

The Environmental Effects of FDI: Evidence from MENA Countries

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Abstract

Empirical work on the environmental effects of FDI has produced a mixed bag of results, with hardly any evidence for MENA countries. A theoretical model is presented, postulating that whether FDI has a positive or negative effect on the environment depends on the position of the underlying country or region on the environmental Kuznets curve. This paper presents results indicating that FDI leads to environmental degradation in MENA countries and that they fall on the rising sector of the EKC. The theoretical model is supported by the empirical results.

Keywords: Foreign Direct Investment, Environmental Degradation, Environmental Kuznets Curve, Pollution Haven Hypothesis, Pollution Halo Hypothesis

JEL Classification: F21, F23, Q56

1. Introduction

Interaction between the environment and foreign direct investment (FDI) flows takes one of two forms. The first is that regulation aimed at combatting environmental degradation may deter FDI as foreign firms may choose destinations where environmental regulation is not stringent. In this case, the effect runs from the environment to FDI. Conversely, FDI may exert a negative or positive effect on the environment. The negative effect arises when a polluting industry relocates to the host country and when foreign firms choose to outsource their polluting operations by using the services of domestic firms. The positive effect arises when foreign firms utilising modern, less-polluting production techniques displace polluting domestic firms and when the latter are forced to use less polluting technology in response to the presence of foreign firms.

From a theoretical perspective, the impact of FDI on the environment can be decomposed into a scale, composition and technique effects. These effects are produced respectively by growth in economic activity, changes in industrial structure, and the implementation of technological innovations to reduce the pollution intensity of output. In general, two conflicting hypotheses describe the effect of FDI on the environment: the pollution haven hypothesis, which predicts a negative impact of FDI on the environment, and the pollution halo hypothesis, which predicts that FDI leads to environmental improvement. Numerous empirical studies have been conducted to find evidence for either hypothesis, producing a mixed bag of results.

While a large amount of work has been done on the determinants of FDI flows in MENA countries, nothing much has been done on the environmental effects of FDI. This is an attempt to fill the gap in the literature where an alternative hypothesis is presented by

introducing the environmental Kuznets curve (EKC). The hypothesis is that whether FDI has a positive or negative effect on FDI depends on the position of the host country on the EKC. It is postulated that if a country falls on the upward-sloping section of the EKC, FDI will have a negative effect on the environment, and vice versa. This hypothesis is derived mathematically, described diagrammatically and tested empirically.

2. Literature Review

The effect of FDI on the environment is frequently examined by using the theoretical model proposed by Antweiler et al. (2001) to decompose the impact of trade openness on the environment into scale, composition, and technique effects. The scale effect of FDI refers to the environmental degradation resulting from growth in economic activity, in which case FDI exerts a negative effect on the environment. The composition effect stems from the possibility that FDI may alter the industrial structure of the host country, which may be positive or negative, depending on which industries gain importance at the expense of others. For example, if non-polluting industries thrive as a result of FDI, the effect on the environment will be positive. The technique effect arises when FDI brings about environmentally-friendly technological innovation, which is conducive to clean production, in which case the effect of FDI on pollution will be negative. The total effect, therefore, may be negative or positive, depending on the balance of the three effects.

In general, two conflicting hypotheses describe the effect of FDI on the environment (Zarsky, 1999; Albornoz et al., 2009; Chung, 2014; Hille, 2018). The first is the pollution haven hypothesis whereby foreign firms may seek to gain a competitive advantage by relocating their dirty production to countries with lower environmental standards, leading to environmental deterioration in the host country. The pollution halo hypothesis, on the other

hand, postulates that foreign enterprises may bring their environmental knowledge and advanced technologies, leading to a clean-up of the environment. This would happen if foreign firms from developed countries are less pollution-intensive than the domestic firms of a developing country.

Several arguments can be put forward to support the proposition that FDI has a positive effect on the environment. First, firms from developed countries (the source of FDI) typically use newer, more energy efficient technology than the domestic firms of host developing countries. Second, foreign firms are typically larger than domestic firms, which means that the former are likely to have better access to the resources needed to undertake a greater degree of research and development and staff training. They are also more likely to adopt environmental management practices and accreditation schemes such as ISO 14001.¹ Third, the production systems used by foreign firms are likely to be compliant with stringent OECD environmental regulation, and as such they are likely to continue to operate these systems in developing countries, particularly if they wish to export to OECD markets.

