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## How does foreign direct investment really affect developing countries' growth?

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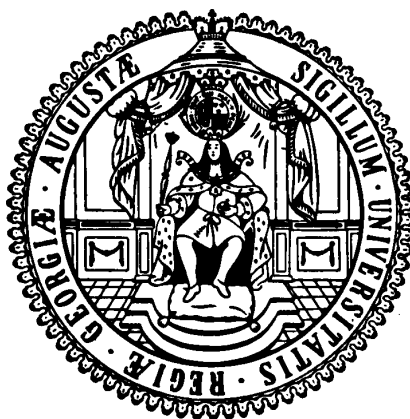
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**How does foreign direct investment really affect  
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**Dierk Herzer**

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# How does foreign direct investment really affect developing countries' growth?

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## **Abstract**

This paper contributes to the literature on foreign direct investment (FDI) and economic growth in two main ways. First, we examine the effect of FDI on economic growth for 44 developing countries over the period 1970 to 2005 using heterogeneous panel cointegration techniques that are robust to omitted variables and endogenous regressors. In contrast to previous studies, we find that FDI has, on average, a negative effect on growth in developing countries, but that there are large cross-country differences in the growth effects of FDI. Second, we use a general-to-specific model selection approach to systematically search for country-specific factors explaining the cross-country differences in the growth effects of FDI. Contrary to previous results, we find that the cross-country differences in per capita income, human capital, openness, and financial market development cannot explain the cross-country differences in the growth effects of FDI. Instead, the growth effects of FDI are positively related to freedom from government intervention and freedom from business regulation, and negatively related to FDI volatility and natural resource dependence.

*JEL-Classification:* F21; F43; C23; C21

*Keywords:* FDI; Growth; Developing countries; Panel cointegration; General-to-specific approach

## **1. Introduction**

Since the early 1980s, most developing countries have significantly eased restrictions on foreign direct investment (FDI) and many have offered seductive tax incentives and subsidies to attract foreign capital. The rationale behind this is that FDI contributes to economic growth by stimulating capital accumulation and/or through positive externalities in the form of knowledge and productivity spillovers to local firms, as theory predicts. But does it really? Skeptics point out, for example, that FDI can reduce capital accumulation when foreign investors claim scarce resources, such as import licenses, skilled manpower, credit facilities, etc., thereby crowding out investment from domestic sources. Further, it is argued that knowledge spillovers are often illusory, since domestic firms using backward production technology and unskilled workers are typically unable to

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learn from multinationals. Finally, because multinationals generally have lower marginal costs due to some firm specific advantage, critics argue that they can attract demand away from domestic firms, forcing the domestic companies to reduce their production. Competition from foreign companies can thus, paradoxically, reduce the productivity of domestic firms, as some firm-level studies suggest (see, e.g., Haddad and Harrison, 1993; Aitken and Harrison, 1999).

Despite these (and other) concerns, most macroeconomic studies conclude that FDI has a positive effect on the economic growth of developing countries. In particular, countries with higher levels of per capita income, better educated workers, higher degrees of openness, and well-developed financial system seem to benefit significantly from FDI (see, e.g., OECD, 2002).

This paper challenges that conventional wisdom, arguing that existing studies suffer from econometric problems, such as country-specific omitted variables, endogeneity of the regressors, cross-country heterogeneity in the growth effects of FDI, neglected long-run level relationships between FDI and output, and/or unrepresentative, small country samples. Consequently, the positive growth effects of FDI as portrayed in existing literature are unreliable.

The objective of this paper is to address each of these issues and to reassess the relationship between FDI and growth. Specifically, we make the following contributions:

- (1) We employ heterogeneous panel cointegration techniques that are robust to omitted variables and endogenous regressors to estimate the long-run level relationship between FDI and output for developing countries both individually and as a whole. Given that we consider 44 countries over the period from 1970 to 2005, our sample includes more countries over a longer time period than the samples used in previous panel (cointegration) studies in this area. To preview the main results: We find that FDI has, on average, a robust *negative* long-run effect on growth in developing countries, but that there are large cross-country differences in the growth effects of FDI.
- (2) We adopt a model-selection approach which is based on a general-to-specific methodology to systematically search for country-specific conditions that are important factors in explaining the cross-country differences in the effects of FDI on economic growth. Our main result is that cross-country differences in the growth effects of FDI cannot be explained by cross-country differences in per capita income, human capital, openness, or financial market development. Instead, we find that the effects of FDI on economic growth in developing countries are positively related to freedom from government intervention and freedom from business regulation, and negatively related to FDI volatility and natural resource dependence.
- (3) A methodological contribution of this paper is to use a two-step estimation procedure that combines panel and cross-sectional methods: The first step involves estimating the effect of

FDI on economic growth for each country using heterogeneous panel estimators. The second step involves estimating the determinants of the FDI-growth relationship using cross-sectional regressions with the estimated growth effect as the dependent variable.

The plan of the paper is as follows. Section 2 discusses previous empirical work on this topic. Section 3 reexamines the impact of FDI on economic growth. Section 4 analyzes the determinants of the growth effects of FDI. Section 5 concludes.

## **2. The empirical literature: Review and critique**

There exists a vast empirical literature on the effects of FDI on developing countries' economic growth. In this section, we review the main contributions and critique the methods used therein. First, we discuss cross-country studies on the FDI-growth relationship. Then, we review panel studies on FDI and economic growth. Finally, we analyze cointegration studies for individual countries and panel cointegration studies on this topic.

### *2.1. Cross-country studies*

Cross-country studies generally find evidence of a robust, positive effect of FDI on economic growth in developing countries. However, the growth impact seems to depend on several country-specific factors, such as the level of per capita income, the human capital base, the degree of trade openness and the level of financial market development.

Blomström et al. (1994), for example, use cross-country data for 78 developing countries and find that lower income developing countries do not enjoy substantial growth benefits from FDI, whereas higher income developing countries do. The authors conclude from this finding that a certain threshold level of development is necessary to absorb new technology from investment of foreign firms. Balasubramanyam et al. (1996), examining a sample of 46 developing countries, find that the effects of FDI on growth are stronger for countries that are more open to trade. They argue that economies that are more open are likely to both attract a higher volume of FDI and promote more efficient utilization thereof than closed economies. Borensztein et al. (1998), in turn, use cross-country analysis of 69 developing countries and find that the effect of FDI on economic growth depends on the level of human capital in the host country. Accordingly, FDI contributes to economic growth only if the level of education is higher than a certain threshold. And finally, Alfaro et al. (2004), using cross-country data for 71 developing and developed countries, find that FDI plays an important role in contributing to economic growth, but also that the level of development of local financial markets is crucial for these positive effects to be realized. They argue that local firms generally need to reorganize their structure (buy new machines and hire new

managers and skilled labor) to take advantage of FDI-induced knowledge spillovers, which is difficult to do in underdeveloped financial markets.

Admittedly, numerous authors emphasize methodological problems with estimating cross-country growth equations, thus casting serious doubts on the validity of these findings (see, e.g., Carkovic and Levine, 2005). One of the main criticisms directed at cross-country studies is the implicit assumption of the existence of a common economic structure and similar production technologies across countries. In fact, however, production technologies, institutions, and policies differ substantially between countries, so that country-specific omitted variables may lead to highly misleading cross-country regression results. Moreover, a statistically significant relationship between FDI and economic growth does not necessarily need to be the result of a causal impact of FDI on economic growth. Given that rapid economic growth generally generates better profit opportunities for FDI, a positive correlation or coefficient of FDI in the growth equation can be equally compatible with causality running from growth to FDI. Accordingly, cross-country studies may suffer from serious endogeneity problems (see, e.g., Nair-Reichert and Weinhold, 2001).

## *2.2. Panel studies*

A solution to these problems is the use of panel estimation techniques. Panel estimation makes it possible to account for unobserved country-specific effects, thus eliminating a possible source of omitted-variable bias. Moreover, by including lagged explanatory variables, panel procedures allow control for potential endogeneity problems and, furthermore, enable one to explicitly test for Granger causality. Carkovic and Levine (2005), for example, use the GMM system panel estimator proposed by Arellano and Bover (1995) and Blundel and Bond (1998) to control for the potential biases induced by endogeneity and omitted variables. Using several specifications estimated for a sample of 65 developed and developing countries, they find that FDI has no robust effect on growth—even when allowing FDI to affect growth differently depending on per capita income, trade openness, education, and domestic financial development. Nevertheless, the authors emphasize that FDI is not irrelevant for growth given that the FDI variable turns out to be positive and statistically significant in many specifications.

Busse and Groizard (2008), on the other hand, apply an Arellano and Bond (1991) style GMM difference estimator to data for 84 developed and developing countries and find (again) that the impact of FDI on economic growth depends on the level of financial development. In addition, their results suggest that the growth effect of FDI is negatively related to the level of regulation in the host country. Busse and Groizard (2008) explain this finding by arguing that restrictive or costly

regulations impede both the allocation of foreign capital to the most productive sectors and the creation of linkages with (and spillovers to) local firms.

A common feature of traditional panel estimators, such as the ones used by Carkovic and Levine (2005) and Busse and Groizard (2008), is the homogeneity imposed on slope parameters. Recent advances in the heterogeneous panel literature, however, suggest that estimation and inference in standard dynamic panel models can be misleading when the slope coefficients differ across cross-section units. To deal with this problem, Nair-Reichert and Weinhold (2001) use what they refer to as the mixed fixed and random coefficient (MFR) approach to test for causality between FDI and growth. The MFR approach allows for complete heterogeneity in the coefficients for the explanatory variables, thus avoiding the biases induced by possibly incorrect homogeneity restrictions. Using a sample of 24 developing countries over the period 1971 to 1995, the authors find that FDI has, on average, a positive causal effect on economic growth, but this growth effect is (in fact) highly heterogeneous.

