Foreign Direct Investment and the Environment: Pollution Haven Hypothesis Revisited

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Abstract

We examine the impact of environmental policy on location decision, the outflow of "dirty" Foreign Direct Investment (FDI). We also examine the impact of "dirty" FDI in host countries, on annual CO_2 total emission; total emission of known particulate matters; rising temperature; and total energy use. Using disaggregated FDI data, panel data regression, we found that, "dirty" FDI outflow is positively correlated with environmental policy in eleven OECD countries. But FDI inflow is not significant in explaining the level of pollution and energy use in fourteen non-OECD countries.

I. INTRODUCTION.

The problem of foreign exchange constraints in economic growth and role of foreign investment in developing countries has been recognised since the works of Chenery and Strout, (1966) Chenery and Bruno, (1962), McKinnon, (1964). Foreign investment is expected to bridge the internal resource and savings gap, increase managerial abilities, reduce the foreign exchange shortage and improve balance of payment in less developed countries. This is supported by the debate on trade liberalisation, and the robust results from empirical studies on the role of trade as engine of growth. (Balassa, 1978, Bhagwati and Srinivasan, 1983, Krueger, 1997)

But, trade liberalisation and free movement of capital has also become an important environmental issue. Some argue that environmental quality is a normal good and

that, free trade and the resulting economic growth would lead to cleaner environment. Part of this argument is rooted in the discredited Environmental Kuznets Curve (EKC) which is due to Shafik and Bandyopadhyay (1992), Seldon and Song (1994), Grossman and Krueger (1991)

Trade is governed by the law of comparative advantage which postulate that efficient exchange of goods leads to optimal outcomes. In this process, as agent of free trade, multinationals serve in reducing cost and respond to market imperfections. However, the Samuelson-Heckscher-Ohlin trade theory assumes low factor specificity or easily transferable resources; Rachardo-Viner theory assumes high factor specificity and hard to transfer resources; the increasing return to scale theory which is used to explain intra-industry trade all assumed that trade is benign and also overlooked the additional connections and complexities in the economic system created by trade. One of these complexities is the environmental degradation and the sensitivity of multinational corporations to cost of pollution abatement. Higher domestic cost therefore provides incentives for multinational corporations to expand their geographical range into other areas, including other countries in search for cheaper operating environment and additional resources.

The Pollution haven hypothesis refers to the possibility that foreign investment could sensitive to weaker environmental standards. A possible asymmetry exists between foreign capital and local environmental standards. When firms avoid environmental regulations by relocation it could trigger competition for lax environmental policy in order to gain comparative advantage in “dirty” goods production. The power of foreign firms, especially, and the desperate attempt to woo and tame foreign capital

by poor countries might sometimes force these countries to lower the country-specific regulation. Direct and strict environmental regulation may increase production cost, for this reason and in attempt to promote investment and attract foreign capital, trade liberalisation in emerging and transition economies might, by design or by default, lead to lax environmental policies.

a. Pollution Haven:

The pollution haven hypothesis has three dimensions. The first is the relocation of heavy polluting industries from developed countries with stringent environmental policies to developing countries where similar policies do not exist, are lax or not enforced. Accordingly, global free trade would encourage polluting industries and processes to move to countries with weak environmental policy. The second dimension is the dumping of hazardous waste generated from developed countries (industrial and nuclear energy production), in developing countries. This issue was the subject of the Basle Convention on hazardous waste. The last dimension is the unrestrained extraction of non-renewable natural resources in developing countries by multinational corporations engaged in producing petroleum and petroleum products, timber and other forest resources, etc. All the dimensions relate to conscious decisions on environmental policy and how they impact on the environment, future production and trade.

Esty and Gentry (1997 cited in OECD 1997) outlined three types of FDI namely, market seeking; production platform seeking and resource seeking FDI. We add low cost seeking FDI. The cost include labour cost, operating cost, factor cost etc. The first two categories provided by Esty and Gentry are less likely to be sensitive to

environmental policy/cost. Industries in the third category may be sensitive environmental cost. The category we have added would certainly be susceptible to environmental cost especially because of the increased global competition and the rising corporate power in the global economy.

The pollution haven hypothesis therefore has two empirical consequences, namely: FDI outflow in developed countries is positively correlated with environmental policy stringency and pollution in developing countries is positively linked to FDI inflow. We intend to examine both using disaggregated data.

b. Previous Studies:

Levinson (1996) surveyed the empirical literature on the sensitivity of investment to environmental regulations, both internationally and domestically within the U.S. He reported that differences in pollution across states do not affect plant location decisions and concluded, "more than twenty years of empirical research has been unable to show convincingly that stringent environmental standards deter investment or that weak regulation attract investment". Copeland and Taylor (2003) found that, effects of pollution on FDI movement depend not on stringency of policy but also on the type of instrument used. Xing (1998) reported strong evidence on the impact of lax environmental regulation in attracting foreign investment. However, while environmental pollution and movements of capital and "dirty" goods could be observed, lax environmental problem may be difficult to determine. Copeland and Taylor (1994) argued that on the whole, free trade increases world pollution because, increased world income and its skewed distribution, means for a given endowments

and trade frictions, a country could import clean goods if its income is sufficiently high.

Lofdalh (2002) argued that the activities of MNCs, collectively, have increased the scale of international trade and production, thereby increasing cross border trade and increased *lateral pressure on the environment*, defined by expansion, competition, rivalry and conflict amongst them. By reducing transaction costs and responding to market imperfections, the MNCs serve to promote international trade and comparative advantage. Higher domestic cost is an incentive to MNCs to expand production spatially into other countries or in search for additional resources.

List and Co (1999) estimated the effects of environmental regulation on foreign multinationals new plant location decision and found evidence that, heterogeneous environmental policies across countries do matter. Levinson and Tylor (2003) argued that, industries in the US, where abatement cost has increased most, there is largest increase in net imports i.e. are these goods are produced elsewhere.

