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How do South-South and North-South FDI affect total factor productivity growth in developing countries?

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Abstract

This study uses a unique dataset to examine not only the effect of total FDI on TFP growth in a large sample of developing countries but also, and especially, the productivity growth effects of South-South versus North-South FDI. It is found that total FDI has a significant positive effect on TFP growth in developing countries. However, this effect is driven by North-South FDI; while South-South FDI is insignificant and sometimes negative, North-South FDI exerts a statistically significant positive effect on TFP growth in developing countries.

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1. Introduction

Economists and policy makers often assume that foreign direct investment (FDI) in developing countries brings with it not just capital but also knowledge that "spills over" to local firms through mechanisms such as imitation effects, competition effects, labor mobility, and vertical linkages between foreign and domestic firms. If this assumption is correct, one would expect to find a significant positive effect of FDI on total factor productivity (TFP) growth in developing countries at the macro level. However, the few published studies on this issue provide mixed results.

Woo (2009), for example, finds for a sample of 70 developing countries that FDI promotes TFP growth; De Mello (1999) reports for a sample of 17 developing countries that FDI is not significantly related to TFP growth; and the results of Wang and Wong (2009), based on a sample of 69 developing countries, suggest that FDI has a negative effect on TFP growth in developing countries with low levels of human capital, but the negative effect becomes smaller in absolute value—and then turns positive—as the level of human capital rises.

There are several possible explanations for why studies find insignificant or negative effects of FDI on TFP growth in developing countries. First, domestic firms using very backward production technology and low-skilled workers may be unable to learn from multinationals (Görg and Greenaway, 2004). The implication is that a minimum level of human capital may be necessary for FDI to contribute to productivity growth. Second, multinationals have lower marginal costs due to some firm-specific advantage, which allows them to attract demand away from domestic firms, thus forcing the domestic firms to reduce production and move up their average cost curve (Görg and Greenaway, 2004). This negative competition effect may reduce not only the productivity of domestic firms but also the productivity of the economy as a whole (depending on relative productivity of foreign firms and the amount of the reduction of the productivity of domestic firms). Third, multinationals often source fewer inputs locally than the domestic firms they displace, implying that FDI can cause a decrease in local demand for inputs, which, in turn, can reduce input variety and thus overall productivity (Rodríguez-Clare, 1996). Finally, and alternatively, it is also possible that the failure to find a positive effect of FDI on TFP growth in developing countries is due to statistical problems—such as endogeneity, omitted variables, measurement error, and sample size.

In this context, it should be noted that the macro studies cited above are part of a broader literature, which investigates the productivity effects of FDI both at the micro and macro level. A general limitation of this literature, however, is the lack of studies on the productivity effects of South-South versus North-South FDI. In one of the few micro studies on this issue, Pfeiffer et al. (2015) find, for sub-Saharan firms, that South-South FDI tends to generate larger productivity gains than North-South FDI. In the only study to date that uses macroeconomic data, Kim et al. (2015) find, based on relatively few observations and a very parsimonious model with only two covariates (South-South and North-South imports),[1] that North-South FDI has a significant positive effect on TFP growth, whereas the effect of South-South FDI is not significant in most of their regressions.

Given the limited amount of research—specifically on the macro effects of South-South and North-South FDI on productivity growth—and the mixed nature of the findings, it is still unclear, whether and how FDI affects TFP growth in developing countries. This motivates the present study. The novelty of this study is that it uses a unique dataset to

[1] The limited number of observations in the study of Kim et al. (2015) is due to the fact that bilateral FDI data for developing countries were not available at the time of their study. Therefore, they were forced to construct their data on South-South and North-South FDI by combing bilateral OECD FDI data and unilateral FDI data for developing countries. Unfortunately, it is not clear from their paper how they constructed their data. We contacted the corresponding author and requested their data for reanalysis, but he did not respond to our emails.

examine not only the general effect of (total) FDI on TFP growth in a large sample of (86) developing countries but also the specific effects of South-South and North-South FDI on productivity growth in developing countries. The latter is the main focus of this paper because there may be important differences between the effects of these two types of FDI.

