A Dynamic Approach to the FDI-Environment Nexus: The Case of China and India

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An autoregressive distributed lag (ARDL) model is applied to examine the short- and long-run relationships among foreign direct investment (FDI), economic growth, and the environment in China and India. We find that, for China, FDI tends to deteriorate environmental quality in both the short- and long-run. For India, on the other hand, FDI is found to have a detrimental effect on the environment in the short-run, but has little effect in the long-run. Finally, it is found that income growth in both countries tends to worsen the environment in both short- and long-run.

Keywords: China, Environment, Foreign direct investment, India, Time-series analysis
JEL: F18, Q56, C22

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본 연구는 자기회귀시차분포모델을 적용하여 중국 및 인도의 외국인 직접투자, 경제성장, 환경간의 장기 및 단기적 관계를 분석하는 데 그 목적이 있다. 실증연구 결과에 따르면, 중국의 경우 외국인직접투자의 유치가 장기 및 단기적으로 환경에 부정적인 영향을 미친 것으로 나타난 반면, 인도의 경우는 외국인직접투자의 증가가 환경을 단기적으로 악화시킨 것으로 나타났다. 끝으로, 경제발전 추구를 통해 양국은 장기 및 단기적으로 환경이 악화된 것으로 나타났다.

핵심용어: 중국, 환경, 외국인직접투자, 인도, 시계열분석
JEL 분류: F18, Q56, C22
I. Introduction

Since the beginning of economic reforms and opening up to the outside world in the late 1970s and the early 1980s, China and India have been the fastest growing economies in the world. Between 1992 and 2007, for example, the Chinese and Indian economies have grown on average by approximately 10% and 7% annually (Figure 1). During the same period, foreign direct investment (FDI) inflows to the two countries have grown rapidly. For example,
the average annual inflows of FDI into China and India have reached $60.4 billion and $9.4 billion between 2000 and 2007, respectively, more than double the amount for the 1992-1999 period (Table 1). As a result, China and India have become the largest and the seventh-largest FDI recipients (in terms of annual FDI inflows) among developing countries during the 2000-2007 period. However, the unprecedented economic growth in both countries over a period of almost three decades has been accompanied by problems of environmental pollution. Between 1980 and 2007, for example, carbon dioxide (CO₂) emissions in both China and India have increased by more than 300% (Figure 1). Although some improvement achieved in the late 1990s due to reinforcement of pollution control policies, China has overtaken the United States as the world’s largest emitter of CO₂ since 2006. The primary objective of this paper is to examine the dynamic relationship between the inflow of FDI and environmental quality in China and India.

A plethora of studies has been conducted to deal with the economics of FDI

|                | 1992-1999 Average        | 2000-2007 Average       |
|----------------|--------------------------|-------------------------|
|                | Inward FDI (Million $)   | Share (%)               |
| China          | 35,322                   | 25.5                    |
| Hong Kong      | 10,754                   | 7.8                     |
| Mexico         | 9,710                    | 7.0                     |
| Brazil         | 12,141                   | 8.8                     |
| Singapore      | 9,288                    | 6.7                     |
| Russia         | 2,330                    | 1.7                     |
| India          | 1,857                    | 1.3                     |
| Chile          | 3,873                    | 2.8                     |
| Thailand       | 3,400                    | 2.5                     |
| Korea          | 2,846                    | 2.1                     |
| Sub Total      | 91,519                   | 66.2                    |
| Total          | 138,301                  | 100.0                   |
|                | 60,389                   | 20.7                    |
|                | 35,201                   | 12.1                    |
|                | 21,864                   | 7.5                     |
|                | 21,074                   | 7.2                     |
|                | 16,701                   | 5.7                     |
|                | 16,259                   | 5.6                     |
|                | 9,375                    | 3.2                     |
|                | 6,486                    | 2.2                     |
|                | 6,184                    | 2.1                     |
|                | 5,554                    | 1.9                     |
|                | 199,087                  | 68.2                    |
|                | 291,852                  | 100.0                   |