Eskeland and Harrison (1997) argued that foreign firms are significantly more energy efficient and use cleaner types of energy than local firms. They challenge the pollution haven hypothesis and argued that, liberalisation of trade and increased foreign investment in Latin America has not been associated with pollution intensive industrial development and concluded that, protected economies are more likely to favour pollution intensive industries, while openness actually encourages cleaner industries through the importation of developed pollution standards.

OECD (1997) contended that, data on whether FDI is sensitive to stringency is sparse and that, foreign capital flows to a wide range of industries some which are “dirty”, some of which are clean. While low cost operation could be an objective of FDI flow abroad, foreign firms generally seek consistent environmental regulation rather than lax environmental policy, they are also likely to make new investment that protect and improve the environment provided similar standard is enforced on their competitors. Removing cost advantage puts industries at a disadvantage in international competition especially when competitors from other countries do not face similar regulations or if they receive government subsidy to compensate their cost of compliance.

In responding to changing regulatory instruments only firm whose capital is mobile could migrate. Other firms subject to impediments in mobility may use time rather than location to respond to/mitigate the adverse effects of regulatory changes. This option is particularly important for firms extracting natural resources, who attempt to optimise the timing of production/exploration in a dynamic framework. Kunce et al, (2002) studied the extent to which firms engaged in oil and gas industry adjust the timing and intensity of production in the face of changes in environmental regulations.

Raspiller, S. and N. Riedinger (2004) observed that in France, paradoxically, the most pollution intensive goods are imported relatively more from the most environmentally stringent countries and that, the pollution intensity of the imported goods remains positively related to the environmental stringency of the country where they are

produced. This suggests that, environmental cost is not a major determinant of location compared to other effects.

In summary, some of the prominent/plausible reasons for relocation decision are labour intensity, towards labour abundant countries; natural resource endowment, in some industries like petroleum and petro-chemicals, paper and pulp, cement, wood and timber; environmental and technological factors, most "dirty" industries are basic industries associated with early stage of industrialisation; high return to capital because of capital scarcity, although Lucas, (1990) has dismissed this as a factor of capital mobility; and increase in the share of service industry in developed countries' GDP, or the knowledge society argument.

II. ENVIRONMENTAL STRINGENCY

a. Measures of stringency

Environmental regulation or stringency involves setting and enforcing standards. These standards could be classified into different forms: ambient quality standards; emission/discharge standards; production process standards; and products standards. Barde (1995)

Different variables have been used in previous studies as proxy for assessing the level of regulation – lax/stringent policies. Some of them include: consumption energy and "dirty" fuel; degree of ratification/participation in international environmental protection treaties, especially those that cover transboundary pollution; index of water and air ambient and emission standards; effluents intensity of output; level of corruption in a country; index of environmental sensitivity performance; actual

reduction in carbon, lead emission, water pollutants etc; comparative indices of environmental policy performance - state of environmental awareness, scope of policies adopted, legislations enacted, control mechanisms in place, the degree of success in implementing environmental policies; and environmental and environment related taxes.

Applicability of these measures depends on the local conditions. Drawing uniform/global environmental policy standard may be difficult, and although desirable, it may not be effective because of concerns about internal democratic deficits in international organisations expected to monitor these standards, free-rider and global common in international environmental protection (Johal and Ulph, 2002), and because pollution assimilative capacities are likely to be different amongst countries, so are social preferences regarding environmental quality.

b. Environmental Policy as a Comparative Advantage

While advocates of comparative advantage claim that trade bring mutual benefits to countries, it however assumes that all costs are internalised. Many studies have examined the argument that, lenient environmental standards give developing countries a comparative advantage in pollution-intensive goods. Dean (2002) surveyed the literature on openness and growth, and the environmental Kuznet's curve, and reported that the opposite may be true. Low and Yeats (1992) reported that, there has been a large increase in the average number of countries with revealed comparative advantage in “dirty” industries mainly because, developing countries have stronger tendency to develop comparative advantage in heavy polluting relative to non-polluting industries. The same expansion has occurred in all the polluting

sectors. “Dirty” industries account for largest share of exports of some developing countries and there is a reduction in “dirty” goods exports from industrial countries. That is to say that, while pollution intensive industries are being dispersed internationally, the dispersion is greatest towards developing countries. Their result also indicated that most “dirty” industries are capital intensive with high factor intensity.

Less developed countries could have actual and reveal comparative advantage in heavily polluting industries, which could have locational influence of these industries’ production. This is also because other factors which are related to the environment in the process of production like labour intensity, high return to capital, natural resource endowment also influence their migration to developing countries.

There are many plausible reasons why there is higher pollution intensity and loose environmental regulation in developing countries. First, environmental amenities are normal goods. At higher income there is higher demand for safe environment. Wealthier people tend to demand better environmental quality, support stricter laws and enforcement concerns, purchasing costly green goods. Poor people who depend more on the environment than the wealthy lack the means to express the demand. Second, the relative financial strength of developing countries means, costs of monitoring environmental standards are higher in developing countries. There is scarcity of trained manpower and equipment. Third, economic growth in developing countries is associated with a shift from subsistence agriculture into manufacturing. This and the resulting, urbanisation, increase in investment in infrastructure would lead to a deteriorating environment. Birdsall and Wheeler (1993)

Another reason may be the absence of, weak or un-enforced environmental regulation, because of corruption, knowledge base/human capital, the relative strength of the private sector and the interest it seek to protect, the share of multinational corporations in the ownership of industries. While the first three reasons could be benign, part of the development process, the last reason could have serious repercussion for the role of trade and investment in developing countries. Newell (2001)

The fear that, nation states may, acting independently, engage in a race to the bottom in setting weak environmental standards in order to gain strategic trade advantage and respond to the relocation of multinational companies is rooted on among other reasons, evidences for deindustrialisation (secular decline in the share of manufacturing in national employment and output) among the developed countries. However, industries choose location where expected profits are highest which involves a *combination* of factors like labour market conditions, market size and accessibility, taxes, infrastructure and public service, external economies, energy costs, raw materials availability and environmental compliance expenditure. Therefore environmental policy alone would not confer advantage to countries seeking to attract or tame foreign investment. Gerking and List (2001)

c. Environmental Policy and International Competitiveness

Corporate power of the multinationals, through direct and indirect means, has made government environmental regulatory policy weak. Stricter regulation would impose additional cost and give countries with lax regulation a comparative advantage in attracting multinationals. List et al (2003) found that in developing countries, while

domestic firms are influenced by environmental regulations, foreign firms are not because they provide economic stimuli, benefits of foreign investment, more jobs, and increased local wages.