The basic reason why such differences can exist is that the technological gap tends to be larger between domestic firms and developed-country multinationals than between domestic firms and developing-country multinationals (Pfeiffer et al., 2015). A larger technology gap implies that Northern multinationals are in general more technologically advanced than multinationals from the South. A larger gap also means more opportunities for domestic firms to improve their efficiency by adapting new technologies (Wang and Blomström, 1992). This, however, does not necessarily imply that North-South FDI has a greater potential to boost productivity growth than South-South FDI. Given that Northern multinationals tend to be more technologically advanced than Southern multinationals, negative competition effects are more likely to be associated with developed-country multinationals. In addition, if the technological gap is too wide, domestic firms may be unable to absorb the knowledge available from the multinationals (Görg and Greenaway, 2004). Thus, narrower technological gaps between foreign and domestic firms may facilitate absorption of technological knowledge, implying that South-South FDI could generate more spillovers than North-South FDI. In addition, developing-country multinationals have a greater propensity to establish linkages with local firms than do their counterparts from developed countries, which in turn enables them to more deeply integrate into the host economies (UNCTAD, 2006), and this deeper integration could be particularly beneficial in terms of (vertical) knowledge spillovers. However, this benefit may be mitigated by the fact that most South-South FDI is concentrated in extractive industries and infrastructure, where spillovers are limited (World Bank, 2006).

Whether and how South-South and North-South FDI affect TFP growth in developing countries is thus an empirical question. We investigate this question using 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 techniques allow to control for potential endogeneity problems.

The rest of this paper is organized as follows. Section 2 presents the empirical model and describes the data. Section 3 presents the empirical analysis, and Section 4 concludes.

2. Empirical model and data

2.1. Model

The basic model is as follows:

$$\Delta \log TFP_{it} = \beta FDI/GDP_{it-1} + \sum_{m=1}^{M} \gamma_m X_{mit} + \mu_i + \lambda_t + \varepsilon_{it}\,, \qquad (1)$$

where i and t are country and time indices, $\Delta\log TFP$ is growth rate of TFP (measured in percentage points), and *FDI/GDP* represents three measures of FDI: (1) FDI from all countries as a percentage of GDP, *ALLFDI/GDP*, (2) FDI from developing countries as a percentage of GDP, *SSFDI/GDP*, and (3) FDI from developed countries as a percentage of GDP, *NSFDI/GDP*. The use of GDP in the denominator of the variables is intended to account for economic size, as is common practice in the literature. Because some of the observations are negative (due to disinvestment), we follow most of the literature and do not log-transform the FDI variables to avoid loss of data. All FDI variables are lagged one year to

take into account the possible endogeneity of FDI,[2] as well as the fact that spillovers take time to be realized. As a robustness test, we also use a specification in which our main variables of interest, *SSFDI/GDP* and *NSFDI/GDP*, are lagged two years.

Our empirical model assumes that a correlation between the current value of $\Delta\log TFP$ and past values of *FDI/GDP* implies causality from *FDI/GDP* to $\Delta\log TFP$. This assumption rules out the possibility of reverse causality—that the (correct) *expectation* of future changes in TFP growth causes changes in FDI. We consider this possibility unlikely because growth rates of TFP (or their determining (non-FDI) factors) are extremely difficult to predict in advance, especially in the case of developing countries. Therefore, and because instrumental variables estimators are less efficient than OLS when the explanatory variables are exogenous, we estimate the regression Equation (1) by OLS. In the robustness section, we also use GMM instrumental variable estimators to address potential reverse causality concerns.

X is the usual vector of *m* time-varying control variables. Our choice of control variables is guided by the existing macro-literature on the FDI-TFP relationship (Wang and Wong, 2009; Woo, 2009; Ashraf et al., 2016). In the baseline model, we control for education, *Schooling* (measured by the secondary school enrolment rate), population growth (measured in percentage points), $\Delta\log Pop$, trade openness (the sum of imports plus exports as a percentage of GDP), *Trade*, and the inflation rate (measured in percentage points), *Inflation*, as a measure of macroeconomic stability.

In the robustness checks, we extend the vector of control variables in Equation (1) to include government consumption expenditures (as a percentage of GDP), *Gov*, as a proxy for distortions caused by unproductive government expenditures and the associated taxation, the Kaufmann-Kraay-Mastruzzi measure of political stability and absence of violence, *Stability*, a "law and order" index as a measure of institutional quality, *Law*, and scientific and technical journal articles per capita, *Articles*, as a proxy for absorptive capacity. We also test for possible conditional effects by interacting *Articles* and the FDI variables.

Additionally, we include country fixed effects, μ_i, to control for any country-specific factors that are relatively stable over time (such as geography, culture, etc.). Also included are year fixed effects, λ_t, to control for any factors (such as global business cycles, oil shocks, etc.) that are common across countries but vary across time.