However, another methodological problem with both cross-country and panel studies is the use of the growth rate of output as the dependent variable, while either the level or the growth rate of the FDI-to-GDP ratio is used as the explanatory variable. A regression with the growth rate of output on the left-hand side and the level of the FDI-to-GDP ratio on the right-hand side is problematic for the following reason: Growth rates are generally stationary while the FDI-to-GDP ratio has exhibited a strong positive trend since 1970 for most developing countries, implying that there cannot be a stable long-run relationship (over time) between the growth rate of output and the level of the FDI-to-GDP ratio. Moreover, such unbalanced regressions do not allow for standard statistical inferences, in particular when applied to panel data sets with relatively long time series. On the other hand, regression models with the growth rate of output on the left-hand side and the growth rate of the FDI-to-GDP ratio preclude the possibility of a long-run or cointegrating relationship between the level of output and the level of FDI, *a priori*. Ericsson et al. (2001), for example, show that the use of growth rates (or first differences) can lead to highly misleading conclusions regarding the long-run level relationship between the variables—even in cross-country analyses. In addition, and equally important, several recent contributions to the theoretical growth literature focus on levels instead of growth rates. Acemoglu and Ventura (2002), for example, present a model in which cross-country differences in technology, investment rates, and economic policies are associated with differences in output levels, not growth rates. Empirical models including only the growth rate of output exclude such models by assumption.



### *2.3. Cointegration studies*

In response to these criticisms, several studies use cointegration and causality analysis to investigate the long-run level relationship between output and FDI for individual developing countries. Most studies find a positive long-run relationship between the variables with Granger-causality running from FDI to output or in both directions (see, e.g., Ramírez, 2000; Cuadros et al., 2004; Xiaohui et al., 2002; Fedderke and Romm, 2006; Liu et al., 2009). Given, however, that these studies are focused on analyzing a limited number of major FDI recipients, they do not provide a solid basis for general conclusions regarding the overall effects of FDI for developing countries. An exception is the study by Herzer et al. (2008), who investigate the FDI-led growth hypothesis for 28 developing countries over the period 1970 to 2003. Their main result is that there is a long-run positive causal relationship from FDI to GDP in only four countries. For one of the 28 countries (Ecuador), they actually find evidence of a long-run negative growth effect of FDI.

However, the failure to find a long-run or cointegrating relationship in the large majority of countries may simply be due to the low power inherent in individual (country) cointegration tests. Hansen and Rand (2006), for example, employ panel cointegration tests, which have higher power, by exploiting both the time-series and cross-sectional dimensions of the data. Using heterogeneous panel estimators in a sample of 31 developing countries for the period 1970 to 2000 they find clear evidence in favor of cointegration between FDI and GDP. Moreover, their results suggest that FDI has a positive long-run effect on GDP, whereas GDP has no long-run effect on FDI. Also, they find large differences in the growth effect of FDI across countries.

Thus, the overall picture that emerges from these studies is that FDI tends to have a positive effect on economic growth in developing countries, but this growth effect is very heterogeneous. Yet, these studies are limited by two factors. First, since only a relatively small number of countries are considered, it remains questionable whether the findings are representative for all developing countries. Accordingly, a potential problem with these studies is sample selection. Second, although these studies find considerable cross-country differences in the growth effects of FDI, they do not provide any insights into the determinants of this heterogeneity. These issues are addressed in the following sections.

### **3. The impact of FDI on economic growth in developing countries**

This section investigates the impact of FDI on economic growth for a large number of developing countries over time. Specifically, we use panel data techniques that allow us (i) to control for omitted variable and endogeneity bias, (ii) to estimate the long-run level relationship between the FDI-to-GDP ratio and aggregate output, and (iii) to detect possible cross-country

differences in the long-run growth effects of FDI. The analysis proceeds as follows: first, we describe the empirical model and the data. Then, we investigate the unit root properties of the data. Thereafter, we test for the existence of a long-run relationship between GDP and the FDI-to-GDP ratio, and then provide estimates of this relationship. Finally, we test for causality between the two variables and check the robustness of the results.

### 3.1. Model and data

Following previous empirical studies on FDI and economic growth, we consider a bivariate model of the form (see, e.g., Hansen and Rand, 2006; Herzer et al., 2008):

$$\text{Log}(GDP)_{it} = a_i + \delta_i t + \beta(FDI/GDP)_{it} + \varepsilon_{it}, \quad (1)$$

where  $\text{Log}(GDP)_{it}$  represents the natural logarithm of real GDP over time periods  $t = 1, 2, \dots, T$  and countries  $i = 1, 2, \dots, N$  and  $(FDI/GDP)_{it}$  is the FDI-to-GDP ratio (in percent) over the same time periods and countries.<sup>1</sup> The reason for using the FDI-to-GDP ratio, rather than the (log) level of FDI, is to avoid the simultaneity bias associated with the fact that FDI, via the national income accounting identity, is itself a component of GDP. More specifically, a positive correlation between FDI and GDP may emerge simply because FDI is part of GDP, rather than because of any extra contribution that FDI makes to GDP (see, e.g., Herzer et al., 2008).<sup>2</sup> The coefficient  $\beta$  on the FDI-to-GDP ratio thus represents the growth effect of FDI that goes beyond the mere change in FDI volume, while the  $a_i$  and  $\delta_i t$  are, respectively, country-specific fixed effects and country-specific deterministic time trends, capturing any omitted factors that are relatively stable over time or evolve smoothly over time.

Equation (1) assumes that, in the long-run, permanent changes in the FDI-to-GDP ratio are associated with permanent changes in the level of GDP. Econometrically, this implies that both the individual time series for GDP and the individual series for the FDI-to-GDP ratio must exhibit unit-root behavior and that  $(FDI/GDP)_{it}$  must be cointegrated with  $\text{Log}(GDP)_{it}$ . A regression consisting of two cointegrated variables has a stationary error term,  $\varepsilon_{it}$ , in turn implying that no relevant integrated variables are omitted; any omitted nonstationary variable that is part of the

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<sup>1</sup> In cointegration studies, an increase in the (log-)level of GDP is generally interpreted as economic growth. In other words, an effect on GDP is interpreted as an effect on economic growth. This is theoretically justified since GDP is measured in logs. To see this, differentiate Equation (1) and obtain of the growth rate of GDP as a function of the change in FDI-to-GDP ratio. Equation (1) thus stipulates that economic growth is associated with a change in the FDI-to-GDP ratio.

<sup>2</sup> It is common practice in (panel) cointegration studies to regress the (log-) level of GDP on explanatory variables relative to GDP. Since many of these studies find a positive relationship between GDP and these variables (see, e.g., Christopoulos and Tsionas, 2004; Hansen and Rand, 2006; Herzer, 2008), there is no reason to assume that this approach induces a spurious negative relationship between the FDI-to-GDP ratio and the (log) level GDP.

cointegrating relationship would enter the error term, thereby producing nonstationary residuals and thus leading to a failure to detect cointegration. Cointegration estimators are therefore robust (under cointegration) to the omission of variables that do not form part of the cointegrating relationship. This justifies a reduced form model such as Equation (1) (if cointegrated).

We use net FDI data (as a percentage of GDP) from the UNCTAD FDI database (<http://www.unctad.org/templates/Page.asp?IntItemID=3277&lang=1>)<sup>3</sup> and real GDP data from the World Development Indicators 2007 database, and select a panel of developing countries for which both  $(FDI/GDP)_{it}$  and  $Log(GDP)_{it}$  have unit roots. In practice, this means that we eliminate from 65 developing countries for which FDI and GDP data are available over the entire period from 1970 to 2005 those countries for which the individual time series do not pass a simple screening for a unit root via the ADF and the KPSS tests.<sup>4</sup> In addition, we omit countries with unreliable FDI data. That is, we exclude those countries for which the UNCTAD FDI data differ significantly from that reported in the World Development Indicators. Specifically, we exclude all countries whose net FDI data do not have the same sign or are incomplete in the World Development Indicators dataset.<sup>5</sup> This sample selection procedure yields a sample of 44 developing countries.

Of these countries, three are in North Africa (Algeria, Morocco, Tunisia), sixteen are in sub-Saharan Africa (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Niger, Nigeria, Senegal, Sierra Leone, Cameroon, Congo, Democratic Republic of Congo, Kenya, Malawi, Zambia, Zimbabwe, South Africa), eight are in South America (Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Venezuela), seven are in Central America and the Caribbean (Costa Rica, El Salvador, Honduras, Mexico, Dominican Republic, Jamaica, Trinidad and Tobago), one is in West Asia (Turkey), six are in East Asia (Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Thailand), and three are in South Asia (India, Pakistan, Sri Lanka). Accordingly, our sample represents all major developing areas in the world. Nevertheless, we admit that a complete picture of the developing world would require the inclusion of many other countries, in particular, China, which is the largest recipient of FDI flows among developing countries. But the availability (and reliability) of data limits our choice to these 44. Nonetheless, we emphasize that this sample is a much larger sample of countries over a longer time period than those used in previous panel (cointegration) studies.