It has been argued that, strict environmental regulation is detrimental to the competitiveness of an industry, and that it induces phenomena such as ecological dumping, ecological capital flight, and regulatory 'chill' in environmental standards. Other alternative views indicate that, strict environmental regulation triggers industry's innovation potential, and subsequently increases its competitiveness.

The likely consequences of lax environmental regulation are not only distorting trade patterns and comparative advantage but, may likely trigger competition for loose regulatory policy or "race to the bottom", which could further undermine the initial objectives of stringency. This could cause/exacerbate trade imbalance in the short run. Industries that loose the right to pollute might loose comparative advantage because, its access to natural resource endowment - which is also an important determinant of trade patterns - is reduced.

Secondly, if these industries affected employ less educated workers, with low labour demand elasticity, then this portion of the labour force could be most hard hit. (Jaffe et al, 1995) Environmental investment due to stringent policy could crowd out other investment by firms. The crowding out of firms and dislocation of industries to other countries could create a set of social cost. Declining manufacturing in certain sector would endanger economic security interest.

III. DATA ANALYSIS AND RESULTS

a. The Hypothesis:

While openness and trade liberalisation would promote economic growth at both local and global level, it is imperative to address the concern raised on the possible negative impact of trade and trade policy on the environment. Multinational firms seek to maximise profit and view alternative locations offering different combinations of taxes, government regulations, and public service as imperfect substitutes. The theoretical and empirical issues that arise from this is, to what extent do firms actually relocate when different instruments are applied.

Most of the literature on this topic prior to 1997 could not control for heterogeneity, because they used cross-section analysis and treats pollution regulation as exogenous. These studies linked cross section variation in investment and trade flows to industry, country and region specific measures of environmental regulations in addition to other variables like factor cost. Most of the studies reported that, spatial differences in environmental regulation have no or little effect on investment and trade flows. The more recent studies which have taken account of endogeneity of pollution policy and recognised that, country/industry specific variables may affect trade and investment flows, found that environmental policy do affect trade and investment flows. Copeland and Taylor (2004)

All the empirical studies we have come across on this topic used highly aggregated data and implicitly overlooked heterogeneity among multinational firms and spatial differences in and within foreign investment receiving countries. Previous studies have assumed homogenous spatial response vector thereby pooling unaffected

regions, this masked the overall impact of stringent control policies. We suspect that, the impact of more stringent environmental regulations is heterogeneous spatially, and depend on location-specific attributes. It is also a fact that, investment in tertiary industries like the service industry is environment friendly. Firms are heterogeneous in their factor inputs, lobbying power and whether outputs are exported or consumed locally. All these have implications for environmental policy, pollution and firm's location decision.

We disaggregate foreign investment across sectors and determine the impact of policy stringency on the location decision. Location decision of "dirty" industries and analyse their contribution to the level of environment pollution in host countries using panel data analysis.

It will also be desirable to determine the impact of policy on relocation and new investment decision. We suspect that, stringency is more likely to affect new investment decision rather than relocation. It is also important to determine if the rate and pattern of change in "dirty" industries is similar or different from other industries. However, we do not address these issues here.

b. Data and Results

We collected two types of data for 11 years, 1990 to 2000. FDI *inflow* data for fourteen developing countries, namely - Argentina, Armenia, Brazil, Chile, Colombia, Indonesia, Kazakhstan, Mexico, Pakistan, Paraguay, Poland, Slovenia, Thailand, Trinidad and Tobago - and FDI *outflow* for eleven developed/OECD countries - Canada, Denmark, Finland, Germany, Iceland, Italy, Japan, Netherlands,

Sweden, Switzerland, UK. For the purpose of this research, Mexico, though a member of OECD, is considered as a net *receiver* of FDI.

Another reason for including Mexico among net FDI receivers is, there were concerns at the inception of the NAFTA of the possibility of "dirty" investment relocating from the US to Mexico. (Markusen, 1999) So also is the recent trade dispute on Tuna exports into the US because of concern over fishing methods which US alleged are harmful to Dolphins and the US refusal to allow Mexican haulage firms to transport goods into the US because of environmental concerns has been attributed to the use of environmental policy as a protectionist measure.

Our choice of which country to include is dictated by data availability. While data was available for many countries, some of the data is highly aggregated. For others, the data is disaggregated but, for too few years. We therefore, had to limit the number of countries because of the need to synchronise the data and make it possible to run a panel data regression. Unfortunately, data is not available for most of the high FDI receivers like the "emerging economies" of East Asia and countries of Eastern Europe. It would have been interesting to include these countries, especially because, they are noted for their high pollution intensity and the use of "dirty" energy in production. FDI outflow from developed countries is available from 1989 to 2002. It is normal to expect data collection and its disclosure to be higher in developed countries. However, FDI inflow and outflow data is not available for the biggest economy in the world, the US.

Not all FDI is environmentally harmful. Therefore, disaggregated FDI data was collected (for both developed and developing countries) in order to determine "dirty" investment and it's correlation with environmental policy (stringency) in the FDI exporting country. We also examined the impact of "dirty" investment inflow and environmental pollution, energy use and levels of temperature in FDI receiving countries

Our definition of "dirty" investment/sectors is due to Mani and Wheeler (1997). They determined major polluting, "dirty" sectors by the use of emissions intensities based on "US manufacturing at 3-digit Standard Industrial Classification (SIC) level, computed by the World Bank in collaboration with the US EPA and the US Census Bureau" From which they computed average sectoral rankings for conventional air pollutants, water pollutants, and heavy metals, which was finally aggregated to determine overall rankings.

