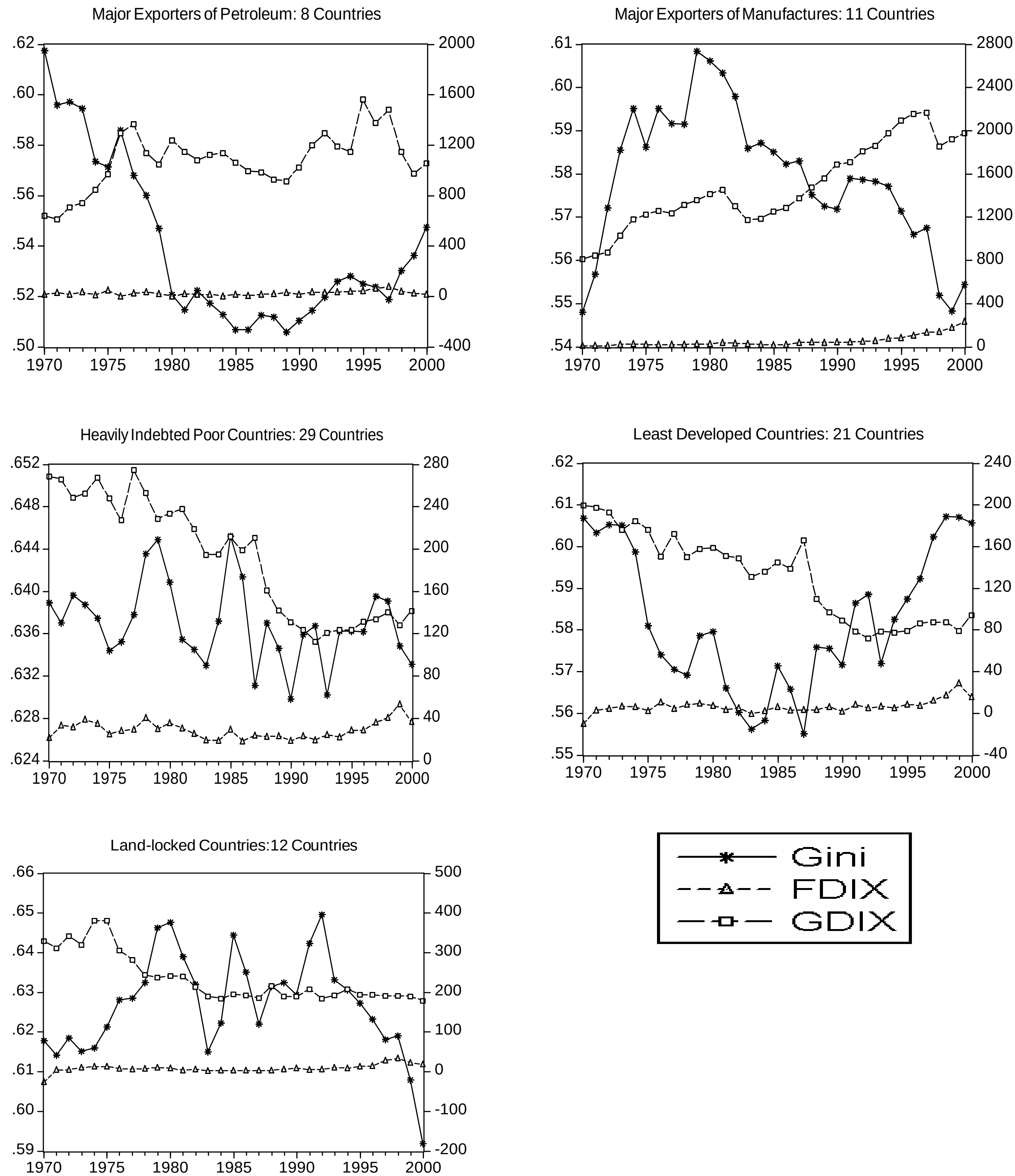


Figure 1 (contd.): Spatial Gini, FDI Aggregate Index and GDI Aggregate Index: 1970 – 2000



Appendix

List of Countries

Full Sample (93 countries)

Angola, Argentina, Australia, Austria, Barbados, Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Canada, Central African Republic, Chad, Chile, Colombia, Congo, Costa Rica, Cote d'Ivoire, Cyprus, Democratic Republic of Congo, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Hong Kong, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Kenya, Korea, Madagascar, Malawi, Malaysia, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Seychelles, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sweden, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, UK, Uruguay, USA, Venezuela, Zambia, Zimbabwe

Developed Countries (20 countries)

Australia, Austria, Canada, Denmark, France, Finland, Greece, Iceland, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, United States of America

High Income Developing Countries (14 countries): Countries with per capita GDP above $4,000 in 1995

Argentina, Barbados, Brazil, Chile, Cyprus, Gabon, Hong Kong, Korea, Malaysia, Seychelles, Singapore, Taiwan, Trinidad and Tobago, Uruguay

Middle Income Developing Countries (26 countries): Countries with per capita GDP between $ 800 and $4,000 in 1995

Bolivia, Colombia, Congo, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Guatemala, Indonesia, Iran, Jamaica, Mauritius, Mexico, Morocco, Panama, Papua New Guinea, Paraguay, Peru, Philippines, South Africa, Thailand, Tunisia, Turkey, Venezuela

Low Income Developing Countries (32 countries): Countries with per capita GDP below $800 in 1995

Angola, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Democratic Republic of Congo, Ethiopia, Gambia, Guyana, Haiti, Honduras, India, Kenya, Madagascar, Malawi, Mauritania, Mozambique, Nicaragua, Niger, Nigeria, Pakistan, Rwanda, Senegal, Sierra Leone, Sri Lanka, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Major Petroleum Exporters (8 countries): Countries with not less than 40 percent of their exports being petroleum and petroleum products that amounted to at least 20 billion US dollars on average in the period 1997-98
Angola, Congo, Gabon, Indonesia, Iran, Nigeria, Trinidad and Tobago, Venezuela

Major Exporters of Manufactures (11 countries): Countries with not less than 50 percent of their exports being manufactured products that amounted to at least 20 billion US dollars on average in the period 1997-98

Brazil, Hong Kong, India, Korea, Malaysia, Mexico, Philippines, Singapore, Taiwan, Thailand, Turkey

Heavily Indebted Poor Countries (29 countries)

Angola, Benin, Bolivia, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Cote d'Ivoire, Democratic Republic of Congo, Ethiopia, Gambia, Ghana, Guyana, Honduras, Kenya, Madagascar, Malawi, Mauritania, Mozambique, Nicaragua, Niger, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia

Least Developed Countries (21 countries)

Angola, Benin, Burkina Faso, Central African Republic, Chad, Democratic Republic of Congo, Ethiopia, Gambia, Haiti, Madagascar, Malawi, Mauritania, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia

Landlocked Countries (12 countries)

Bolivia, Burkina Faso, Central African Republic, Chad, Ethiopia, Malawi, Niger, Paraguay, Rwanda, Uganda, Zambia, Zimbabwe.

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