Note: Total means the sum of inflow FDI in developing economies. Share indicates % shares of each country’s inward FDI in developing economies total FDI.
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in developing countries over the last three decades. *Theoretical* research in this area can be classified roughly into two categories. The first category includes studies that have provided the theoretical rationale for the effect of FDI inflows on economic growth, which is known as the *FDI-growth nexus* (e.g., Romer 1986; Lucas 1988; Rebelo 1991; Helpman and Grossman 1991). For example, the modern endogenous growth theory shows that long-term economic growth of the economy can result from more open and liberal government policies conducive to FDI inflows. More specifically, if capital is regarded as knowledge rather than simply something like plant and equipment, then the inflow of foreign capital can itself result in technological change and spillovers of ideas across countries (Grossman and Helpman 1991). With capital exhibiting such increasing returns to scale, changes in FDI inflows can be an important vehicle for long-term economic growth in developing countries. The second category includes studies that have attempted to relate theoretical considerations to the impact of FDI on the environment in developing countries, which is referred to as the *FDI-environment nexus* (e.g., Pethig 1976; Copeland and Taylor 1994 and 1995; Porter and van der Linde 1995). For example, recent developments in the literature on pollution haven hypothesis show that under the circumstances of globalization, industrialized countries tend to move pollution-intensive industries to developing countries with weaker regulations to avoid costly pollution control compliance expenditures in their home countries (Copeland and Taylor 2003).

Until recently, on the other hand, *empirical* studies have mostly concentrated on the *FDI-growth nexus* in developing countries (e.g., Tsai 1991; Wang and Swain 1997; Liu *et al.* 1997; Sun and Parikh 2001; Bende-Nabende *et al.* 2001; Liu *et al.* 2002; Shan 2002; Chakraborty and Basu 2002; Yao 2006; Chang 2007). For example, Wang and Swain (1997) employ a single equation model (i.e., ordinary least squares) to analyze factors affecting foreign capital inflows into China and Hungary; they show a positive relation between changes in the level of GDP and the inflow of FDI for those countries. Sun and Parikh (2001) use a structural model (i.e., three least squares) to examine the relationship
between inward FDI, exports and economic growth in China; they find that an increase in FDI (and exports) has a positive and significant impact on Chinese economic growth. Chakraborty and Basu (2002) adopt a non-structural time series model (i.e., vector error-correction) to explore the dynamic interaction between FDI and economic growth in India; they discover evidence that GDP has a significant positive effect on inflows of FDI for the Indian economy in both short- and long-run.

Empirical analyses of the FDI-environment nexus in developing countries have received little attention. To the best of our knowledge, Smarzynska and Wei (2001), Xing and Kolstad (2002), Eskeland and Harrison (2003), and He (2006) are the only four empirical studies that have attempted to address this issue. For example, Xing and Kolstad (2002) examine the effect of the U.S. FDI on environmental quality in both developed and developing countries; they find that developing countries tend to utilize lenient environmental regulations as a strategy to attract dirty industries from developed countries, thereby worsening their environmental problems. He (2006) explore the relationship between FDI and the environment in China; he discover evidence that an increase in FDI inflow results in deterioration of environmental quality. In these studies, however, the emphasis has typically been on the use of a static structural model; few studies thus consider dynamic movements of FDI (and economic growth) and environmental quality in a time-series dynamic modeling framework. In other words, despite the time-series properties of datasets on measures of economic activity such as FDI and GDP, and corresponding environmental change, dynamic interrelationships between FDI and environmental quality have been neglected. Furthermore, even though the short-run effects of FDI inflow on environmental quality is likely to be different from the long-run effect, hardly any effort has been made to incorporate both the short- and long-run dynamics in a model. As such, no study has examined how short-run dynamics affects the stability of a long-run relationship and what new equilibrium levels could be obtained given policy shifts.