Data for the 1850-2002 was collected for Carbon emissions from energy use, non-CO_2 emissions, Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons, Sulfur hexafluoride, Carbon Emissions from Land Use, Concentrations in PPMV, Temperature in °C, Commercial energy use (kt of oil equivalent), emissions from public electricity and heat producers (in Million metric tons carbon dioxide), Electricity production (kWh)

OECD and non-OECD countries data were obtained on Coal, Crude Oil, Nuclear, Biomass energy, Gas and Hydro-energy production. The objective is to determine energy intensities, and whether change in FDI flow/inflow is related to the energy

intensity and its by-product – pollution levels. Most of the energy sources are either non-renewable or a major source of environmental pollution and or carbon emission.

We used two variables as proxy for environmental policy/stringency. These variables are, environmental tax in the OECD countries, and the "Environmental Sustainability index" ESI, 2002 prepared by the Global Leaders for Tomorrow, World Economic Forum; Center for International Earth Science Information Network, Columbia University; and Yale Center for Environmental Law and Policy. We however dropped the ESI data because it is still new, only two years data, and because, the underlying definition and computation method of the environmental sustainability among countries could give rise to multicollinearity in our regression.

It is important in explaining pollution haven hypothesis, to examine whether locational push of "dirty" industries towards developing countries exist. We used environmental tax as a proxy as a proxy for stringency. Data was obtained from the OECD dataset. We also included GDP as an explanatory variable so to determine whether the outflow is due to increased prosperity and the need to break new grounds and because FDI flow and GDP have been increasing world wide.

Finally we do not imagine a contemporaneous relationship between the dependent variables and explanatory variables. The Explanatory variables were set against lagged values of the independent variables.

c. Panel Data Results:

In the case of net FDI receivers or the less developed countries, we attempt to examine if FDI inflow is correlated with the level of pollution in these countries. We used data from four major pollutants namely, CO_2, total concentration of known pollutants, level of temperature and energy use. We also included GDP in order to determine the impact of rising economic prospects in these countries in attracting investment including FDI.

FDI Outflow = cons + Envr. Tax + Lag GDP

Model		Constant	Envr. Tax	Lag GDP	n
OLS	Between Effect Model	8322.288 (0.94)	-5.5926 (-0.32)	2.14e-09 (1.29)	110
	Fixed Effect Model	-38860.32 (-3.22)	4.283477 (1.50)	4.18e-08 (3.59)	
	Random Effect Model	1003.354 (0.30)	7.866245 (2..92)	3.12e-09 (1.85)	
GLS		2618.089 (1.33)	6.015706 (1.97)	2.42e-09 (3.36)	110

CO_2 fossil-fuel emissions = cons + Lag FDI-inflow + lag GDP

Model		Constant	FDI Inflow	Lag GDP	n
OLS	Between Effect Model	16256.81 (1.76)	4.187772 (1.69)	8.13e-08 (1.81)	140
	Fixed Effect Model	14901.04 (4.36)	0.0090318 (0.04)	1.55e-07 (6.13)	
	Random Effect Model	16445.39 (2.17)	0.0763576 (0.33)	1.43e-07 (6.61)	
GLS		17959 (6.55)	2.514341 (4.37)	9.47e-08 (7.29)	140

Total Concentrations of known polutants = Lag FDI-inflow + lag GDP

Model		Constant	FDI Inflow	Lag GDP	n
OLS	Between Effect Model	0.0307837 (1.83)	9.00e-06 (2.00)	1.84e-13 (2.26)	140
	Fixed Effect Model	0.2820893 (16.13	1.37e-06 (1.14)	-1.50e-12 (-11.58)	
	Random Effect Model	0.1023678 (4.61)	-1.77e-06 (-1.09)	-1.64e-13 (-1.75)	
GLS		.0399135 (5.38)	3.78e-06 (2.43)	1.98e-13 (5.64)	140

Temperature in C° = Lag FDI-inflow + lag GDP

Model		Constant	FDI Inflow	Lag GDP	n
OLS	Between Effect Model	0.0001199 (1.82)	3.09e-08 (1.75)	6.39e-16 (2.00)	140
	Fixed Effect Model	0.0014207 (14.47)	6.55e-09 (0.97)	-8.30e-15 (-11.43)	
	Random Effect Model	0.0003403 (3.82)	-1.09e-08 (-1.24)	-2.99e-16 (-0.76)	
GLS		0.0001608 (4.59)	1.00e-08 (1.37)	6.65e-16 (4.01)	140

Energy-use = Lag FDI-inflow + lag GDP

Model		Constant	FDI Inflow	Lag GDP	n
OLS	Between Effect Model	16991.49 (2.05)	7.272467 (3.27)	1.77e-07 (4.39)	140
	Fixed Effect Model	18847.68 (4.86)	0.1039192 (0.39)	2.73e-07 (9.51)	
	Random Effect Model	20911.16 (2.91)	0.2419458 (0.90)	2.56e-07 (10.98)	
GLS		20010.81 (7.21)	4.366181 (7.49)	1.99e-07 (15.18)	140

In most of our regression results we noted that Hausman test is spurious, because the data failed to meet the asymptotic assumptions of the Hausman test. We are unable to choose between the “fixed effect” and “between effect”. Most of the equations also suffer from autocorrelation and heteroscedasticity. We therefore decided to use the remedy for both autocorrelation and heteroscedasticity in the disturbances. We run a GLS in order to obtain robust standard errors.

Both FDI and GDP are positively correlated and statically significant in explaining the movements in CO_2 emissions. GDP and the constant are found to be statistically significant in explaining the movements in “total concentration of known pollutants” while FDI is not. Both FDI and GDP are not significant in explaining the movements in temperature over the years. The constant is significant, which is an indication of possible omission of important explanatory variables. Lastly, GDP is statistically significant in explaining the rise in energy use over time in the selected countries,

while FDI is not. We could therefore conclude that, FDI is only significant in explaining the level of CO_2 emissions in less developed countries.

In the case of FDI outflow from OECD countries, both GDP and environmental policy are statistically significant in explaining the outflow of "dirty" FDI to less developed countries. However, GDP is 'more significant' than the FDI in explaining the outflow of "dirty" FDI in these countries.