Among others, Cole et al. (2017) and Shahbaz et al. (2015) provide an overview of the empirical literature. A large variety of methods are used to analyse the FDI-environment relationship, including (but not limited to) input-output models (Jiang et al., 2015), causality testing (Omri et al., 2014), computable general equilibrium models (Hübler, 2011), and variance decomposition (Yang et al., 2008). Some studies examine one country (typically at a regional level) while other studies consider a group of countries.

¹ ISO 14001 is the international standard that specifies requirements for an effective environmental management system. It provides a framework that an organisation can follow, rather than establishing environmental performance requirements.

China in particular has received a lot of attention with respect to this topic. Liang (2006) and He (2006) analyse sulfur dioxide (SO₂) emissions for 260 cities and 29 provinces in China, respectively. Liang (2006) uses a reduced form equation and finds negative correlation between FDI and air pollution over the period 1996-2003, concluding that FDI may be beneficial for the environment. By employing a system of simultaneous equations to estimate the FDI-emission relation, He (2006) reveals that FDI had a very small negative effect on industrial SO₂ emissions between 1994 and 2001. Likewise, He (2008), Bao et al. (2011), and Yang et al. (2013) use simultaneous equation models. He (2008) finds a very small negative effect of FDI whereas Bao et al. (2011) reveal that the environmental impact of FDI varies from one case to another, depending on the pollutant and region. Similar results are found by Yang et al. (2013), who compare the environmental effects of domestic and foreign capital for six different pollution intensities in 25 Chinese provinces between 1992 and 2008.

Elliott et al. (2013) investigate the influence of FDI on the energy intensity of Chinese cities to find that FDI has a negative impact on energy intensity, although this effect varies by region. They argue that regional differences reflect the abilities of regions to absorb and benefit from environmental spillovers. Wang and Chen (2014) also examine the effect of FDI in Chinese cities and consider the role played by institutions. They find that FDI tends to boost SO₂ emissions, which can be mitigated by strong legal and environmental institutions. Another study of China by Lan et al. (2012) shows that the effect of FDI on the environment depends on the technological capabilities of a region, which they capture by using measures of human capital. They find that FDI reduces pollution emissions in provinces with higher levels of human capital.

Some studies have been conducted on a variety of countries, with contrasting results. Kheder (2010), for example, finds mixed effects for French FDI outflows to developed, developing and emerging economies between 1999 and 2003. Using a reduced-form equation, Paziienza (2015) examines the impact of FDI inflows on CO₂ emissions from fuel combustion. For a set of 30 OECD countries, FDI produced a rather small reduction in emissions over the period 1981-2005. Overall, research has produced mixed results when the scale, composition and technique effects of FDI are considered simultaneously. The results in general show that FDI produces either a positive or a rather small negative impact on the environment.

Cole et al. (2017) review the literature on the relation between FDI and the environment, suggesting that the first theoretical contributions to the FDI-environment debate consider the impact of regulatory differences on comparative advantage (for example, Baumol and Oates, 1988; Markusen et al., 1993; Chichilnisky, 1994; Motta and Thisse, 1994). These studies reach the conclusion that capital flows from countries with stringent regulations to those with less stringent regulations, providing support for the pollution haven hypothesis. For example, Baumol and Oates (1988) present a partial-equilibrium two-country model with two sectors that differ in terms of their pollution intensity and demonstrate that the developed country has more stringent regulations and hence a comparative disadvantage in the production of dirty goods, whereas the opposite is true in the developing country. Pearson (1987) considers environmental issues as part of the decision to invest abroad, taking environmental services to be a factor of production alongside labour and capital.

Some papers follow the political economy approach, whereby FDI may influence and be influenced by environmental regulation (for example, Markusen et al., 1995; Hoel, 1997; Kayalica and Lahiri, 2005; Ulph and Valentini, 2001; Cole et al., 2006; De Santis and

Stahler, 2009). It can be demonstrated that environmental differences are generated endogenously when firms seek lower environmental standards or at least to avoid higher standards (for example, Oates and Schwab, 1988; Hillman and Ursprung, 1992, 1993; Rauscher, 1995; Fredriksson, 1997, 1999). The conclusion derived from these papers is that FDI flows from high- to low-regulation countries or regions. Contrary to these theoretical predictions, some empirical studies fail to find conclusive evidence for the pollution haven hypothesis. Supportive evidence is produced by Tang (2015), Xing and Kolstad (2002), Eskeland and Harrison (2003), List and Co (2000), Keller and Levinson (2002), Kheder and Zugravu (2012), Zhang and Fu (2008), and by Millimet and Roy (2015). No evidence is found by Javorcik and Wei (2004), Kahouli et al. (2014), Manderson and Kneller (2012), Rivera and Oh (2013), and by Bu and Wagner (2016). Mixed evidence is found by Bialek and Weichenrieder (2015), Dam and Scholtens (2008), Waldkirch and Gopinath (2008), Dean et al. (2009), Fredriksson et al. (2003), Rezza (2013), and by Kalamova and Johnstone (2012).