The contribution of this study, therefore, is to examine the FDI
inflow-environment nexus within a dynamic time-series framework. For this purpose, we assess the short- and long-run relationships among FDI, carbon dioxide (CO₂) emissions and GDP in China and India using an autoregressive distributed lag (ARDL) approach to cointegration (Pesaran et al. 2001). This approach is being used for several reasons. First, ARDL is a convenient tool for estimating both the short- and long-run parameters of the model simultaneously, since an error-correction model (ECM) can be easily derived from the ARDL model through a simple linear transformation. Second, the ARDL approach is more robust and performs better for small sample size than other cointegration techniques (e.g., Engle and Granger 1987; Johansen 1988). Finally, since the ARDL model is applicable irrespective of the whether the underlying regressors are $I(0)$ or $I(1)$, it does not require the same order of integration among variables and thus pre-testing for unit roots. This analysis will shed new light on dynamic interrelationships among FDI inflows, economic growth and the environment, and contribute to the empirical literature on FDI-environment nexus. The remaining sections present the model, data, empirical findings, and conclusions.

II. The model

In examining the dynamic linkages among foreign direct investment and economic growth and the environment, following the previous literature on the FDI-environment nexus (i.e., Smarzynska and Wei 2001; He 2006), the reduced-form equation for pollution emissions ($E$) can be specified as a function of the inflow of foreign direct investment ($FDI$) and economic growth ($GDP$) as follows:

$$E = E(GDP, FDI)$$  \hspace{1cm} (1)
In general, the relationship between pollution levels and GDP is expected to be positive, indicating that an increase in the scale of economic activity through income growth necessarily brings about a proportionate increase in pollution ($\frac{\partial E}{\partial GDP} > 0$). Defining environmental quality as a normal good, however, it is further hypothesized that pollution emissions decrease as rising income passes beyond a threshold level ($\frac{\partial E}{\partial GDP} < 0$). Economists call this relationship the Environmental Kuznets Curve (EKC) (Grossman and Krueger 1991 and 1993). On the other hand, the relationship between pollution levels and FDI in developing countries is ambiguous and uncertain. More specifically, if pollution-intensive foreign capital tend to move to developing countries with weaker regulations, then the inflow of FDI causes environmental quality to deteriorate ($\frac{\partial E}{\partial FDI} > 0$). By contrast, if developing countries rely on technology transfer through FDI from developed countries as a primary means of technology acquisition, the inflow of FDI tends to enforce environmental regulations via economic growth, thereby improving environmental quality ($\frac{\partial E}{\partial FDI} < 0$). As a result, the effect of FDI inflow on the environment is essentially an empirical question and could be different according to circumstances such as individual countries’ stages of development and environmental regulations.

To illustrate the ARDL modeling approach, we then express equation (1) in a log linear form as follows:

$$\ln E_{it} = \alpha + \beta_1 \ln FDI_{it} + \beta_2 \ln GDP_{it} + \varepsilon_{it}$$  \hspace{1cm} (2)

where $E$ denotes the measure of pollution emissions defined as carbon dioxide (CO$_2$); $FDI$ is the inflow of FDI; $GDP$ is the real income; and $\varepsilon_{it}$ represents the error-term. Subscripts $i$ and $t$ indicate country ($i=$China and India) and year, respectively. As noted earlier, the effects of changes in FDI inflows and income on environmental quality are ambiguous. For example, $\beta_i$ can be positive (negative), implying that pollution levels increase (decrease).
with increased FDI inflows. Similarly, if $\beta_2$ is positive (negative), this suggests that income growth causes an increase (decrease) in pollution levels; in other words, since income in individual countries such as China and India have not moved (have moved) beyond the EKC curve turning points, these countries tend to follow a pattern of rising (declining) pollution levels with growing income.