IV. CONCLUSION.

Our results indicate that, environmental policy is important in explaining the outflow of FDI from OECD countries to less developed countries. This is not surprising since investors are sensitive to all types of tax. However, at the other end of the spectrum, we were unable to find evidence that, FDI inflow into developing countries is responsible for the level of environmental pollution and energy use. FDI is however correlated with CO_2 emissions.

The implications of these results is that, less developed countries should continue to attract FDI because of its contribution GDP and economic growth, the *foregoing evidence* indicates that FDI is environmentally benign although in OECD countries, economic growth and stringent environmental policies, proxied by environmental taxes, by increasing production cost have increased the amount of FDI abroad

Disaggregated data on FDI is scanty and full of problems. It is hoped that in future both the data collection and reporting will improve. In the case of empirical works

cited, the quality of evidence both statistical and case study is poor compared with research needs. Their conclusions are therefore suspect.

For those studies that reported a positive impact of environmental policy on FDI and positive impact of FDI on pollution levels, a more systematic and rigorous study is required to determine the relative weight of factors that affect FDI movements given the multiple factors that affect location/relocation decisions of industries.

It is also important to disaggregate cooperative and non-cooperative situation amongst “dirty” multinational industries. Most multinational corporations are aware of their corporate social responsibility, it is therefore important to determine the impact their business activities on the environment that could arise by design and by default. It is important because, it is not available at the moment, to determine the level of pollution intensity of various multinational industries with a view to conclude whether foreign investment is benign or negative. Regression results that seek to show the link between FDI and environmental policy sould be complemented by data on industry specific pollution intensity.

NOTES ON DATA SOURCES

1. Foreign investment data was sourced form the UNCTAD on-line data base.

2. We obtained pollution/pollutants emission data from the country by country CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring 1751-2000 prepared by Gregg Marland and Tom Boden at the Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee. All emission estimates are expressed in thousand metric tons of carbon. Per capita emission estimated, are expressed in metric tons of carbon.

3. We also obtained data on various energy sources/production from the OECD database. Missing data on energy production and consumption was obtained from the United Nation's Statistical Yearbook for various years.

4. Data was also sourced from the BP Statistical Review of World Energy June 2004 on oil consumption - barrels and tonnes; gas production and consumption, primary energy consumption and electricity generation.

5. Missing data on energy production and consumption was obtained from the United Nation's Statistical Yearbook for various years.

6. Most of the data was in US dollars. However, some of the data obtained which were reported in local currencies were converted into US dollars using either annual exchange rate or Purchasing Power Parity (PPP). We had to do a double conversion for Italy - which is currently within the Euro zone - before and after the introduction of the Euro.

7. Emission data was also obtained from the Climate Analysis Indicators Tool (CAIT), an information and analysis tool on global climate change developed by the World Resources Institute, which provides a comprehensive database of greenhouse gas emissions data and other climate-relevant indicators.

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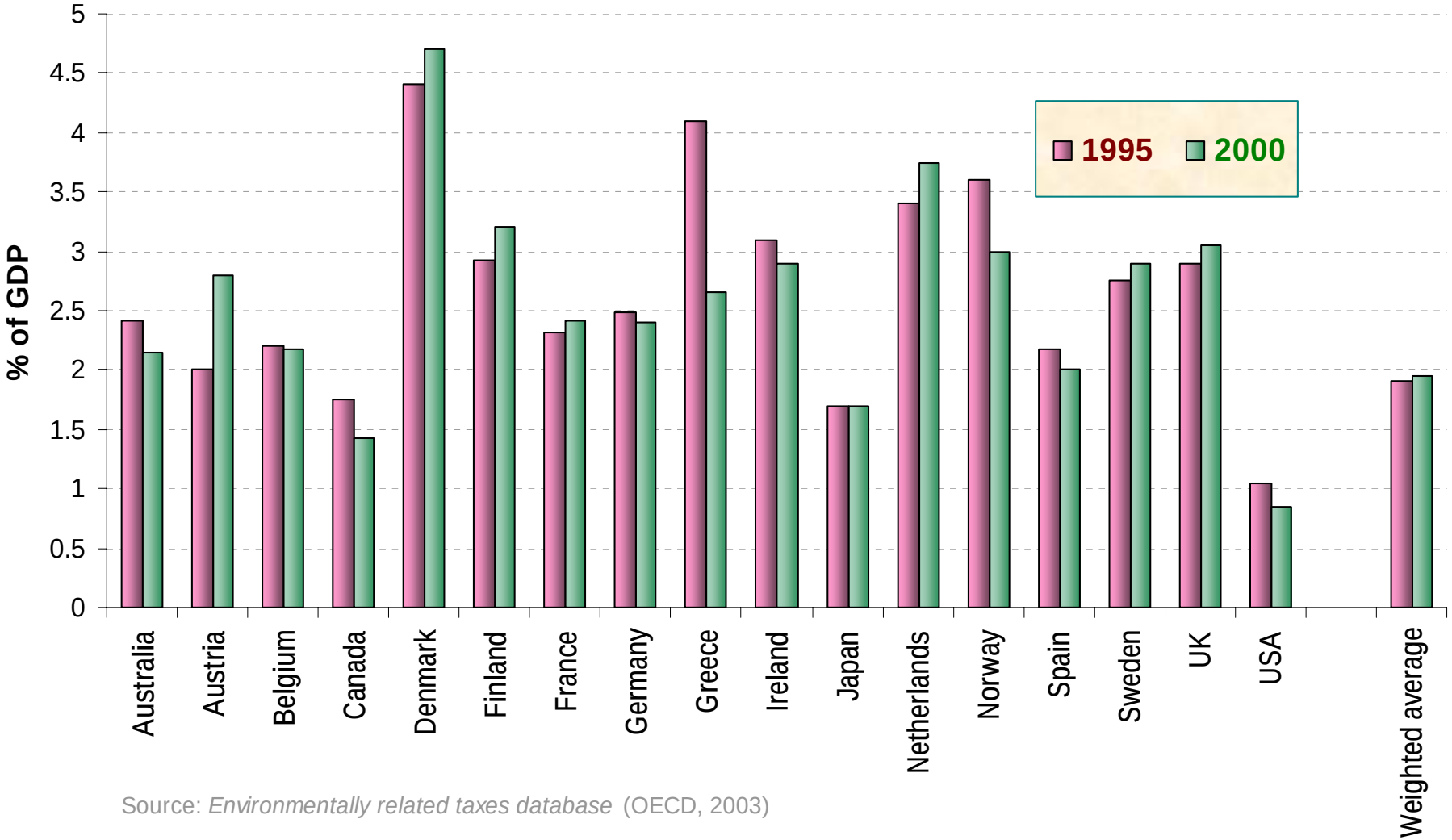
APPENDICES