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<sup>3</sup> Following previous research (see, e.g. Nair-Reichert and Weinhold, 2001; Basu et al, 2003; Hansen and Rand, 2006; Herzer et al., 2008) we use net FDI flows, defined as net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It includes equity capital, reinvestment of earnings and other long term and short-term capital as shown in the balance of payments.

<sup>4</sup> These countries are: the Central African Republic, Gabon, Liberia, Madagascar, Mauritania, and Panama.

<sup>5</sup> These countries are: Chad, Bolivia, Egypt, Gambia, Guatemala, Guyana, Haiti, Iran, North Korea, Nicaragua, Rwanda, Saudi Arabia, Seychelles, Togo, and Uruguay.

### 3.2. Testing for unit-roots

To ensure that the failure to reject the null hypothesis of a unit root is not simply due to the low power inherent in the individual country unit root tests, we compute the panel unit root test developed by Im, Pesaran, and Shin (2003) (IPS). This allows us to test the null hypothesis that all of the individuals of the panel have a unit root versus the alternative that some fractions are (trend) stationary. It is based on the ADF regression:

$$\Delta x_{it} = z_{it}'\gamma + \rho_i x_{it-1} + \sum_{j=1}^{p_i} \phi_{ij} \Delta x_{it-j} + \varepsilon_t, \quad (2)$$

where  $p_i$  is the lag order and  $z_{it}$  represents deterministic terms, such as fixed effects or fixed effects combined with individual time trends. Accordingly, the null hypothesis of a unit root ( $H_0: \rho_i = 0$ ,  $\forall i = 1, 2, \dots, N$ ) is tested against the alternative of (trend) stationarity ( $H_1: \rho_i < 0$ ,  $i = 1, 2, \dots, N_1$ ;  $\rho_i = 0$ ,  $i = N_1 + 1, N_1 + 2, \dots, N$ ) using the standardized  $t$ -bar statistic:

$$\Gamma_{\bar{t}} = \frac{\sqrt{N}[\bar{t}_{NT} - \mu]}{\sqrt{v}}, \quad (3)$$

where  $\bar{t}_{NT}$  is the average of the  $N (= 44)$  cross-section ADF  $t$ -statistics,  $\mu$  and  $v$  are, respectively, the mean and variance of the average of the individual  $t$ -statistics, tabulated by Im, Pesaran, and Shin (2003). Table 1 reports the test results for the variables in levels and in first differences. The test statistics are unable to reject the hypothesis that all countries have a unit root in levels. Since for the first differences the unit root hypothesis can be rejected, we conclude that  $(FDI/GDP)_{it}$  and  $Log(GDP)_{it}$  are integrated of order one,  $I(1)$ . Thus, the next step in our analysis is an investigation of the cointegration properties of the variables.

Table 1

Panel unit root tests

Variable	Deterministic terms	IPS test statistics	Deterministic terms	IPS test statistics
Levels				
$Log(GDP)$	$c, t$	-0.98	$c$	4.84
$(FDI/GDP)$	$c, t$	-1.44	$c$	0.87
First Differences				
$\Delta Log(GDP)$			$c$	-6.56***
$\Delta(FDI/GDP)$			$c$	-10.66***

$c(t)$  indicates that we allow for different intercepts (and/or time trends) for each country. \*\*\* denote significance at the 1% level. Four lags were selected to adjust for autocorrelation. The standardized IPS statistics are distributed as  $N(0, 1)$ .

### 3.3. Testing for cointegration

We first test for cointegration using the Pedroni (1999, 2004) approach, which allows for both heterogeneous cointegrating vectors and short-run dynamics across countries. It involves estimating the hypothesized cointegrating regression separately for each country and then testing the estimated residuals for stationarity using seven test statistics. Four of these test statistics pool the autoregressive coefficients across different countries during the unit root test and thus restrict the first-order autoregressive parameter to being the same for all countries. Pedroni (1999) refers to these statistics as *panel cointegration statistics*. The other three test statistics are based on averaging the individually estimated autoregressive coefficients for each country. Accordingly, these statistics allow the autoregressive coefficient to vary across countries and are referred to as *group mean panel cointegration statistics*. Both the panel cointegration statistics and the group mean panel cointegration statistics test the null hypothesis  $H_0$ : “all of the individuals of the panel are not cointegrated.” For the panel statistics, the alternative hypothesis is  $H_1$ : “all of the individuals of the panel are cointegrated,” while for the group mean panel statistics, the alternative is  $H_1$ : “a significant portion of the panel members are cointegrated” (see, e.g., Pedroni, 2004).

The first of the panel cointegration statistics is a non-parametric variance ratio test. The second and the third are panel versions of the Phillips and Perron (PP) rho and  $t$ -statistic, respectively. The fourth statistic is a panel ADF statistic analogous to the Levin et al. (2002) panel unit root test. Similarly, the first two of the group mean panel cointegration statistics are panel versions of the Phillips and Perron rho and  $t$ -statistic, respectively. The third is a group mean ADF test analogous to the IPS (2003) panel unit root test. The standardized distributions of the panel and group statistics are given by:

$$\kappa = \frac{\varphi - \mu\sqrt{N}}{\sqrt{v}} \Rightarrow N(0, 1), \quad (4)$$

where  $\varphi$  is the respective panel, or group, statistic, and  $\mu$  and  $v$  are the expected mean and variance of the corresponding statistic, tabulated by Pedroni (1999).

A weakness of the Pedroni (1999, 2004) approach is that it requires that the long-run cointegrating vector for the variables in levels being equal to the short-run adjustment process for the variables in their differences. If this common factor restriction is empirically invalid, residual-based (panel) cointegration tests may suffer from a significant loss of power (see, e.g., Westerlund, 2007). Moreover, and perhaps more importantly, residual-based (panel) cointegration tests are not invariant to the normalization of the cointegration vector.

As an additional test for cointegration, we therefore use the Larsson et al. (2001) procedure, which is based on Johansen's (1995) maximum likelihood approach. Like the Johansen time-series cointegration test, the Larsson et al. panel test treats all variables as potentially endogenous, thus avoiding the normalization problems inherent to residual-based cointegration tests. In addition, the Larsson et al. (2001) procedure does not impose a possibly invalid common factor restriction. It involves estimating the Johansen vector error correction model for each country and then computing the individual trace statistics  $LR_{iT}\{H(r)|H(p)\}$ . The null hypothesis is that all countries have the same number of cointegrating vectors  $r_i$  among the  $p$  variables  $H_0 : rank(\Pi_i) = r_i \leq r$ , and the alternative hypothesis is  $H_1 : rank(\Pi_i) = p$ , for all  $i = 1, \dots, N$ , where  $\Pi_i$  is the long-run matrix of order  $p \times p$ . To test  $H_0$  against  $H_1$ , a panel cointegration rank trace test is constructed by calculating the average of the  $N$  individual trace statistics,

$$\overline{LR}_{NT}\{H(r)|H(p)\} = \frac{1}{N} \sum_{i=1}^N LR_{iT}\{H(r)|H(p)\}, \quad (5)$$

and then standardizing it as follows:

$$\Psi_{\overline{LR}}\{H(r)|H(p)\} = \frac{\sqrt{N}(\overline{LR}_{NT}\{H(r)|H(p)\} - E(Z_k))}{\sqrt{Var(Z_k)}} \Rightarrow N(0, 1), \quad (6)$$

where the mean  $E(Z_k)$  and variance  $Var(Z_k)$  of the asymptotic trace statistic are tabulated by Breitung (2005) for the model we use (the model with a constant and a trend in the cointegrating relationship). As shown by Larsson et al. (2001), the standardized panel trace statistic has an asymptotic standard normal distribution as  $N$  and  $T \rightarrow \infty$ .

For completeness, we also compute the Fischer statistic proposed by Madalla and Wu (1999), which is defined as:

$$\lambda = -2 \sum_{i=1}^N \log(p_i), \quad (7)$$

where  $p_i$  is the significance level (the  $p$ -value) of the trace statistic for country  $i$ . The test is distributed as  $\chi^2$  with  $2 \times N$  degrees of freedom.

Finally, to accommodate certain forms of cross-sectional dependency and the effect of common disturbances that impact all countries of the panel, we also use data that have been demeaned with respect to common time effects; i.e., in place of  $Log(GDP)_{it}$  and  $(FDI/GDP)_{it}$ , we employ:

$$Log(GDP)'_{it} = Log(GDP)_{it} - \overline{Log(GDP)}_t,$$

$$(FDI / GDP)'_{it} = (FDI / GDP)_{it} - \overline{(FDI / GDP)_t}, \text{ where}$$

$$\overline{Log(GDP)_t} = N^{-1} \sum_{i=1}^N Log(GDP)_{it}, \text{ and}$$

$$\overline{(FDI / GDP)_t} = N^{-1} \sum_{i=1}^N (FDI / GDP)_{it}. \quad (8)$$

Table 2 reports the results. As can be seen, all test statistics clearly indicate cointegration for both the unadjusted and demeaned data. The standardized panel trace statistic and the Fischer statistic clearly support the presence of one cointegrating vector. Also, the Pedroni test statistics reject the null of no cointegration at the one-percent level. In particular, the panel cointegration statistics decisively reject the null hypothesis in favor of the alternative hypothesis (“all of the individuals of the panel are cointegrated”), suggesting cointegration for the panel as a whole.<sup>6</sup>

Table 2

Panel cointegration tests

	Panel cointegration statistics		Group mean panel cointegration statistics	
	Unadjusted	Time demeaned	Unadjusted	Time demeaned
Pedroni (1999)				
Variance ratio	3.97***	4.22***		
PP rho statistics	-16.38***	-15.14***	-11.03***	-10.06***
PP <i>t</i> -statistics	-20.42***	-21.34***	-17.68***	-20.71***
ADF <i>t</i> -statistics	-19.35***	-20.17***	-15.36***	-17.25***
Cointegration rank				
	<i>r</i> = 0		<i>r</i> = 1	
	Unadjusted	Time demeaned	Unadjusted	Time demeaned
Larsson et al. (2001)				
$\Psi_{LR}\{H(r) H(2)\}$	9.05***	9.19***	0.50	1.01
Fisher $\chi^2$ test	230.6***	238.1***	89.27	98.86

\*\*\* indicate a rejection of the null hypothesis of no cointegration at the 1% level. All test statistics are asymptotically normally distributed. The panel rank test has a critical value of 2.326 (1.645) at the 1% (5%) level. The Fisher test has a critical value of 121.8 (110.9) at the 1% (5%) level. The number of lags was determined by the Schwarz criterion.