Equation (2) is then reformulated as the error-correction version of the ARDL model developed by Pesaran et al. (2001):

$$\Delta \ln E_{it} = \alpha + \sum_{k=1}^{p} \varepsilon_k \Delta \ln E_{i,t-k} + \sum_{k=1}^{p} \phi_k \Delta \ln FDI_{i,t-k} + \sum_{k=1}^{p} \phi_k \Delta \ln GDP_{i,t-k}$$

$$+ \lambda_1 \ln E_{i,t-1} + \lambda_2 \ln FDI_{i,t-1} + \lambda_3 \ln GDP_{i,t-1} + \varepsilon_t$$

(3)

where $\Delta$ is the difference operator; and $p$ is lag order. Equation (3) is called the error-correction version of the ARDL, since the linear combination of lagged variables (terms with $\lambda$s) replaces the lagged error-correction term ($\varepsilon_{c,-1}$) in a standard error-correction model. Note that Equation (3) is different from a standard VAR model in that a linear combination of lagged-level variables are used as proxy for lagged error-correction terms, which is used to confirm the existence of the long-run relationship. Hence, $\lambda$s represents the long-run (cointegration) relationship, while the coefficients following the summation signs ($\Sigma$) correspond to the short-run relationship between $CO_2$ emissions and its determinants (e.g., $FDI_i$ and $GDP_i$). Another advantage of this approach is that it has been proven to have superior small sample properties (Pesaran and Shin 1998; Panopoulou and Pittis 2004), which makes it a good choice for our sample of about 30 annual observations than other cointegration methods (e.g., Engle and Granger 1987; Johansen 1988).

Estimating equation (3) starts with the determination of the existence of a long-run cointegrated relationship among the variables. For this purpose, we test the null hypothesis of non-existence of a long-run relationship, namely
$H_0: \lambda_1 = \lambda_2 = \lambda_3 = 0$ in equation (3). This can be done by using an $F$-test with a pair of critical values that have been tabulated by Pesaran et al. (2001) with a series of Monte Carlo studies. If the $F$-statistic is above the upper critical value, which corresponds to all variables being $I(1)$, the null hypothesis of no long-run relationship can be rejected, indicating cointegration of the variables. If the $F$-statistic is below the lower critical value, which corresponds to all variables being $I(0)$, the null hypothesis cannot be rejected, showing lack of cointegration. Finally, if the $F$-statistic falls between the lower and upper critical values, the result is inconclusive. In this case, following Kremers et al. (1992) and Banerjee et al. (1998), the error-correction term ($\epsilon_{t-1}$) in the ARDL model can be used to establish cointegration. Thus, if the coefficient is negative and significant, this indicates that the variables are moving together toward equilibrium and there exists a long-run relationship among them.

After determining existence of the level relationship, the selected ARDL model is used to estimate the long-run coefficients and error-correction model. More specifically, the long-run model can be estimated from the reduced-form solution of equation (3), when the first-differenced variables jointly equal zero. The error-correction model is estimated by the ARDL approach. For this purpose, a general-to-specific modeling approach guided by the Akaike information criterion (AIC) is used to select the optimal lag structure of the ARDL specification.

### III. Data

Annual time-series data on carbon dioxide (CO$_2$) emission, GDP and inward foreign direct investment (FDI) are collected for China over the period 1980-2007 and for India over the period 1978-2007, respectively. The carbon emissions (measured in thousand tons) for China and India are obtained from a large database constructed by the Carbon Dioxide Information Analysis
Center, which is the primary climate-change data and information analysis center of the U.S. Department of Energy (DOE). The real GDP of China and India is measured as the real GDP index (2000=100) and is taken from the International Financial Statistics (IFS) Online Service provided by the International Monetary Fund (IMF). The values of FDI for China and India are measured as the inward FDI flows (measured in million U.S. dollars) and are obtained from the World Investment Report (WIR) provided by the United Nations Conference on Trade and Development (UNCTAD) GlobStat Database. The inward FDI flows are deflated using the GDP deflators (2000=100) obtained from the IFS. Finally, all variables are in natural logarithms.