Zugravu-Soilita (2017) examines the impact of FDI from France, Germany, Sweden, and the United Kingdom on national emissions of a range of pollutants, concluding that the environmental impact of FDI depends on the host country's environmental regulations, capital endowments, technology gap between foreign and domestic firms, and domestic labour productivity. More specifically, he finds that FDI is associated with a reduction in pollution in countries with relatively low capital-labour ratios and relatively stringent regulation. In contrast, FDI is associated with an increase in pollution in relatively capital-abundant countries with lax regulations. These findings are consistent with the factor endowment hypothesis and the pollution haven hypothesis (Cole and Elliott, 2003; 2005).

Kim and Adilov (2012) also undertake a country-level study of the effects of FDI, this time on CO₂ emissions. They find that FDI into developing countries has the effect of reducing per capita CO₂ emissions, which they interpret as evidence that FDI brings with it advanced, cleaner technology. In contrast, Shahbaz et al. (2015) find that inward FDI has the effect of boosting CO₂ emissions in developing countries, indicating that such results appear to be sensitive to the econometric specification and to the choice of countries and time periods within the sample.

The evidence for MENA countries is sparse. Koçak and Şarkgüneşi (2018) examine the impact of FDI on CO₂ emissions in Turkey by estimating an augmented version of the EKC. Their results indicate the existence of a long-term relation between FDI, economic growth, energy usage, and CO₂ emission, and that the potential impact of FDI on CO₂ emission is positive. Asghari (2013) tests the validity of pollution haven and pollution halo hypotheses by analysing correlation between carbon emissions and FDI inflow of seven MENA countries during the period 1980-2011. The results show that FDI inflows have a weak and statistically significant negative relationship with CO₂ emission, which suggests weak support for the pollution halo hypothesis.

3. A Mathematical Exposition

The starting point is to combine two functional relations representing the effect of FDI on income per capita and the EKC. The final equation shows that FDI may exert a positive or negative effect on the environment, depending on whether the underlying economy is on the rising or falling sector of the EKC.

The literature tells us that FDI is beneficial to the host country, in the sense that it boosts growth. Accordingly, it is assumed that income per capita is positively related to FDI such that

$$y = \alpha_0 + \alpha_1 f \quad (1)$$

where y is income per capita and f is foreign direct investment inflows. Suppose that the relation between environmental degradation, proxied by CO2 emissions, and income per capita follows the environmental Kuznets curve (EKC) such that

$$e = \beta_0 + \beta_1 y - \beta_2 y^2 \quad (2)$$

where e is emissions per capita. For equation (2) to have the inverted U-shaped EKC, the conditions $\beta_2 > 0$ and $\beta_1 > 0$ must be satisfied. By substituting (1) into (2), we obtain

$$e = \beta_0 + \beta_1(\alpha_0 + \alpha_1 f) - \beta_2(\alpha_0 + \alpha_1 f)^2 \quad (3)$$

By expanding and rearranging equation (3), we arrive at the following expression:

$$e = (\beta_0 + \beta_1 \alpha_0 - \beta_2 \alpha_0^2) + (\beta_1 \alpha_1 - 2\beta_2 \alpha_0 \alpha_1) f - \beta_2 \alpha_1^2 f^2 \quad (4)$$

By differentiating equation (4) with respect to f , we have

$$\frac{de}{df} = \beta_1 \alpha_1 - 2\beta_2 \alpha_0 \alpha_1 - 2\beta_2 \alpha_1^2 f \quad (5)$$

The first order condition for a turning point is satisfied when the first derivative is equal to zero, which gives

$$f = \frac{\beta_1 \alpha_1 - 2\beta_2 \alpha_0 \alpha_1}{2\beta_2 \alpha_1^2} \quad (6)$$

The second order condition for a local maximum is satisfied since

$$\frac{d^2 e}{df^2} = -2\beta_2 \alpha_1^2 < 0 \quad (7)$$

Therefore, the effect of FDI on the environment may be positive or negative, depending on the position on the EKC. In the absence of the EKC, equation (2) reduces to

$$e = \beta_0 + \beta_1 y \quad (8)$$

which gives

$$e = \beta_0 + \beta_1(\alpha_0 + \alpha_1 f) \quad (9)$$

where

$$\frac{de}{df} = \beta_1 \alpha_1 > 0 \quad (10)$$

which means that in the absence of the EKC and the presence of a monotonic positive relation between emissions and income per capita, FDI leads to environmental degradation.