### 3.4. Estimating the long-run relationship

Having found that there is a long-run relationship between FDI and GDP, the next step in our analysis is to estimate the long-run coefficient  $\beta$ . To this end, we use the between-dimension, group-mean panel DOLS estimator suggested by Pedroni (2001). Pedroni emphasizes several advantages of using between-dimension group-mean-based estimators over the within-dimension approach. For example, it is argued that the between-dimension estimator allows for greater flexibility in the presence of heterogeneous cointegrating vectors, whereas under the within-

<sup>6</sup> Given that panel cointegration tests may tend to falsely reject the null of no cointegration if there are cointegrating relations among the variables across the countries in the panel (see, e.g., Banerjee et al., 2004), we also tested for cross-country cointegration in the GDP and the FDI series using the Johansen approach; we found no instances of cross-country cointegration.

dimension approach, the cointegrating vectors are constrained to be the same for each country. Another advantage of the between-dimension estimators is that the point estimates provide a more useful interpretation in the case of heterogeneous cointegrating vectors, since they can be interpreted as the mean value of the cointegrating vectors (which does not apply to the within estimators). And finally, the between-dimension estimators suffer from much lower small-sample size distortions than is the case with the within-dimension estimators.

The DOLS regression in our case is given by:

$$\text{Log}(GDP)_{it} = a_i + \delta_i t + \beta_i (FDI/GDP)_{it} + \sum_{j=-p_i}^{p_i} \Phi_{ij} \Delta(FDI/GDP)_{it-j} + \varepsilon_{it}, \quad (9)$$

where  $\Phi_{ij}$  are coefficients of lead and lag differences, which account for possible serial correlation and endogeneity of the regressor(s), thus yielding unbiased estimates. Accordingly, in contrast to cross-sectional and conventional panel approaches, the approach that we use does not require us to assume that the FDI variable is exogenous.

From regression (9), the group-mean DOLS estimator for  $\beta$  is constructed as:

$$\hat{\beta} = \left[ N^{-1} \sum_{i=1}^N \left( \sum_{t=1}^T z_{it} z'_{it} \right)^{-1} \left( \sum_{t=1}^T z_{it} \tilde{s}'_{it} \right) \right]_1, \quad (10)$$

where  $z_{it}$  is the  $2(K+1) \times 1$  vector of regressors  $z_{it} = ((FDI/GDP)_{it} - \overline{(FDI/GDP)}_i, \Delta(FDI/GDP)_{it-K}, \dots, \Delta(FDI/GDP)_{it+K})$ ,  $\tilde{s}_{it} = s_{it} - \bar{s}_i$ , and the subscript 1 outside the brackets indicates that only the first element of the vector is taken to obtain the pooled slope coefficient. Because the expression following the summation over the  $i$  is identical to the conventional time series DOLS estimator applied to the  $i$ th country of the panel ( $\hat{\beta}_i$ ), the between-dimension estimator for  $\beta$  can be calculated as:

$$\hat{\beta} = N^{-1} \sum_{i=1}^N \hat{\beta}_i, \quad (11)$$

where the associated  $t$ -statistic is computed as follows:

$$t_{\hat{\beta}} = N^{-1/2} \sum_{i=1}^N t_{\hat{\beta}_i}. \quad (12)$$

Table 3 reports both the individual country DOLS point estimates and the group-mean point estimate. As can be seen from the table, the individual country estimates show considerable heterogeneity in the slope coefficients, ranging from -0.60 (Pakistan) to 0.36 (Cameroon). Such heterogeneity was also found by Nair-Reichert and Weinhold (2001) and Hansen and Rand (2006), as discussed in Section 2. However, in contrast to the results by Nair-Reichert and Weinhold (2001), Hansen and Rand (2006) and most other studies, we find that FDI has, on average, a



statistically significant *negative* long-run effect on economic growth. The group-mean estimate of the coefficient on (*FDI/GDP*) is -0.0243, implying that an increase in the FDI-to-GDP ratio by one percentage point *decreases* GDP in developing countries by 0.0243 percent, on average. Admittedly, this negative average growth effect is marginal.

Table 3

DOLS approach

Country	Coefficient on ( <i>FDI/GDP</i> )	<i>t</i> -stat	Country	Coefficient on ( <i>FDI/GDP</i> )	<i>t</i> -stat
Algeria	-0.0962***	-4.02	Malawi	-0.0165	-1.38
Argentina	0.0719***	4.15	Malaysia	0.0392***	5.70
Benin	-0.0520***	-4.13	Mexico	-0.0703**	-2.05
Brazil	-0.0283**	-2.22	Morocco	-0.0777***	-4.85
Burkina Faso	-0.0191	-0.49	Niger	0.0941**	2.56
Cameroon	0.3618***	6.43	Nigeria	0.0445**	2.76
Chile	0.0676***	3.76	Pakistan	-0.6061***	-5.84
Colombia	-0.0921***	-4.53	Paraguay	-0.1203**	-2.38
Congo	-0.0711***	-3.97	Peru	0.0008	0.05
Congo, Dem. Rep.	-0.2856***	-4.65	Philippines	-0.0563*	-1.99
Costa Rica	0.0680***	5.05	Senegal	-0.0125	-0.62
Côte d'Ivoire	0.0485	1.46	Sierra Leone	-0.0659***	-5.53
Dominican Republic	0.0281*	1.88	Singapore	-0.0530**	-2.68
Ecuador	-0.0420***	-6.54	South Africa	-0.0199	-1.13
El Salvador	0.1400***	4.30	Sri Lanka	0.0527***	4.24
Ghana	0.15290***	5.88	Thailand	-0.0263	-0.36
Honduras	-0.0454**	-2.42	Trinidad and Tobago	-0.0294**	-2.44
Hong Kong	-0.0308***	-5.93	Tunisia	0.0372**	2.61
India	0.1762***	6.33	Turkey	-0.0936*	-1.97
Indonesia	0.0496**	2.20	Venezuela	0.0345**	2.73
Jamaica	0.0339*	1.91	Zambia	-0.0176*	-1.78
Kenya	-0.4503***	-8.47	Zimbabwe	-0.0906**	-2.09
Group-mean estimator	-0.0243***	-3.09			

\*\*\* (\*\*) [\*] indicate significance at the 1% (5%) [10%] level. The number of leads and lags was determined by the Schwarz criterion.

But even the positive growth effects for the individual countries are surprisingly small compared, for example, to the expected impact of domestic investment in the standard Solow model. In the Solow model, in which the capital share is one-third, the elasticity of steady state output (per capita) with respect to the savings rate is approximately one-half. Assuming a savings rate of around 20 percent, this implies that a one-percentage point increase in the savings and investment rate would increase steady-state output by around 2.5 percent. However, all our estimates for the growth effects of FDI are significantly lower, which might suggest that FDI is generally not more productive than domestic investment (even in the countries with positive effects).

### 3.5. Testing for causality

The above interpretation of the estimation results is based on the assumption that long-run causality runs from  $(FDI / GDP)$  to  $GDP$ . To investigate whether this assumption holds, we enter the residuals from the individual DOLS long-run relations,

$$ec_t = \text{Log}(GDP)_{it} - [a_i + \delta_i t + \beta_i (FDI / GDP)_{it}], \quad (13)$$

as error correction terms into a simple panel vector error correction model (VECM):

$$\begin{bmatrix} \Delta \text{Log}(GDP)_{it} \\ \Delta (FDI / GDP)_{it} \end{bmatrix} = \begin{bmatrix} c_{1i} \\ c_{2i} \end{bmatrix} + \sum_{j=1}^k \Gamma_j \begin{bmatrix} \Delta \text{Log}(GDP)_{it-j} \\ \Delta (FDI / GDP)_{it-j} \end{bmatrix} + \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} ec_{it-1} + \begin{bmatrix} \varepsilon_{1it} \\ \varepsilon_{2it} \end{bmatrix}, \quad (14)$$

where the  $c_i$  are fixed effects. A significant error correction term implies long-run Granger causality from the explanatory to the dependent variables, where long-run Granger non-causality and weak exogeneity can be regarded as equivalent (see, e.g., Hall and Milne 1994).