RANKING OF DIRTY INDUSTRIES

Rank	Air	Water	Metals	Overall
1	371 Iron and Steel	371 Iron and Steel	372 Non-Ferrous Metals	371 Iron and Steel
2	372 Non-Ferrous Metals	372 Non-Ferrous Metals	371 Iron and Steel	372 Non-Ferrous Metals
3	369 Non-Metallic Min. Prd.	341 Pulp and Paper	351 Industrial Chemicals	351 Industrial Chemicals
4	354 Misc. Petroleum, Coal Prd.	390 Miscellaneous Manufacturing	323 Leather Products	353 Petroleum Refineries
5	341 Pulp and Paper	351 Industrial Chemicals	361 Pottery	369 Non-Metallic Min Prd.
6	353 Petroleum Refineries	352 Other Chemicals	381 Metal Products	341 Pulp and Paper
7	351 Industrial Chemicals	313 Beverages	355 Rubber Products	352 Other Chemicals
8	352 Other Chemicals	311 Food Products	383 Electrical Products	355 Rubber Products
9	331 Wood Products	355 Rubber Products	382 Machinery	323 Leather Products
10	362 Glass Products	353 Petroleum Refineries	369 Non-Metallic Min. Prd.	381 Metal Products

Mani and Wheeler (1997)

ENVIRONMENTAL TAXES AS A PERCENTAGE OF GDP IN OECD COUNTRIES – 1995 T0 2000



Source: *Environmentally related taxes database* (OECD, 2003)

FDI OUTFLOW FROM SELECTED OECD COUNTRIES – IN MILLION DOLLARS

FDI Outflow	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Canada	569.407	109.781	317.007	595.33	1911	1310.39	367.747	2627.71	2884.58	2143.08	11134.8
Denmark	239.745	302.679	498.021	510.591	387.012	630.515	292.163	1226.51	878.737	761.418	1714.98
Finland	291.761	291.761	291.761	2191.91	3125.64	1207.58	2256.83	3661.44	6476.17	3758.51	13868.4
Germany	12260.1	10558.3	8633.1	5706.7	8325.2	11375.5	8381.71	13595.6	74298.1	34353.9	32813.6
Iceland	6.35566	12.8734	-0.9091	1.86054	13.9969	12.9767	-4.6804	29.7689	23.9257	56.5656	71.0706
Italy	1254.49	1233.27	994.807	1577.81	1974.7	1130.21	1060.34	2901.39	2120.06	4384.19	3497.33
Japan	11881.6	8908.21	6919.54	6900.28	7950.75	10320.1	13270	14023.5	9395.36	29124.9	8294.29
Netherlands	5402.06	8202.97	8870.12	8489.49	9719.22	8720.73	16152.9	10635.8	29085.2	25656.2	42519.8
Sweden	6763.11	2312.88	-1670.4	715.771	1824.11	4486.65	1239.49	7121.15	4153.19	5924.57	11949.7
Switzerland	2575.05	2325.49	3502.81	3339.54	4943.77	4395.13	4235.47	8147.17	5037.65	4872.19	12239.9
UK	7227.93	8511.16	8093.43	7934.76	21249.8	18665.8	15183.9	18927	21460.7	71096.1	20137.4

FDI INFLOW IN FOURTEEN SELECTED NET FDI RECEIVING COUNTRIES – IN MILLION DOLLARS

FDI Inflow	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Argentina	597	597	597	980	1882	2371	3192	3746	1851	1964	1529
Armenia	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	82.4	22
Brazil	2753	2753	2753	2753	2753	2753	2753	3075	4695	12061	8320
Chile	171.9	171.9	171.9	560.2	475.1	389	980.6	624.3	620.9	837.8	251.5
Columbia	132.6	211.9	104.3	257.9	466.6	758.7	869.7	907.1	629.1	2137.4	221.3
Indonesia	3979	3979	3979	3438.9	18770.8	26851.3	15962.9	23014.5	8381.8	6929.3	10629.5
Khazastan	44.7	44.7	44.7	44.7	62.5	559.5	1216.8	430.8	183.8	55.3	-418.28
Mexico	7529.3	7529.3	7529.3	7529.3	7529.3	4991.2	5030.9	7388.6	5151.2	9020.5	9155.2
Pakistan	187.1	187.1	187.1	187.1	187.1	187.1	187.1	187.1	156	121.9	220.3
Paraguay	14.2	39.6	85.1	44.5	65.3	93.8	64.2	44.4	78.2	64.5	63.3
Poland	1815.4	1815.4	1815.4	1815.4	1815.4	1815.4	1815.4	1488.4	2176.9	1749.8	2085.4
Slovania	969.6	969.6	969.6	969.6	969.6	1168.7	1237.7	1345.5	2074.9	1803	1700.1
Thailand	1211.7803	934.23992	687.75591	451.51862	211.88867	566.48605	708.00616	1859.4886	2165.5746	1267.9431	1868.3686
Trinidad	2	2.6	0.1	1.6	132.5	4.5	7.3	10.6	11.2	6.8	6.8