The relation between emissions and FDI in the presence of the EKC can be derived diagrammatically as shown in Figure 1. Part 1 of the diagram (top right) represents equation (1), whereas part 2 (top left) is a twisted EKC (y as a function of e rather than e as a function of y). Parts 1 and 2 of the diagram define the same levels of y associated with f and e . Part 3 (bottom left) is a 45-degree line that is used to switch the axes, such that e is measured on the vertical rather than the horizontal axis. The fourth part (bottom right) depicts the relation between emissions and foreign direct investment, which is positively (negatively) sloped for the rising (declining) sector of the EKC.

4. The Empirical Model

The corresponding empirical model contains a stochastic trend that accounts for the effects of the explanatory variables that do not appear explicitly on the right hand-side of the equation. A structural time series model describing the effect of FDI on the environment can be represented by the following equation

$$e_t = \mu_t + \delta_t f_t + \varepsilon_t \quad (11)$$

where e is emissions of some sort as a proxy of environmental degradation and f is a measure of FDI inflows. μ_t and ε_t are the time series components of e_t : μ_t is the trend and ε_t is the random component. If f has any effect on e , the coefficient δ must be statistically significant. The trend, which represents the long-term movement of the dependent variable, is specified as

$$\mu_t = \mu_{t-1} + \phi_{t-1} + \eta_t \quad (12)$$

$$\phi_t = \phi_{t-1} + \zeta_t \quad (13)$$

where $\eta_t \sim NID(0, \sigma_\eta^2)$, and $\zeta_t \sim NID(0, \sigma_\zeta^2)$. The model may also contain a cyclical component but a pre-examination of the data series indicates the absence of cycles.

The model is estimated in a TVP framework using maximum likelihood and the Kalman filter to update the state vector (Harvey, 1989; Koopman et al., 2006). If the coefficient on the explanatory variable turns out to be significant, while the trend is also significant, this means that while the explanatory variable appearing explicitly on the right hand side of the equation is an important determinant of the dependent variable, the effects of other determining variables are embodied in the trend. If the trend is insignificant, then only the explanatory variable determines the dependent variable. And if the coefficient on the explanatory variable is insignificant while the trend is significant, then the dependent variable is determined by variables other than the one appearing explicitly in the equation. The trend reflects the behaviour of the variables affecting emissions that do not appear explicitly as explanatory variables.

The same methodology is used to estimate the EKC as represented by the equation

$$e_t = \mu_t + \gamma_t y_t + \varepsilon_t \quad (14)$$

where the trend is specified as in equations (12) and (13). The empirical results should be interpreted as supporting the theoretical model if $\delta_t > 0$ when $\gamma_t > 0$, and vice versa. This means that if MENA countries fall on the upward-sloping section of the EKC ($\gamma_t > 0$), FDI has a negative effect on the environment as it boosts emissions ($\delta_t > 0$).

5. Data and Empirical Results

Annual data going back to 1990 on CO2 emissions, foreign direct investment inflows and GDP per capita are collected from the World Bank data base. CO2 emissions are measured in metric tons per capita.² FDI is measured in terms of net inflows as a percentage of GDP.³ GDP per capita is measured in current PPP dollars.⁴ The data sample covers the following individual countries: Algeria, Egypt, Iran, Jordan, Morocco, Saudi Arabia, Oman, Turkey, United Arab Emirates, Yemen, Sudan and Tunisia. Combined data have also been collected for MENA (excluding high-income countries) and total MENA. Figure 2 depicts the relation between emissions and income per capita, both measured as period averages for each country. It is quite clear that the two variables are positively related, implying that MENA countries fall on the rising segment of the EKC.

² CO2 emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced by the consumption of solid, liquid, and gas fuels and gas flaring.