Following Herzer (2008), we test for weak exogeneity by imposing zero restrictions on the insignificant short-run parameters ( $\Gamma_k$ ) and then we decide on the significance of the  $\alpha$ s. In doing so, we reduce the number of parameters and thereby we increase the precision of the weak exogeneity tests on the  $\alpha$ -coefficients. Since all variables in Equation (14), including  $ec_{t-1}$ , are  $I(0)$  variables, conventional  $t$ -tests can be used for this purpose.

Given the low frequency of the data and the small sample size, we start with two lags in the VECM,  $k = 2$ . However, including lags induces a correlation between the error term and the lagged dependent variable, so that standard panel estimation techniques, such as the least square dummy variable technique, yield biased and inconsistent estimates. To deal with this problem, we follow Christopoulos and Tsionas (2004) and use  $\Delta \text{Log}(GDP)_{it-3}$ ,  $\Delta \text{Log}(GDP)_{it-4}$ , and  $\Delta (FDI / GDP)_{it-3}$ ,  $\Delta (FDI / GDP)_{it-4}$ , respectively, as instruments for the lagged dependent variables. After applying the general-to-specific model reduction procedure, we obtain the results in Table 4.

Table 4

Vector error correction model, tests for Granger-causality (instrumental variable estimation)

Independent variable	Dependent variable: $\Delta \text{Log}(GDP)_{it}$	Dependent variable: $\Delta (FDI / GDP)_{it}$
$\Delta \text{Log}(GDP)_{it-1}$	0.0728** (2.68)	
$\Delta \text{Log}(GDP)_{it-2}$	-0.0573** (-2.11)	
$\Delta (FDI / GDP)_{it-1}$		-0.0112*** (-4.02)
$\Delta (FDI / GDP)_{it-2}$		
$ec_{t-1}$	-0.0089*** (-9.51)	-0.1841 (-1.40)
Adj. $R^2$	0.10	0.02

$t$ -statistics in parentheses. \*\*\* indicate significance at the 1% level. Insignificant short-run dynamics were eliminated successively according to the lowest  $t$ -values. Fixed effects estimates are not reported.

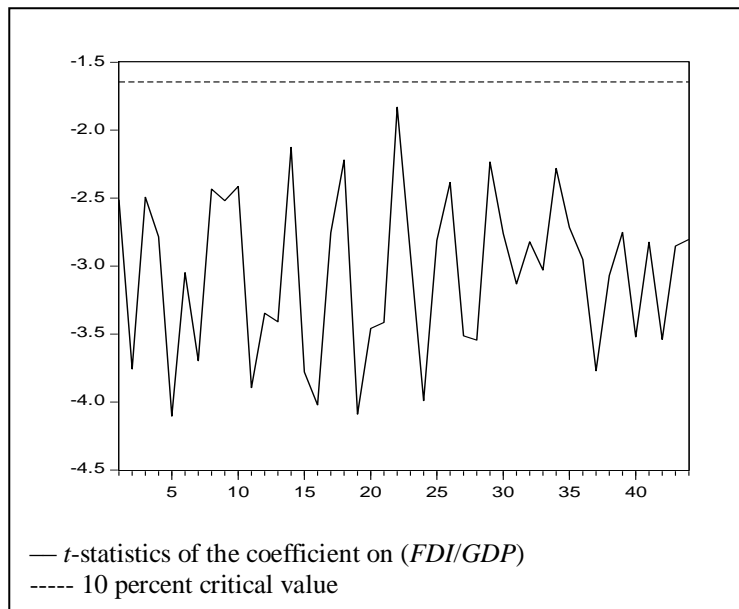
According to the  $t$ -statistics of the error correction terms, the FDI-to-GDP ratio can be regarded as weakly exogenous, whereas weak exogeneity of the GDP variable is decisively rejected. Consequently,  $\text{Log}(GDP)_{it}$  is the only variable that is endogenous in the cointegrating relation and hence Granger-caused by FDI in the long run. In other words, long-run causality is unidirectional from FDI to growth, which is in line with the results by Hansen and Rand (2006). Since the short-run dynamics of FDI turned out to be insignificant in the GDP equation, we conclude that there is no short-run Granger causality from FDI to GDP. Similarly, the lagged first differences of the GDP variable were found to be insignificant in the FDI equation, suggesting that no short-run causality exists from growth to FDI.

### 3.6. Robustness

Since the negative relationship between FDI and economic growth challenges previous econometric work, and since sample selection and structural breaks may influence the coefficient estimates, we now check the robustness of the results.

Figure 1

Group-mean estimation with single country excluded from the sample



We first examine whether outliers are responsible for the negative impact of FDI on economic growth. To this end, we reestimate the group-mean coefficient  $\beta$ , excluding one country at a time from the sample. The estimated  $t$ -statistics on  $(FDI/GDP)_{it}$ , along with the ten-percent critical values, are presented in Figure 1. As can be seen, the results appear robust to potential

outliers; the effect of FDI remains negative and statistically significant (at least at the ten-percent level).

Next, we reestimate Equation (1), excluding countries from North Africa, sub-Saharan Africa, South America, Central America and the Caribbean, East Asia, and South Asia. The resulting group-mean values for  $\beta$  are reported in Table 5. Regardless which of these regions is excluded from the sample, the relationship between FDI and economic growth remains negative. Admittedly, the FDI coefficient becomes statistically insignificant when countries from sub-Saharan Africa are excluded, but this is due to the large sample size of this country group.

Table 5

Group-mean estimation with regional country groups excluded from the sample

	Coefficient on ( <i>FDI/GDP</i> )	<i>t</i> -stat	Number of countries
Excluding North Africa	-0.0227**	-2.21	41
Excluding sub-Saharan Africa	-0.0237	-1.20	29
Excluding South America	-0.0266**	-2.58	36
Excluding Central America and the Caribbean	-0.0322***	-4.69	37
Excluding East Asia	-0.0260**	-2.82	38
Excluding South Asia	-0.0168***	-3.94	41

\*\*\* (\*\*) indicate significance at the 1% (5%) level. The countries included in each region are: North Africa: Algeria, Morocco, and Tunisia; sub-Saharan Africa: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Niger, Nigeria, Senegal, Sierra Leone, Cameroon, Congo, Democratic Republic of Congo, Kenya, Malawi, Zambia, Zimbabwe, and South Africa; South America: Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Venezuela; Central America and the Caribbean: Costa Rica, El Salvador, Honduras, Mexico, Dominican Republic, Jamaica, Trinidad and Tobago; East Asia: Hong Kong, Indonesia, Malaysia, Philippines, Singapore, and Thailand; South Asia: India, Pakistan, and Sri Lanka.

Finally, we test whether the estimated  $\beta$ -coefficient is biased due to potential unmodeled structural breaks in the individual DOLS regressions. To this end, each individual DOLS regression is reestimated using step dummy variables for each possible break date in the period of observation. Following Ahmed and Rogers (1995), the significance of these dummies is assessed by a sequential Wald test, which is  $\chi^2_{(1)}$  distributed. If any of the sequentially computed Wald statistics are larger than the conventional five-percent critical value of  $\chi^2_{(1)}$ , the null hypothesis of no structural break can be rejected. Accordingly, the dates of the potential structural breaks are identified endogenously, i.e., through the testing procedure itself.<sup>7</sup>

We include dummy variables for each break point detected by this procedure, although we admit that the sequential Wald test might tend to reject the null of no structural break too often at the (nominal) five-percent significance level, in particular when the sample period is short. Consequently, the individual coefficient estimates may be biased by the inclusion of too many

<sup>7</sup> Following common practice, we computed the Wald statistics for each breakpoint in the interval  $0.15T - 0.85T$ .

dummy variables. Given, however, that the biases might be randomly and equally distributed across the countries, we can (again) construct the group-mean panel DOLS estimator for  $\beta$  from the sample average of the individual DOLS estimators. Table 6 reports the results.

Table 6

DOLS approach with structural breaks

Country	Dummy	Coefficient on (FDI/GDP)	t-stat	Country	Dummy	Coefficient on (FDI/GDP)	t-stat
Algeria	D91	-0.0721***	-4.27	Malawi	D96	-0.0482***	-3.51
Argentina	D93	0.0444***	2.86	Malaysia	D85	0.0458***	8.47
Benin	D75	-0.0596***	-6.00	Mexico	D86	-0.0878***	-3.11
Brazil	D90	-0.0284**	-2.71	Morocco		-0.0777***	-4.85
Burkina Faso		-0.0191	-0.49	Niger	D98	0.0688**	2.32
Cameroon	D95	0.4042***	11.42	Nigeria	D81	0.0237**	2.15
Chile	D74 D82	0.0319**	2.28	Pakistan	D82	-0.3085***	-3.54
Colombia	D00	-0.0416*	-1.80	Paraguay	D99	-0.0877**	-2.34
Congo	D82	-0.0062	-0.37	Peru	D89	0.0281**	2.22
Congo, Dem Rep. of	D93	-0.1958***	-5.39	Philippines	D84 D00	-0.0746***	-3.27
Costa Rica	D82	0.0193*	1.99	Senegal	D78	-0.0383**	-2.33
Côte d' Ivoire	D77	0.0955***	3.94	Sierra Leone		-0.0659***	-5.53
Dominican Republic	D90	0.0410***	3.75	Singapore		-0.0530**	-2.68
Ecuador	D83	-0.0526***	-11.73	South Africa	D97	-0.1003***	-4.99
El Salvador	D81	0.0445**	2.21	Sri Lanka	D88	0.0469***	4.47
Ghana	D81	0.0892***	3.64	Thailand	D89	-0.1387***	-3.91
Honduras	D77 D82	-0.0247**	-2.34	Trinidad and Tobago	D84	-0.0383***	-4.20
Hong Kong	D79 D91	-0.0282***	-9.40	Tunisia	D91	0.0493***	4.66
India	D79 D88	0.1110***	4.64	Turkey	D79 D87	-0.1869***	-4.79
Indonesia	D78	0.0876***	6.52	Venezuela		0.0345**	2.73
Jamaica	D90	0.0436***	3.70	Zambia	D79	-0.0288***	-3.17
Kenya		-0.4503***	-8.47	Zimbabwe	D77	-0.1371***	-3.60
Group-mean estimator		-0.0259***	-5.65				

\*\*\* (\*\*) [\*] indicate significance at the 1% (5%) [10%] level. The number of leads and lags was determined by the Schwarz criterion. Dxx is 1 from 19xx (20xx) onwards and 0 otherwise.