GDP (CONSTANT 1995 US$) – IN MILLION US$

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ARGENTINA	187869	211671.4	236946.7	250942.9	265588.4	258031.9	272292.5	294378.3	305712.4	295362.6	293032.2
ARMENIA	5466.443	4826.869	2809.238	2562.025	2700.374	2886.7	3056.017	3157.509	3389.281	3501.127	3711.195
BRAZIL	603537.9	611384	608327	638135	675785	704168	723180.5	747045.5	747792.5	753774.9	786941
CHILE	42998.76	46425.76	52125.88	55767.54	58950.82	65215.86	70050.64	75228.73	78181.06	77286.93	80687.55
COLOMBIA	74107.82	75886.25	78836.82	83082.5	87931.04	92505.6	94407.38	97645.83	98190.64	94212.3	96651.61
INDONESIA	138426.7	150785.1	161672.6	173400.4	186474.9	202132	217580.5	227806.6	197903	199468.7	209239.2
KAZAKHSTAN	32450.51	28880.95	27350.26	24834.04	21704.95	19925.15	20024.77	20365.19	19978.25	20517.67	22528.4
MEXICO	265258.6	276458.5	286490.3	292078.4	304974.6	286166.8	300913.9	321291.7	337453.8	349679	372888.4
PAKISTAN	48393.45	50842.91	54760.81	55723.37	57792.92	60674.67	63615.32	64260.63	65899.43	68311.43	71209.71
PARAGUAY	7688.641	7878.514	8020.298	8352.784	8610.647	9016.098	9130.52	9366.676	9327.35	9372.629	9344.438
POLAND	99272.65	92323.57	94723.98	98323.49	103436.3	110676.9	117317.5	125295.1	131309.2	136692.9	142160.6
SLOVENIA	19300.34	17582.61	16633.15	17098.88	18005.12	18743.33	19399.34	20291.71	21062.8	22158.06	23177.33
THAILAND	111029.6	120531.8	130274.9	141023.9	153698	167895.8	177803.9	175365.6	156934.7	163888.4	171487.1
TRINIDAD TOBAGO	4973.66	5107.048	5022.918	4950.14	5126.478	5329.214	5539.442	5731.889	6052.325	6480.808	6926.398

TEMPERATURE IN C°

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ARGENTINA	0.000605	0.00054	0.00047	0.0004	0.00034	0.00027	0.00021	0.00016	0.0001	5.6E-05	2E-05
ARMENIA	2.61E-05	2.2E-05	1.8E-05	1.1E-05	8.5E-06	6.9E-06	5.1E-06	3.9E-06	2.5E-06	1.3E-06	5.3E-07
BRAZIL	0.001314	0.00118	0.00104	0.00091	0.00077	0.00064	0.0005	0.00037	0.00024	0.00013	4.8E-05
CHILE	0.000206	0.00019	0.00017	0.00015	0.00013	0.00011	8.6E-05	6.4E-05	4.2E-05	2.3E-05	7.9E-06
COLOMBIA	0.000306	0.00027	0.00024	0.00021	0.00017	0.00014	0.00011	7.8E-05	4.9E-05	2.5E-05	9.3E-06
INDONESIA	0.001025	0.00093	0.00083	0.00073	0.00062	0.00051	0.0004	0.00029	0.00019	0.00011	4.1E-05
KAZAKHSTAN	0.000996	0.00084	0.00068	0.00053	0.0004	0.0003	0.00021	0.00014	9.1E-05	4.8E-05	1.8E-05
MEXICO	0.001711	0.00152	0.00132	0.00113	0.00094	0.00075	0.00058	0.00042	0.00028	0.00015	5.6E-05
PAKISTAN	0.000418	0.00038	0.00034	0.00029	0.00025	0.0002	0.00016	0.00012	7.6E-05	4.2E-05	1.5E-05
PARAGUAY	1.59E-05	1.5E-05	1.3E-05	1.2E-05	1E-05	8.4E-06	6.4E-06	4.7E-06	3.1E-06	1.6E-06	5.3E-07
POLAND	0.001779	0.00155	0.00134	0.00113	0.00092	0.00074	0.00056	0.00039	0.00024	0.00013	4.4E-05
SLOVENIA	7.03E-05	6.2E-05	5.4E-05	4.7E-05	3.9E-05	3.2E-05	2.5E-05	1.8E-05	1.1E-05	6.1E-06	2.2E-06
THAILAND	0.000677	0.00062	0.00056	0.0005	0.00043	0.00036	0.00028	0.0002	0.00012	6.8E-05	2.5E-05
TRINIDAD AND TOBAGO	6.61E-05	5.8E-05	5.1E-05	4.3E-05	3.5E-05	2.9E-05	2.3E-05	1.6E-05	1.1E-05	6.8E-06	2.6E-06

TOTAL CONCENTRATIONS OF KNOWN POLLUTANTS IN ppmv

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ARGENTINA	0.12309	0.11551	0.10751	0.09886	0.09019	0.08059	0.07061	0.05965	0.04728	0.03368	0.01783
ARMENIA	0.00442	0.00395	0.00348	0.00265	0.00225	0.00202	0.00172	0.00149	0.00118	0.00082	0.00047
BRAZIL	0.27504	0.25976	0.24331	0.22624	0.20787	0.18803	0.16587	0.14021	0.11115	0.07862	0.04206
CHILE	0.04468	0.04241	0.04016	0.03769	0.03501	0.03191	0.02844	0.0243	0.0193	0.01387	0.00703
COLOMBIA	0.06121	0.0575	0.05361	0.04931	0.04465	0.03972	0.03444	0.02882	0.02236	0.01511	0.00821
INDONESIA	0.21917	0.20878	0.19677	0.18415	0.16926	0.15303	0.1345	0.11399	0.09069	0.06592	0.03669
KAZAKHSTAN	0.1694	0.15111	0.13262	0.11324	0.09631	0.08081	0.06669	0.05379	0.04175	0.02888	0.01587
MEXICO	0.34361	0.32154	0.29803	0.27331	0.24781	0.21995	0.19262	0.1628	0.12954	0.09163	0.0494
PAKISTAN	0.08762	0.08297	0.07807	0.0726	0.0665	0.05992	0.05261	0.04436	0.03534	0.02546	0.0136
PARAGUAY	0.00339	0.00323	0.00308	0.0029	0.00267	0.0024	0.00208	0.00176	0.00139	0.00096	0.00047
POLAND	0.33776	0.31216	0.28605	0.25953	0.23197	0.20485	0.17574	0.14274	0.10909	0.07507	0.03897
SLOVENIA	0.01414	0.01317	0.01224	0.01133	0.01033	0.00927	0.00809	0.00678	0.00525	0.00366	0.00193
THAILAND	0.14402	0.13768	0.13063	0.12263	0.11323	0.10247	0.08932	0.07392	0.0571	0.04104	0.02202
TRINIDAD AND TOBAGO	0.01364	0.01275	0.01187	0.01083	0.0098	0.00887	0.00788	0.00668	0.00554	0.00414	0.00232