³ FDI is measured as the net inflows of investment intended to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series is the ratio to GDP of net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors.

⁴ GDP per capita is converted to international dollars using the exchange rates consistent with purchasing power parity. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

The results of estimating equation (11) are presented in Table 1, which displays the estimated coefficient on the explicit explanatory variable at the end of sample period (t statistic in parentheses), as well as the coefficient of determination, (R^2) and the diagnostics for serial correlation (Q), heteroscedasticity (H) and normality (N). Q is the Ljung-Box statistic, which has a χ^2 distribution and H is a test statistic for heteroscedasticity with an F distribution. N is the test statistic for the normality of the residuals based on skewness and kurtosis. Since we are only interested in the effect of FDI on the environment, estimates of the trend (which represent the effect of other explanatory variables) are not reported.

In all cases the model has a high explanatory power and passes the diagnostics for serial correlation, heteroscedasticity and normality. The coefficient on the explanatory variable (FDI inflows) is significantly positive (implying that FDI leads to environmental deterioration) in all cases, except for the oil exporting countries: Saudi Arabia, Oman and the UAE. This may be explained in terms of the dominance of the oil industry, in which both domestic and foreign firms (government-owned) use similar technologies. In terms of the magnitude of effect of FDI inflows on CO2 emissions, a comparison can be found in Figure 3, which is a plot of the coefficient on the explanatory variable (δ_t). The magnitudes of the effect of FDI on emissions are quite close, ranging between 0.00023 for Jordan and 0.00009 for Sudan. This means that for each percentage point rise in the FDI/GDP ratio, emissions rise by 0.00023 metric tons per capita in Jordan and by 0.00009 metric tons per capita in Sudan.

The results of estimating equation (14) are presented in Table 2. In each case CO2 emissions are positively related to income per capita as the coefficient γ_t is significantly positive in all cases, implying that the countries fall on the positively-sloped section of the EKC. The

magnitudes of the effect of income on emissions are also quite close, ranging between 1.353 for Tunisia and 1.086 for Yemen. This means that for each dollar rise in income per capita, emissions rise by 1.353 metric tons per capita in Tunisia and by 1.086 metric ton per capita in Yemen. The empirical results, therefore, support the theoretical model.

6. Concluding Remarks

FDI may have a positive or negative effect on the environment in the host country. A positive effect arises if the foreign firms providing FDI flows use less-polluting production techniques, which may also force domestic firms to use less polluting technology in response to the presence of foreign firms. The negative effect arises when a polluting industry relocates and when foreign firms choose to outsource their polluting operations by using the services of domestic firms. The net effect of FDI on the environment is determined by the relative weights of the scale, composition, and technique effects of FDI.

While an extensive amount of work has been carried out to find evidence on the pollution haven and halo hypotheses, this work has produced a mixed bag of results. Hardly any work exists that examines this issue for MENA countries. This paper presents results indicating that FDI leads to environmental degradation in MENA countries. The theoretical model predicts that this can only be the case if the underlying country falls on the rising sector of the EKC. The empirical results show that this is the case.

The results do not only fill a gap in the literature, but they also provide policy implications. Countries all around the world strive to attract FDI, most likely without any consideration of the environmental consequences of FDI. If the results show that a country is on the declining sector of the EKC, such that FDI has a positive effect on the environment, then there is no

need to worry about the environmental consequences of FDI. The case for MENA countries is the opposite, which means that environmental considerations should not be overlooked by pursuing pro-growth policies through FDI.

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Table 1: Model Estimation Results (Equation 11)

Country	δ_i	R^2	Q	H	N
Algeria	0.00023 (3.07)	0.89	3.11	0.15	5.12
Egypt	0.00017 3.39	0.73	6.10	0.21	2.71
Iran	0.00026 (2.90)	0.23	1.04	0.31	3.62
Jordan	0.00036 (5.75)	0.96	12.83	0.34	2.50
Morocco	0.00020 (4.29)	0.86	9.35	0.23	1.20
Saudi Arabia	0.00021 (1.65)	0.29	1.69	0.21	2.01
Oman	0.00014 (1.51)	0.64	14.09	4.69	0.22
Turkey	0.00022 (7.39)	0.97	3.25	0.48	0.02
United Arab Emirates	0.00020 (1.23)	0.08	2.29	0.10	14.20
Yemen	0.00019 (2.87)	0.48	7.34	0.68	0.81
Sudan	0.00009 (2.35)	0.47	1.30	7.30	0.02
Tunisia	0.00022 (4.85)	0.94	5.41	0.11	12.04
MENA (excluding high-income)	0.00023 (6.40)	0.93	5.18	0.12	1.02
MENA	0.00023 (6.27)	0.91	3.93	0.25	0.57

The t statistics are placed in parentheses underneath the estimated coefficients. The Q , H and N statistics are distributed as $\chi^2(1)$, $F(7,7)$ and $\chi^2(2)$, respectively.