As can be seen, the individual DOLS point estimates in Table 6 are of about the same magnitude as the estimated  $\beta_i$ s in Table 3. By the way, the correlation between the two sets of FDI coefficients is 0.912, suggesting a very similar variation pattern. In addition, a simple  $F$ -test fails to reject the null hypothesis of equal variances between the estimated  $\beta_i$ s in Tables 6 and 3 with a  $p$ -value of 0.25. Similarly, the null hypothesis of equal means cannot be rejected with a  $p$ -value of 0.95 using a simple  $t$ -test. As a consequence, the group-mean estimate of  $\beta$  in Table 6 (-0.0259) is almost identical to the estimated group-mean value in Table 3 (-0.0243), as well. Moreover, both FDI coefficients are statistically significant at the one-percent level.

All in all we conclude from this sensitivity analysis that the negative effect of FDI on economic growth in developing countries is robust to outliers, sample size, and potential structural breaks. Nevertheless, it must be emphasized that there are large cross-country differences in the effects of FDI on a country's economic growth.

#### **4. The determinants of the growth impact of FDI**

In this section, we search for country-specific conditions that are important factors in explaining the cross-country differences in the growth impact of FDI. Previous studies have examined this issue in the context of standard growth regressions by including interaction terms between FDI and a small number of factors which are a priori assumed to influence the FDI-growth relationship. A limitation of the conventional interaction-term approach, however, is the inability to empirically identify which independent variable in the interaction term determines the effect of the other independent variable on the dependent variable. For example, a statistically significant interaction term between FDI and human capital does not necessarily imply that the effectiveness of FDI aid depends on human capital. A statistically significant FDI-human capital interaction term can also be compatible with the growth effect of human capital being influenced by FDI.

In this section, we follow a different approach: We use a cross-sectional regression model with the estimated growth effect as the dependent variable to consider a large number of factors possibly affecting the growth effect of FDI. Because we use the *growth effect* of FDI, rather than the *growth rate*, as the dependent variable, and because we include as many variables as possible relevant to the growth effect of FDI, this approach is less subject to endogeneity and omitted variable bias than the conventional interaction-term approach used in previous studies.

We proceed as follows: we first describe the variables that we consider to be potentially relevant to the FDI-growth relationship and that we use in the empirical analysis. Then, we present the empirical analysis.

##### *4.1. Variables and data*

As discussed in Section 2, the previous literature has mainly focused on four variables as potential determinants of the FDI-growth relationship. These are: the general level of development, trade openness, human capital, and development of local financial markets. In our analysis, the general level of development is represented by real per capita GDP, and the ratio of exports plus imports to GDP is the measure for openness employed. The secondary school enrolment rate is used as a proxy for human capital, while the ratio of domestic credit to the private sector to GDP is our

measure of financial development. We emphasize here that the estimation results do not change when alternative measures of financial sector development and/or human capital are used.

Furthermore, we consider resource dependence to be a possible factor explaining the cross-country differences in the growth effect of FDI. In resource-rich countries, FDI is generally concentrated in the primary sector, which, by its nature, does not have many linkages with, and spillovers into, the economy. Moreover, high FDI inflows into the primary sector can lead economies to shift away from competitive manufacturing sectors in which many externalities necessary for growth are generated (see, e.g., Aykut and Sayek, 2007). Thus, FDI may reduce productivity in the long run if it induces an expansion of sectors that do not exhibit positive externalities while other sectors with positive externalities shrink. Accordingly, it can be hypothesized that the growth effect of FDI depends on the level of resource dependence. Following common practice, natural resource dependence is measured by the ratio of primary exports to GDP.

Next, we consider the possibility that the growth effect of FDI depends on the economic significance of FDI. In fact, in many countries, FDI as a share of GDP is very small, often amounting to less than one percent. Accordingly, FDI might be simply too marginal in such countries to have a serious growth impact (see, e.g., Herzer, 2008), implying that the size of the growth impact of FDI possibly increases with the economic significance of FDI. To investigate this issue, the FDI-to-GDP ratio is included in our analysis.

We also include the volatility of FDI. Increased FDI volatility can lead to increased macroeconomic uncertainty, which in turn may hamper efforts at economic planning and reduce the quantity, as well as efficiency, of domestic investment. On the other hand, economic and political instability may discourage FDI, and thus be associated with FDI volatility (see e.g., Lensink and Morrissey, 2006). Thus, FDI volatility captures two important aspects that can affect the growth effects of FDI: It captures disincentives to investment and it also reflects political and economic instability in the broadest sense. For the empirical analysis, we estimate FDI volatility from a GARCH (1, 1) model using the FDI-to-GDP ratio.

As argued by Herzer et al. (2008) and Busse and Groizard (2008), the growth effects of FDI might also depend on the institutional, policy, and regulatory environment in which firms operate. To investigate the relevance of these aspects, we employ the measures of economic freedom published by the Heritage Foundation.<sup>8</sup> More specifically, we consider the following indices:

- (1) Business freedom—this measure assesses the ability to create, operate, and close an enterprise quickly and easily. It represents the overall burden, as well as the efficiency, of government regulations.

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<sup>8</sup> <http://www.heritage.org/research/features/index/downloads.cfm>

- (2) Freedom from government—this factor measures both the government’s use of scarce resources for its own purposes (government expenditures, including consumption and transfers) and the government’s control over scarce resources through ownership.
- (3) Property rights—the Property Rights Index measures the ability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state.
- (4) Freedom from corruption—this index assesses the perception of corruption in the business environment, including levels of government legal, judicial, and administrative corruption.
- (5) Financial freedom—this index measures the extent of government regulation of financial services.
- (6) Fiscal freedom—this is a measure of the burden of government from the revenue side. It includes both the tax burden in terms of the top tax rate on income and the overall amount of tax burden (as portion of GDP).
- (7) Investment freedom assesses the restrictions a country imposes on foreign investment.<sup>9</sup>

Finally, we include the inflation rate (based on the consumer price index) as a measure of macroeconomic instability and roads per square kilometer to measure infrastructure development. The variables and their sources are listed in Table 7. All variables are used in logarithmic form except for the dependent variable. The dependent variable is the estimated growth effect of FDI,  $\hat{\beta}_i$ , from Table 3.<sup>10</sup>

#### 4.2. Empirical analysis

To determine which of the above variables are important for explaining the cross-country variations in the effect of FDI on economic growth, we use the general-to-specific model selection approach suggested by Hoover and Perez (2004). Hoover and Perez show by means of Monte Carlo simulations that this approach is very effective in identifying the true parameters of the data generating process and thus outperforms other variable selection procedures, such as the extreme bounds approaches of Levine and Renelt (1992) and Sala-i-Martin (1997).

Following the Hoover and Perez (2004) approach, we start by estimating a general specification, in which all variables from Table 7 are included, and subject the estimated model to a series of specification tests. The test battery includes a Jarque-Bera test (*JB*) for normality of the residuals, a Ramsey RESET test for general nonlinearity and functional form misspecification

<sup>9</sup> See Kane et al. (2007) for a more detailed description of the economic freedoms.

<sup>10</sup> The estimated growth effect of FDI can be interpreted as a time average over the period 1970-2005. Consequently, we also use time averages for the independent variables in that period. Exceptions are the economic freedom indices for which data before 1995 are not available, so that we are constrained to average these values over the period 1995-2005. This should not be a problem since the indices of economic freedom are relatively stable over time.



(*RESET*), a Breusch-Pagan-Godfrey test for heteroscedasticity (*HET*),<sup>11</sup> and a sub-sample stability test (*STABILITY*) using an *F*-test for the equality of the variances of the first three-fourths versus the last one-fourth of the sample. The results of these tests are presented in the top part of Table 8. They show clear evidence of non-normality, misspecification, and parameter instability.