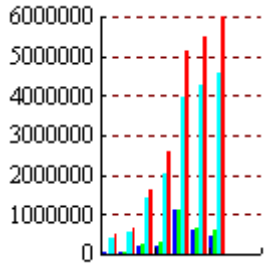
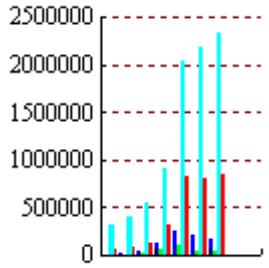
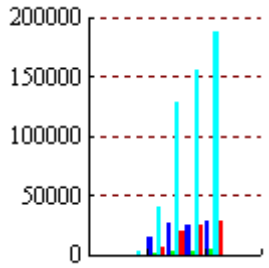
CO_2 FOSSIL FUEL TOTAL EMISSIONS

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ARGENTINA	29948	31527	32449	31257	32905	32554	34375	35647	36108	38676	37715
ARMENIA	0	0	1004	759	778	930	699	883	917	822	958
BRAZIL	55298	58377	58702	61372	64050	68126	75453	78777	82180	82669	83930
CHILE	9643	9166	9580	9739	11238	12064	13762	15850	16430	17062	16239
COLOMBIA	15268	15263	16561	17215	18077	16112	16217	17273	18100	15252	15955
INDONESIA	45224	43471	49453	53879	54857	50861	68776	68946	53490	55908	73572
KAZAKHSTAN	0	0	68967	58423	53716	45184	37829	34910	33368	30753	33099
MEXICO	102435	101285	107946	100826	105902	100235	100058	104995	110933	112659	115713
PAKISTAN	18566	18527	19834	21214	23060	23057	25473	25439	26274	27025	28604
PARAGUAY	617	609	715	804	954	1094	1080	1133	1143	1180	999
POLAND	94865	93912	92571	95583	92093	94572	98606	95260	88434	85747	82245
SLOVENIA	0	0	3361	3443	2959	3799	4004	4177	3978	3936	3986
THAILAND	26130	31671	34586	38874	43161	49483	55239	57221	50743	53316	54216
TRINIDAD AND TOBAGO	4619	5707	5718	4582	5263	5523	5707	5626	5827	6784	7195

ENERGY USE (kt OF OIL EQUIVALENT)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ARGENTINA	45038.59	46421.22	48833.71	48636.68	52493.7	53079.25	54876.53	58042.41	59628.78	61779.16	61469.41
ARMENIA	0	0	4298.48	2260.35	1420.03	1670.51	1790.11	1875.26	1907.93	1845.45	2060.72
BRAZIL	132508.6	134290.4	136393.2	140582.8	147663.7	153496	161789.8	170221.8	175769.8	179904.8	183165
CHILE	13629.62	14106.42	15507.51	15945.71	17201.98	18439.25	20137.33	22092.56	22636.16	25293.84	24403.36
COLOMBIA	25014.24	25254.06	26258.7	27549.03	28510.56	29827.26	30426.72	30398.89	30978.96	28081.1	28785.52
INDONESIA	92815.78	99944.72	102361.6	110789.1	115161.2	123068.9	127275.4	131911.7	131272.4	136666	145574.7
KAZAKHSTAN	0	0	79661.32	65538.92	58271.88	51690.5	44795.3	39467.37	38862.91	35731.87	39063.16
MEXICO	124030	129296.1	132204.2	132423.7	136792.4	132714.1	136807.5	141513.3	147953.7	149908.3	153513.2
PAKISTAN	43424.34	44818.79	47591.87	50068.32	52026.12	54315.47	56799.59	58070.16	59287.47	62618.13	63950.6
PARAGUAY	3088.96	3161.13	3202.21	3292.13	3596.5	3951.31	4232.89	4456.5	4306.65	4140.45	3929.5
POLAND	99846.69	98481.95	97307.95	101312.9	96728.86	99870.25	107480.1	103423.3	97452.64	93481.91	89975.38
SLOVENIA	0	0	5007.75	5302.89	5554.62	5957.9	6266.27	6627.92	6505.37	6394.78	6539.91
THAILAND	43227.47	46457.78	49701.61	52376.89	56209.29	63196.38	68878.78	71199.41	66497.56	70473.88	73618.34
TRINIDAD & TOBAGO	5795.06	5730.31	6319.17	6062.91	5759.88	5779.02	6444.47	6024.07	6955.66	8059.44	8664.78

FOREIGN DIRECT INVESTMENT:
INWARD AND OUTWARD FLOWS AND STOCKS

COUNTRY/GROUP	INDICATOR	
Developed countries	FDI inflows (millions of dollars) FDI outflows (millions of dollars) FDI inward stock (millions of dollars) FDI outward stock (millions of dollars)	
Developing countries	FDI inflows (millions of dollars) FDI outflows (millions of dollars) FDI inward stock (millions of dollars) FDI outward stock (millions of dollars)	
Central and Eastern Europe	FDI inflows (millions of dollars) FDI outflows (millions of dollars) FDI inward stock (millions of dollars) FDI outward stock (millions of dollars)	
LDC	FDI inflows (millions of dollars) FDI outflows (millions of dollars) FDI inward stock (millions of dollars) FDI outward stock (millions of dollars)