Table 2: Model Estimation Results (Equation 14)

Country	γ_i	R^2	Q	H	N
Algeria	1.270 (48.67)	0.99	2.50	1.73	9.97
Egypt	1.227 (24.47)	0.99	0.36	6.54	3.63
Iran	1.264 (30.56)	0.98	5.15	2.59	1.55
Jordan	1.214 (17.55)	0.99	1.21	3.14	0.93
Morocco	1.165 (20.29)	0.99	0.97	2.07	0.29
Saudi Arabia	1.177 (28.73)	0.99	3.25	1.81	1.16
Oman	1.103 (32.75)	0.99	4.80	1.02	1.06
Turkey	1.146 (4.51)	0.99	3.22	3.09	3.78
United Arab Emirates	1.171 (28.02)	0.98	0.46	3.75	0.72
Yemen	1.086 (21.67)	0.97	3.70	2.73	7.22
Sudan	1.296 (22.55)	0.99	3.01	0.51	0.50
Tunisia	1.353 (31.31)	0.99	0.62	2.03	2.09
MENA (excluding high-income)	1.267 (24.21)	0.99	1.10	2.68	0.09
MENA	1.254 (25.09)	0.99	0.95	1.63	1.53

The t statistics are placed in parentheses underneath the estimated coefficients. The Q , H and N statistics are distributed as $\chi^2(1)$, $F(7,7)$ and $\chi^2(2)$, respectively.