IV. Empirical results

The ARDL modeling starts with the determination of the lag length \( p \) of each first difference variable in equation (3). For this purpose, we use the Akaike information criterion (AIC) and Lagrange multiplier (LM) statistics for testing the hypothesis of no serial correlation against lag length 1. With the selected lag lengths, we then test the existence of a long-run cointegrated relationship among the variables. More specifically, the null hypothesis of no long-run relationship (that is, \( H_0 : \lambda_1 = \lambda_2 = \lambda_3 = 0 \) ) in equation (3) is tested using an \( F \)-test with the critical value tabulated by Pesaran et al. (2001). The results show that with two lags \( p = 2 \) for China, the calculated \( F \)-statistic is 4.43 and lies outside the upper critical value 4.14 at the 10% level (Table 2). As a result, the null hypothesis of no cointegration can be rejected, indicating the existence of a stable long-run relationship among CO\(_2\) emissions, GDP and FDI. The LM statistic shows that the null of no serial correlation cannot be rejected at the 10% level, supporting the choice of \( p = 2 \) for this model.

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2) With two regressors and unrestricted intercept and no trend, \( F \)-statistic for 10% critical value bounds is (3.17, 4.14), which is taken from Table CI in Pesaran et al. (2001).
Table 2. Results of ARDL bound tests for cointegration

|                | China | India |
|----------------|-------|-------|
| AIC Lags       | 2     | 5     |
| $\chi^2_{SC}(1)$ | 0.03  | 1.07  |
| F-statistic    | 4.43  | 5.23  |
| Decision       | Cointegration | Cointegration |

Note: A lag order is selected based on Akaike information criterion (AIC). $\chi^2_{SC}(1)$ is LM statistics for testing no serial correlation against lag order 1. $F$-statistic for 10% critical value bounds is (3.17, 4.14), which is taken from Table CI in Pesaran et al. (2001).

Similarly, with five lags for India, the test statistic is 5.23, which is well above the upper value of the 10% level. Combined with the LM statistic, this result also supports the existence of cointegration among the variables for India.

It should be noted that for completeness, following Pesaran and Pesaran (1997), we also consider the significance of the lagged level variables in equation (3) explaining $\Delta \ln FDI$, and $\Delta \ln GDP$. More specifically, we change $\Delta \ln E_t$ (the dependent variable) in equation (3) to $\Delta \ln FDI$, and $\Delta \ln GDP$, namely F(FDI|E, GDP) and F(GDP|E, FDI), and compute the $F$-statistics for the joint significance of $E_{t-1}$, $FDI_{t-1}$ and $GDP_{t-1}$ in these new regressions. In the case of China (India), for example, the calculated $F$-statistics for F(FDI|E, GDP) and F(GDP|E, FDI) are 1.99 (1.13) and 0.36 (0.58), respectively, which fall well below the lower critical value 3.17 at the 10% level and the null of no cointegration cannot be rejected. Hence, the results suggest that, for both cases, there exists a long-run relationship between $E_t$, $FDI_t$, and $GDP_t$, and that the variables $FDI_t$ and $GDP_t$ can be treated as the “long-run forcing” variables for the explanation of $E_t$.

Having found the existence of the long-run relationship, we then shift to the second stage to estimate long-run coefficients and the error-correction model. The long-run model is estimated from the reduced-form solution of equation (3) in which the first-differenced variables jointly equal zero. The results of the
Table 3. Estimated long-run coefficients using the ARDL bound tests

| Variable | China    | India    |
|----------|----------|----------|
| $F_{DI}$ | 0.19     | -0.13    |
|          | (3.46)** | (-1.22)  |
| $GDP_t$  | 0.81     | 1.15     |
|          | (5.13)** | (3.69)** |
| Constant | 11.98    | 8.53     |
|          | (37.41)**| (11.47)**|

Note: ** denotes significance at the 5% level. $t$ values are given in parentheses.