Table 7

Variables and sources

Variables	Definition	Source
<i>Log</i> (GDP)	Log of real per capita GDP (in constant 2000 US dollars). Data averaged over the period 1970 to 2005.	World Development Indicators 2007
<i>Log</i> (openness)	Log of the ratio of total trade (exports + imports) to GDP. Data averaged over the period 1970 to 2005.	World Development Indicators 2007
<i>Log</i> (credit)	Log of the private sector bank loans-to-GDP ratio. Data averaged over the period 1970 to 2005.	World Development Indicators 2007
<i>Log</i> (school)	Log of the secondary school enrolment rate. Data averaged over the period 1970 to 2005.	World Development Indicators 2007
<i>Log</i> (primary)	Log of the primary exports-to-GDP ratio. Data averaged over the period 1970 to 2005.	World Development Indicators 2007
<i>Log</i> ( <i>FDI</i> / <i>GDP</i> )	Log of the <i>FDI</i> -to-GDP ratio. Data averaged over the period 1970 to 2005.	UNCTAD <i>FDI</i> database
<i>Log</i> (volatility)	Log of <i>FDI</i> volatility. Volatility is measured using a GARCH (1, 1) model based on the <i>FDI</i> -to-GDP ratio. Data averaged over the period 1970 to 2005.	UNCTAD <i>FDI</i> database
<i>Log</i> (business)	Log of business freedom. Data averaged over the period 1995 to 2005.	Heritage Foundation
<i>Log</i> (government)	Log of freedom from government. Data averaged over the period 1995 to 2005.	Heritage Foundation
<i>Log</i> (rights)	Log of property rights. Data averaged over the period 1995 to 2005.	Heritage Foundation
<i>Log</i> (corruption)	Log of freedom from corruption. Data averaged over the period 1995 to 2005.	Heritage Foundation
<i>Log</i> (financial)	Log of financial freedom. Data averaged over the period 1995 to 2005.	Heritage Foundation
<i>Log</i> (fiscal)	Log of fiscal freedom. Data averaged over the period 1995 to 2005.	Heritage Foundation
<i>Log</i> (investment)	Log of investment freedom. Data averaged over the period 1995 to 2005.	Heritage Foundation
<i>Log</i> (inflation)	Log of the percentage changes in the consumer prices. Data averaged over the period 1970 to 2005.	World Development Indicators 2007
<i>Log</i> (roads)	Log of roads per square kilometer (km / km <sup>2</sup> of land mass). Data averaged over the period 1970 to 2005.	World Development Indicators 2007
Dependent variable: $\hat{\beta}_i$	Growth impact of <i>FDI</i> , individual DOLS estimates of the coefficient on ( <i>FDI</i> / <i>GDP</i> ) over the period 1970 to 2005.	Table 3

However, we find that Pakistan, Cameroon, Ghana, Kenya, and Nigeria produce large outliers in the residuals. Therefore, we introduce dummy variables for these countries to obtain a well-specified equation. The diagnostic test statistics are presented in the bottom of Table 8. They suggest that the model is now well specified. The assumption of normally distributed residuals

<sup>11</sup> Since an estimated dependent variable may introduce heteroskedasticity into the regressions (see, e.g., Saxonhouse, 1976), it is particularly important to test for heteroscedasticity. An alternative is to use White's heteroskedasticity-consistent standard errors. Because our models are free from heteroscedasticity, the use of White's standard errors does not change the significance levels. Results are available on request.

cannot be rejected, and the *RESET* test does not suggest nonlinearity or misspecification. The model also passes the Breusch-Pagan-Godfrey test for heteroscedasticity and the *F*-test for parameter stability.

Table 8

Diagnostic tests: general specification

Without country dummies	
<i>JB</i> ( $\chi^2_{(2)}$ )	60.20 [0.00]
<i>RESET</i> ( $\chi^2_{(1)}$ )	7.14 [0.01]
<i>HET</i>	$F(16, 27) = 0.50$ [0.92]
<i>STABILITY</i>	$F(10, 32) = 3.74$ [0.00]
With country dummies	
<i>JB</i> ( $\chi^2_{(2)}$ )	1.31 [0.52]
<i>RESET</i> ( $\chi^2_{(1)}$ )	0.48 [0.49]
<i>HET</i>	$F(21, 22) = 0.52$ [0.93]
<i>STABILITY</i>	$F(10, 32) = 1.06$ [0.84]

*JB* is the Jarque-Bera test for normality, *RESET* is the usual test for general nonlinearity and misspecification, *HET* is the Breusch-Pagan-Godfrey test for heteroscedasticity, and *STABILITY* is an *F*-test for the equality of the variances of the first three-fourths versus the last one-fourth of the sample. Numbers in brackets behind the values of the diagnostic test statistics are the corresponding *p*-values.

Next, we use the general model with country dummies and simplify it by removing insignificant variables. To this end, the variables are first ranked according to their *t*-statistics. We then employ five simplification paths in which each of the five variables with the lowest *t*-statistics is the first to be removed. Accordingly, we have five equations. From these equations, variables with insignificant coefficients are then eliminated sequentially according to the lowest *t*-values until the remaining variables are significant at the five-percent level. After removal of each variable, the above tests of model adequacy are performed. Furthermore, an *F*-test of the hypothesis that the current specification is a valid restriction of the general specification is used after each step. The result is that all of these tests are passed, implying five well-specified parsimonious equations, which are all valid restrictions of the general model. Finally, we construct the non-redundant joint model from each of these equations by taking all specifications and performing the *F*-test for encompassing the other specifications. This procedure yields the final specification in Table 9.

As can be seen, the final model passes all the diagnostic tests. Moreover, in Figures 2(a) through 2(c), recursive residuals (a), CUSUM (b), and CUSUM of square-tests (c) are presented, which unanimously support a stable model for the countries involved. In addition, Figure 2(d) shows that the final specification fits the actual data very well (adjusted  $R^2 = 0.80$ ). Thus, statistically valid inferences can be drawn from the regression results in Table 9.

Table 9

General-to-specific approach, final specification

Independent variable	Dependent variable: $\hat{\beta}_i$
Constant	-1.8284*** (-4.21)
<i>Log(government)</i>	0.3603*** (3.86)
<i>Log(business)</i>	0.0808** (2.17)
<i>Log(volatility)</i>	-0.0279*** (-3.05)
<i>Log(primary)</i>	-0.0187** (-2.32)
Pakistan dummy	-0.6304*** (-8.80)
Cameroon dummy	0.3673*** (5.23)
Ghana dummy	0.2475*** (3.50)
Kenya dummy	-0.44075*** (-6.18)
Nigeria dummy	0.2480*** (3.02)
Diagnostic tests	
Adj. $R^2$	0.80
<i>JB</i> ( $\chi^2_{(2)}$ )	0.53 [0.77]
<i>RESET</i> ( $\chi^2_{(1)}$ )	0.23 [0.63]
<i>HET</i>	$F(9, 34) = 0.92$ [0.62]
<i>STABILITY</i>	$F(10, 32) = 1.56$ [0.33]
<i>REST</i>	$F(11, 22) = 0.66$ [0.76]

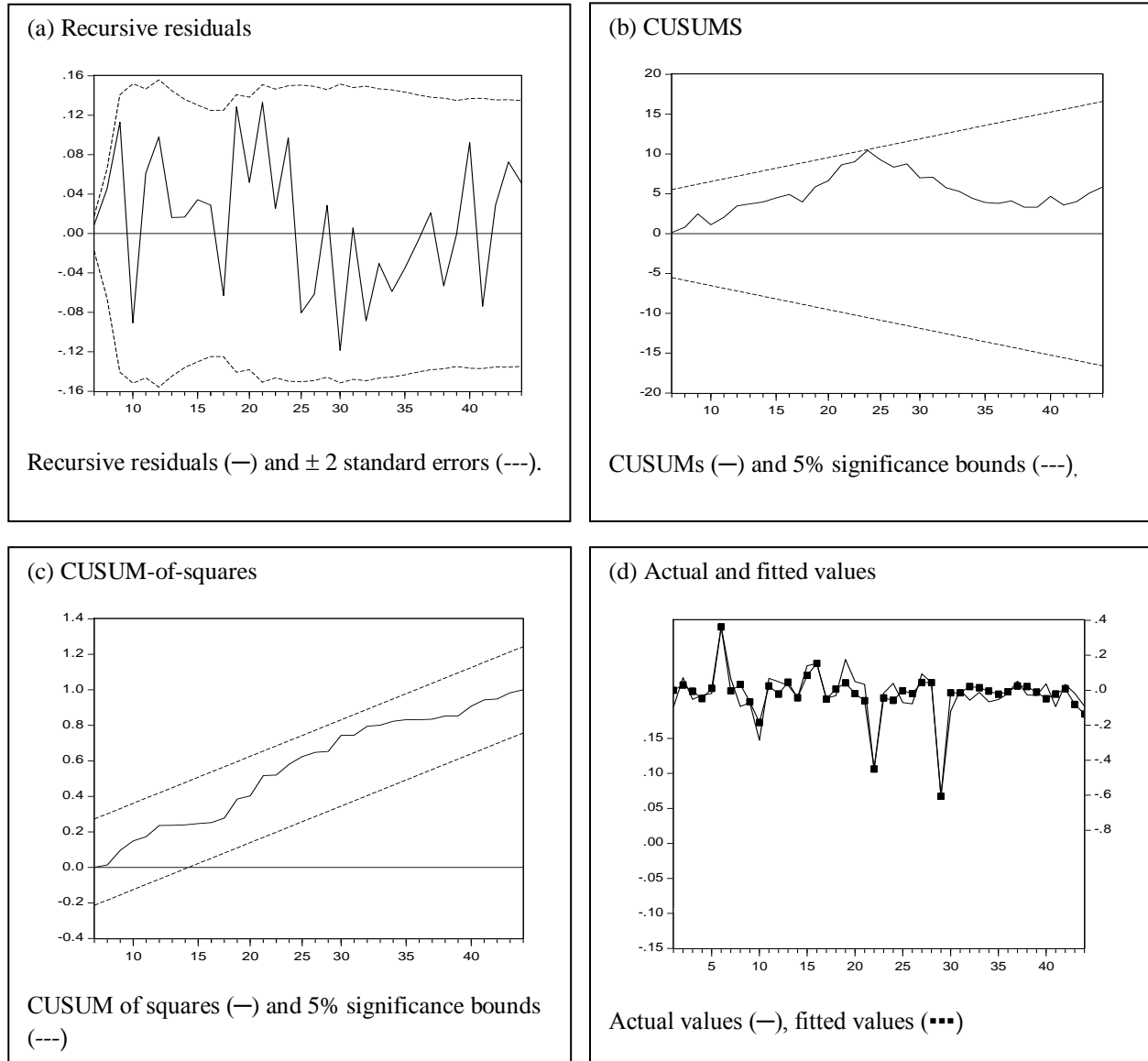
*t*-statistics in parentheses. \*\*\* (\*\*) indicate significance at the 1% (5%) level. *JB* is the Jarque-Bera test for normality, *RESET* is the usual test for general nonlinearity and misspecification, *HET* is the Breusch-Pagan-Godfrey test for heteroscedasticity, *STABILITY* is an *F*-test for the equality of the variances of the first three-fourths versus the last one-fourth of the sample, and *REST* is an *F*-test of the hypothesis that the model is a valid restriction of the general model. Numbers in brackets behind the values of the diagnostic test statistics are the corresponding *p*-values.