Figure 1: Diagrammatic Derivation of the Emissions-FDI Relation

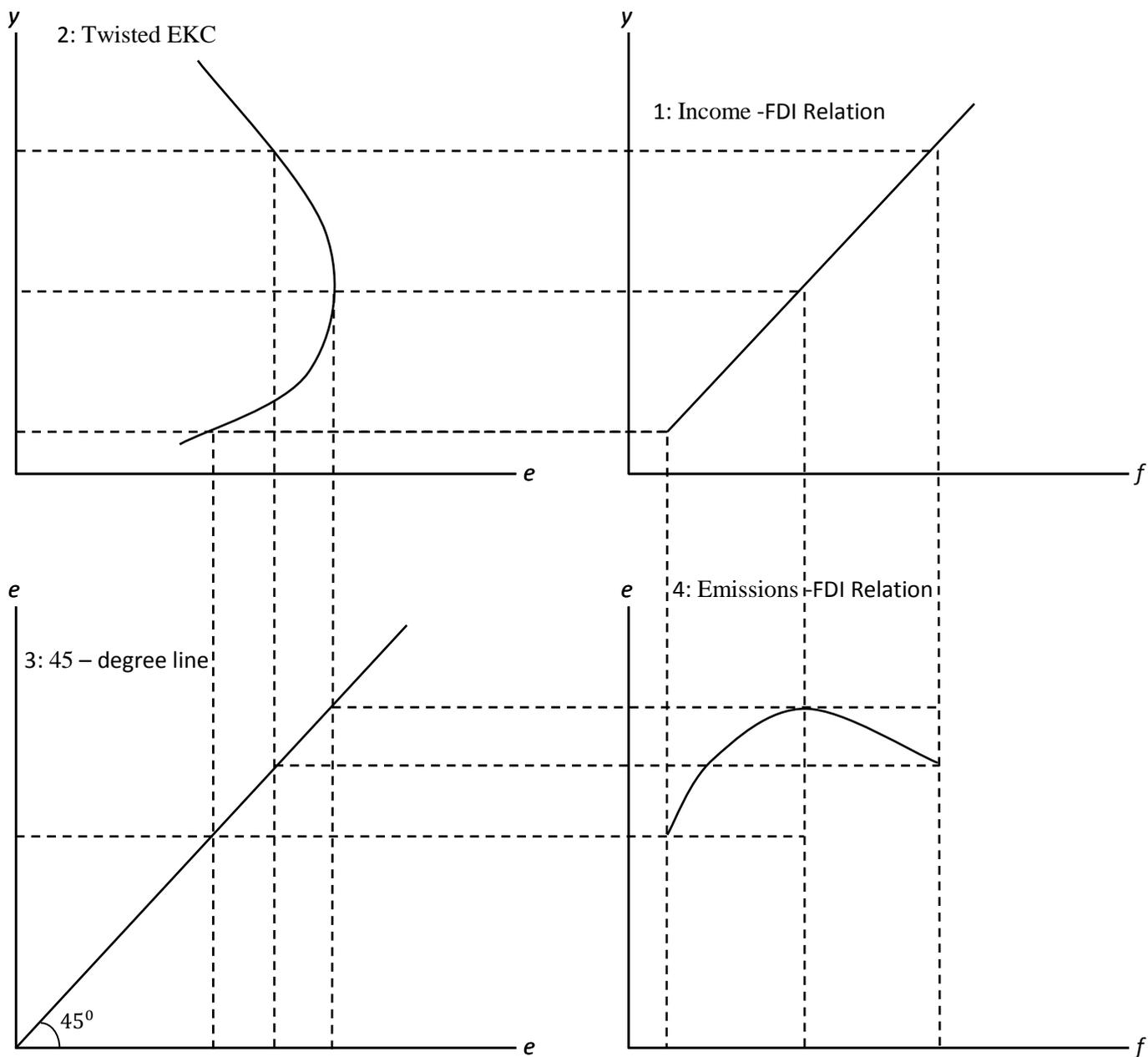


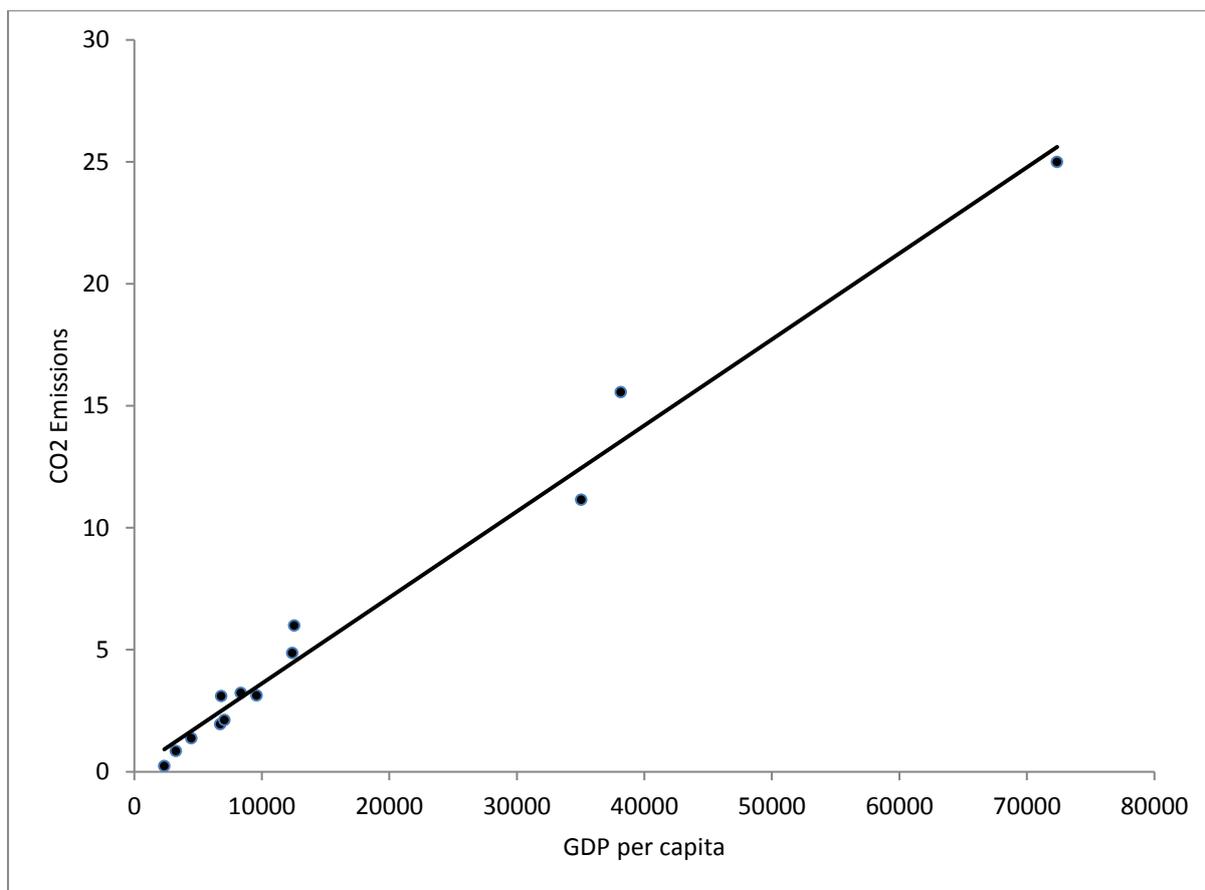
Figure 2: Emissions as a Function of GDP per capita (averages over the sample period)