long-run coefficient estimates for China and India show that all variables except India’s FDI are statistically significant at the 5% level (Table 3). In the case of China, CO2 emissions have a positive long-run relationship with FDI; as the inflow of FDI increases by 1%, for example, CO2 emissions increase by approximately 0.19%. This implies that an increase in FDI inflow results in deterioration of environmental quality in China. This finding can be interpreted to provide indirect support to the pollution haven hypothesis; that is, China, as a developing country, tends to utilize lenient environment regulations in a strategy to attract multinational corporations, particularly those engaged in highly polluting activities from developed countries. In the case of India, on the other hand, FDI is found to be statistically insignificant even at the 10% level, indicating that the flow of FDI has little effect on environmental quality in India. One of possible explanations for this finding is that, although FDI inflows to India have shown a steep increase over the past decades (Table 1), FDI still represents a very small proportion of GDP (less than 1%) as compared to other developing countries, particularly China, and does not seem to play a significant role in catalyzing environmental degradation. In addition, CO2 emissions have a positive long-run relationship with GDP in the two countries; as the economy grows by 1%, for example, CO2 emissions in China (India) increase by 0.81% (1.15%). This indicates that rapid economic growth in China and India has a detrimental effect on environmental quality. This finding further suggests that both China and India may have not been reached income levels
Figure 2. Plots of per capita CO₂ emissions and per capita income for China and India

(a) China

(b) India

high enough to be able to reach the EKC turning points (threshold levels) in a development trajectory; thus, economic growth leads to an increase in the scale of economic activity and, consequently, worse environmental quality (Figure 2).

The error-correction model is estimated by the ARDL approach to capture the short-run dynamics that may exist between the CO₂ emission and its main determinants in China and India (Table 4). The results show that, for both
Table 4. Estimated short-run coefficients using the ARDL bound tests

| Variable       | China       | India       |
|----------------|-------------|-------------|
| $\Delta E_{t-1}$ | 0.58 (3.46)** | -0.34 (-1.60) |
| $\Delta E_{t-2}$ | -0.14 (-0.71) | 0.29 (1.12) |
| $\Delta E_{t-3}$ | 0.22 (1.12) | 0.29 (1.12) |
| $\Delta E_{t-4}$ | 0.29 (1.32) | 0.29 (1.32) |
| $\Delta FDI_t$  | 0.05 (2.63)** | 0.04 (0.06) |
| $\Delta FDI_{t-1}$ | 0.02 (2.55)** | 0.02 (2.55)** |
| $\Delta FDI_{t-2}$ | 0.02 (2.78)** | 0.01 (2.78)** |
| $\Delta FDI_{t-3}$ | 0.01 (2.34)** | 0.01 (2.34)** |
| $\Delta FDI_{t-4}$ | 0.01 (2.62)** | 0.01 (2.62)** |
| $\Delta GDP_t$  | 0.76 (2.84)** | 0.20 (3.10)** |
| Constant        | 2.91 (2.71)** | 2.91 (2.71)** |
| $ec_{t-1}$      | -0.24 (-2.63)** | -0.17 (-3.01)** |

Serial correlation | 0.03 [0.86] | 1.07 [0.30] |
Heteroskedasticity | 1.59 [0.21] | 1.90 [0.17] |
Normality          | 0.13 [0.94] | 1.32 [0.52] |
RESET              | 0.01 [0.96] | 0.14 [0.91] |
CUSUM              | Stable      | Stable      |
CUSUMSQ            | Stable      | Stable      |

Note: ** and * denote significance at the 5% and 10% levels, respectively. Parentheses are t-statistics. Brackets in diagnostic tests are p-values.
China and India, income growth is statistically significant at the 5% level and has a positive relationship with CO₂ emissions. This indicates that, as seen in the long-run results, pollution levels increase with higher income levels in the two countries in the short-run. In addition, unlike the long-run results, the FDI inflows to both China and India are also found to be statistically significant at the 5% level, indicating that FDI has detrimental effects on the environment in the short-run.

It is worth mentioning that the error-correction terms ($ec_{t-1}$) for China and India are negative and significant at the 5% significance level (Table 4). More specifically, the negative coefficients of $ec_{t-1}$ ensure that the long-run equilibrium can be achieved. The absolute value of $ec_{t-1}$ indicates the speed of adjustment to equilibrium. As such, the results indicate that, with shock to the Chinese and Indian economies, CO₂ emission equations tend to recover to their long-run equilibrium position. However, the adjustment toward equilibrium is not instantaneous. For example, the coefficients of $ec_{t-1}$ in China and India are -0.24 and -0.17, respectively, suggesting that approximately 17%-24% of the adjustment occurs in a year for both countries.