The results imply that the cross-country variations in the growth impact of FDI can be largely explained by cross-country differences in the level of freedom from government and business freedom, as well as FDI volatility, and natural resource dependence (measured as the share of primary exports in GDP). According to the estimated coefficients, an increase in freedom from government by one percent raises the long-run growth impact of FDI by 0.36 percentage points per year, and a one percent increase in business freedom is associated with a 0.08 percentage point increase in the growth effect of FDI. In contrast, each extra percent of FDI volatility is estimated to reduce the impact of FDI on economic growth by 0.0279 percentage points per year. Similarly, a one percent increase in the share of primary exports in GDP is associated with a 0.0187 percentage point decrease in the growth impact of FDI.

The dummy variables for Pakistan and Kenya are negative, while the dummies for Cameroon, Ghana, and Nigeria are positively related to the long-run growth effect of FDI. Given that the dummy variables reflect country-specific characteristics that are not captured by any of the variables involved, we admit that the estimated models do not provide a complete picture of the potential determinants of the cross-country differences in the growth effect of FDI.

Figure 2(a)-(d)

Stability tests, actual and fitted values



Outliers (Pakistan, Cameroon, Ghana, Kenya, and Nigeria) were excluded to compute the recursive residuals and the CUSUM and CUSUM of squares statistics.

Another important finding is that the impact of FDI on economic growth does not depend (directly) on the level of per capita income in the host country, the human capital base, the degree of openness in the economy, or the level of financial market development. All these variables turned out to be insignificant and hence were removed from the general model. Consequently, our results support Carkovic and Levine (2005), who also find that the impact of FDI on growth does not robustly vary with the level of per capita income, human capital, trade openness, and financial

market development. Our results are also in line with the finding of Busse and Groizard (2008) that the growth effect of FDI is negatively related to level of regulation.

In Table 10, we provide some information about the performance of the variables that were omitted from the final specification. The second column reports the *t*-statistic of each omitted variable when added individually to the regression in Table 9. The last five columns give an indication of the extent to which the omitted variables are collinear with the regressors of the final model, showing the pair-wise correlation coefficients (including the *t*-statistics) and the *p*-value of the *F*-test for adequacy of the model when the omitted variable is regressed on the four included variables.

Table 10

Effects of adding further regressors individually to the Table 9 regression and correlation coefficients

Regressor	<i>t</i> -statistic of added variable	Correlation coefficients				<i>p</i> -value of <i>F</i> -statistic
		<i>Log</i> (government)	<i>Log</i> (business)	<i>Log</i> (volatility)	<i>Log</i> (primary)	
<i>Log</i> (openness)	-0.01	0.12 (0.81)	0.39 (2.77)	0.60 (4.92)	-0.07 (-0.82)	0.000
<i>Log</i> (credit)	1.43	0.01 (0.08)	0.41 (2.94)	0.18 (1.18)	0.02 (1.13)	0.095
<i>Log</i> (GDP)	-0.31	0.17 (1.14)	0.76 (7.64)	0.48 (3.55)	-0.31 (-2.11)	0.000
<i>Log</i> (school)	0.06	0.01 (0.09)	0.60 (4.91)	0.38 (2.64)	-0.27 (-0.65)	0.000
<i>Log</i> (rights)	1.09	0.14 (0.81)	0.71 (6.54)	0.31 (2.13)	-0.11 (-0.72)	0.000
<i>Log</i> (corruption)	1.22	-0.08 (-0.52)	0.66 (5.64)	0.33 (2.24)	-0.13 (-0.87)	0.000
<i>Log</i> (inflation)	-0.45	-0.31 (-2.10)	-0.13 (-0.83)	0.07 (0.42)	-0.10 (-0.66)	0.234
<i>Log</i> (FDI/GDP)	1.27	0.10 (0.64)	0.48 (3.52)	0.81 (9.27)	-0.20 (-1.34)	0.000
<i>Log</i> (roads)	1.11	0.00 (0.02)	0.53 (4.00)	0.30 (2.13)	-0.13 (-1.28)	0.008
<i>Log</i> (financial)	-0.56	0.24 (1.60)	0.61 (5.00)	0.20 (1.30)	-0.08 (-0.49)	0.000
<i>Log</i> (fiscal)	0.44	-0.06 (-0.38)	0.33 (2.31)	0.05 (0.36)	-0.14 (-0.93)	0.201
<i>Log</i> (investment)	-0.63	0.19 (1.25)	0.55 (4.34)	0.188 (1.24)	-0.17 (-1.09)	0.003

*t*-statistics in parentheses. The last column refers to a regression of each variable on the independent variables in Table 9.

When added individually to the final model, openness is highly insignificant and has an unexpected negative sign, while domestic credit to the private sector is only slightly insignificant (*p*-value = 0.16) and has the expected positive coefficient. Similarly, GDP per capita is insignificant and has the wrong sign, which is consistent with the results by Carkovic and Levine (2005), who find the interaction term between FDI and per capita income to be insignificant and negative in each specification.<sup>12</sup> Schooling is insignificant as, for example, in Lensink and Morrissey (2006), while Carkovic and Levine (2005) actually find schooling to be statistically significantly negative in four out of twelve specifications.

<sup>12</sup> In one specification the interaction term is actually significantly negative.

However, most of the omitted variables are significantly correlated with the variables in the final model, which might suggest that the excluded variables might play an indirect role in the FDI-growth relationship by affecting or interacting with some of the included variables. In terms of individual correlation coefficients, business freedom is highly positively correlated with GDP per capita, schooling, roads per square kilometer, freedom from corruption, financial freedom, investment freedom, and property rights. All correlation coefficients are higher than 0.5. Investment volatility, in contrast, is highly positively correlated with openness (0.60) and the FDI-to-GDP ratio (0.81), which might suggest that these two variables have an indirect negative effect on the FDI-growth relationship through increased investment volatility (although the FDI-to-GDP ratio is overall positively related to the growth impact of FDI (see Table 10, column 2)). On the other hand, freedom from government and the share of primary exports in GDP do not have strong correlations with any of the excluded variables.

Taken together, these findings suggest that cross-country variations in the growth effects of FDI can largely be explained by cross-country differences in freedom from government intervention, business freedom, FDI volatility, and resource dependence. This, however, does not imply that all other variables are irrelevant for exploiting the potential of FDI to affect growth. There are several factors—such as the level of per capita income, human capital, property rights and freedom from corruption—that are correlated with freedom from government, business freedom, FDI volatility and resource dependence and thus are likely to play an important indirect role in the relationship between FDI and growth.

## 5. Conclusion

The results reported in this paper challenge the current belief that FDI generally has a positive effect on economic growth in developing countries. We first examined the nature of the growth effect of FDI using panel cointegration techniques that are specifically designed to deal with key problems plaguing previous studies of the FDI-growth nexus: omitted variables, endogeneity, cross-country heterogeneity and neglected long-run level relationships. Employing data for 44 developing countries over the period 1970 to 2005, we found that the effect of FDI on economic growth in developing countries is negative on average. This finding is robust to outliers, sample size, and potential structural breaks. Nevertheless, there are large cross-country differences in the effects of FDI on economic growth.

Next, we used a general-to-specific model selection approach to identify country-specific factors explaining the differences in the growth effects of FDI. The results are clear: Cross-country differences in the growth effects of FDI cannot be explained by cross-country differences in per

capita income, human capital, openness, and financial market development. Instead, we found that the growth effects of FDI depend positively on levels of freedom from government intervention and freedom from business regulation, and negatively on FDI volatility and natural resource dependence. Nevertheless, there are several factors, such as the level of per capita income, property rights, and freedom from corruption, that are correlated with freedom from government, business freedom, FDI volatility, and resource dependence, suggesting that these factors do play an important indirect role in the FDI-growth relationship.

Our conclusion is that although the current effect of FDI on economic growth in developing countries is negative on average, the future impact need not necessarily be negative. Economic reforms aimed at

- (i) improving resource allocation by eliminating market-distorting policies,
- (ii) minimizing the regulatory burden on business,
- (iii) reducing FDI volatility by increasing political and economic stability, and
- (iv) removing natural resource dependence by diversifying the economy

can protect developing countries from the negative consequences of FDI and induce FDI-led growth in the long run.

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