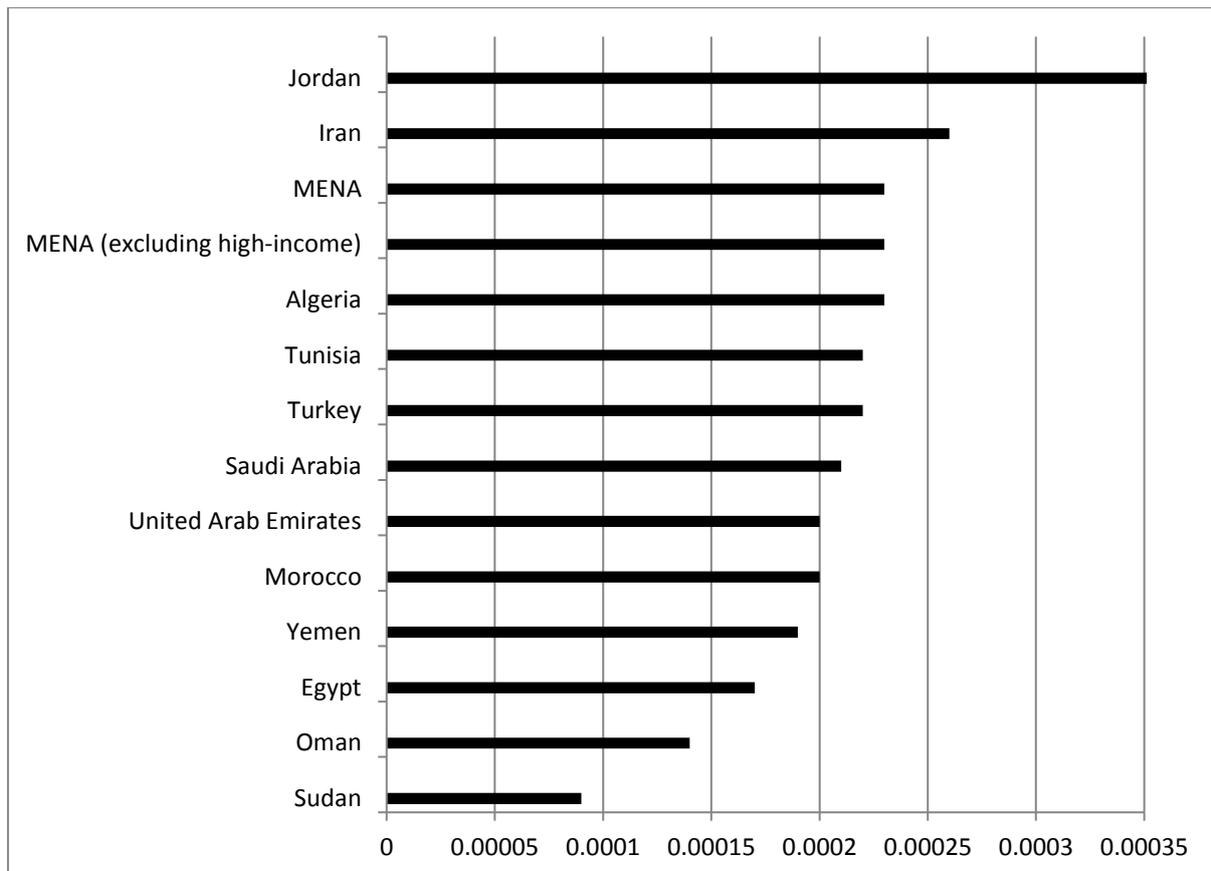
Figure 3: Magnitude of the Effect of FDI on CO2 Emissions

Figure 4: Magnitude of the Effect of Income on CO2 Emissions