Finally, the diagnostic tests on the short-run models as a system indicate no serious problems with serial correlation, heteroskedasticity, normality, and functional form specification (Table 4). For completeness, we examine the stability of the long-run parameters together with the short-run movements for the model. For this purpose, we employ the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests to the residuals of the ECM model (equation (3)). The results show that the estimated coefficients are stable over the sample period (Table 4).

V. Concluding remarks

In this paper, we examine the dynamic interrelationships among FDI,
economic growth and environmental quality in China and India. Although the empirical literature on the FDI-environment nexus exists, relatively little attention has been paid to the dynamic effects of FDI and income on the environment in the framework of dynamic time-series modeling. Hence, this study has attempted to assess the short- and long-run relationships among FDI, economic growth (measured by GDP) and environmental quality (measured by CO₂ emissions) using the ARDL approach.

We find a significant positive relationship between CO₂ emissions and FDI for China in both the short- and long-run; that is, an increase in FDI flows into China results in the deterioration of environmental quality, providing indirect evidence of the pollution haven hypothesis. For India, on the other hand, the inflow of FDI is found to have a detrimental effect on the environment in the short-run, but has little impact in the long-run. Finally, a positive relationship is found between CO₂ emissions and GDP for both China and India; that is, an increase in the level of income leads to worsening of environmental quality through an increase in the scale of economic activity.

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백정호(白正鎬)

현재 알래스카 대학(University of Alaska Fairbanks) 경제학과 조교수로 재직 중이다. 1991년 한양대학교 경제학과를 졸업하고, 1993년 고려대학교 경제학 석사 학위, 2004년 미시간주립대학(Michigan State University)에서 자원경제학 박사를 취득하였다. 1996년부터 1999년까지 대외경제정책연구원의 아시아실과 무역정책실에서 전문연구원으로 근무하였으며, 2004년부터 2009년 8월까지는 노스다코타 주립대학 부설 농업정책 및 국제무역 센터에서 연구교수를 지냈다. 국제상품 및 정책, 환경 및 무역연계, 에너지 분야에 대한 실증연구를 수행하고 있다. 2004년 이후 지금까지 “U.S-Canada Softwood Lumber Trade: Measuring the Market and Welfare Impacts of Restrictions”, Forest Science (2006), “Dynamics Interrelationships between the U.S. Agricultural Trade Balance and Macroeconomy,” Journal of Agricultural and Applied Economics (2007), “The Environmental Consequences of Trade Liberalization: A Country-Specific Time-Series Analysis,” Ecological Economics (2009), “Assessing Exchange Rate Sensitivity of U.S. Bilateral Agricultural Trade,” Canadian Journal of Agricultural Economics (2009) 등 총 15편의 논문이 국제학술지에 게재되어 있다.

구원회(具元會)

현재 노스다코타주립대학(North Dakota State University) 농업 및 응용경제학과 석좌교수 및 부설 농업정책 및 국제무역 센터의 소장으로 재직 중이다. 아이와 주립대학(Iowa State University)에서 경제학박사 학위를 취득하고, 몬태나주립대학(Montana State University)에서 부교수를 역임하였다. 2006년에는 풀 브라이트 재단의 지원으로 고려대학교 식품자원경제학과에서 강의 및 연구를 수행하기도 하였다. 국제무역, 농업관련 정책 및 무역, 환경 등이 주요 연구분야이다. 지금까지 총 130여개의 학술지 논문과 250여개의 연구보고서를 출간하였으며, 미국 경제학과 및 응용경제학과에서 널리 사용되는 “국제경제학(International Trade and Agriculture)” 교과서의 저자이기도 하다. 전미농업 및 응용경제학 협회(Agricultural and Applied Economics Association)에서 수여하는 최우수 연구논문상 (Outstanding Research Award), 미서부 농업 및 응용경제학협회에서 수여하는 최우수 논문상 (Outstanding Published Research Award), 노스다코타주립대에서 수여한 최우수 연구상 등 다수의 수상경력이 있다.