2.2. Data

Following Hall and Jones (1999), we calculate (log) TFP as the residual from a constant returns to scale Cobb-Douglas production function with capital and human capital-augmented labor:

$$\log TFP_{it} = \log Y_{it} - (1-\alpha)\log K_{it} - \alpha \log L_{it}h_{it}, \quad (2)$$

where *Y* is output, *K* is capital input, *Lh* is human capital-augmented labor input, defined as the product of "raw" labor *L* and human capital per worker *h*, $(1-\alpha)$ is the capital share of income, and α is the labor share of income. We assume a constant α of 0.6667, as is common practice in the literature. As a robustness check, we alternatively calculate (log) TFP as the residual from country-specific OLS regressions of log*Y* on log*K* and log*Lh* to allow for the possibility of country-specific labor and capital shares, as well as the possibility of increasing or decreasing returns to scale.

All data used to calculate TFP are from the Penn World Tables (PWT) version 8.1 (Feenstra et al., 2015).[3] *Y* is measured by (real) GDP in constant 2005 dollars, *K* by the constant 2005 dollar value of the stock of (real) capital (constructed by the perpetual

[2] FDI may be endogenous if (i) high TFP growth reflects improvements in economic policy, institutional quality and/or technological knowledge that attract *more* FDI, or if (ii) high TFP growth is associated with high wage growth that leads to *less* (cost-reducing) FDI (Ashraf et al., 2016).

[3] Available at http://www.rug.nl/research/ggdc/data/pwt/. Last accessed May 10, 2016.

inventory method), L by the number of persons employed, and h by $e^{\phi(s)}$, where s is the average years of schooling of the population above 15 years of age, the derivative $\phi'(s)$ is the return to schooling estimated in a Mincerian wage regression, and ϕ is a piecewise linear function, with a zero intercept and a slope of 0.134 through the fourth year of education, 0.101 for the next four years, and 0.068 for education beyond the eighth year.[4]

We use FDI stocks rather than FDI flows because stocks, due to the accumulation of flows, may more effectively capture long-run effects (Chintrakarn et al., 2012). In addition, stock data are considered more reliable than flow data, which are more volatile than stock data (de Sousa and Lochard, 2011). In the robustness checks, we also utilize FDI flow data.

The data used to construct our FDI variables are from the UNCTAD bilateral FDI database.[5] We aggregate the data into three categories of FDI: (1) FDI to developing countries from all countries, (2) FDI to developing countries from developing countries, and (3) FDI to developing countries by firms from developed countries. In the robustness checks, we decompose the second category, South-South FDI, into two further categories, FDI from low-income countries and FDI from middle-income countries.

We classify a country as "developing" if it is included in the low-income or middle-income category by the World Bank in its World Development Reports[6] for the majority of the years in our sample period, while high-income countries are classified as "developed".

We use (nominal) GDP data from the World Development Indicators (WDI) online database[7] to express all our FDI variables as a percentage of GDP. The data on secondary education (enrolment), population growth, trade openness, inflation (measured using the GDP deflator), government consumption as a percentage of GDP, and the number of scientific and technical journal articles are also from the WDI. The Kaufmann-Kraay-Mastruzzi measure of political stability and absence of violence is from the Worldwide Governance Indicators project.[8] It captures "perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism" (Kaufmann et al., 2010: 4). The "law and order" measure is from the International Country Risk Guide.[9] This measure assesses the strength and impartiality of the legal system.

Our dataset is an unbalanced panel of 86 developing countries spanning the period between 2001 and 2011. The sample includes all developing countries and years for which data are available. A list of the countries included in the sample is provided in Table A.I in the Appendix. Table A.II in the Appendix presents some summary statistics on the variables included in our baseline specifications.

3. Empirical analysis

This section investigates the effects of total FDI, South-South FDI, and North-South FDI on TFP growth in (host) developing countries. Our main focus is on the effects of South-South and North-South FDI. We first present results from our baseline model. Then, we check the robustness of our main results.

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[4] The coefficient on the first four years is the return to schooling in sub-Saharan Africa (13.4%). The coefficient on the second four years is the world average return to schooling (10.1%). The coefficient on schooling above eight years is the OECD return to schooling (6.8%). All coefficients are taken from Psacharopoulos (1994).

[5] Available at http://unctad.org/en/Pages/DIAE/FDI%20Statistics/FDI-Statistics-Bilateral.aspx. Last accessed January 20, 2017.

[6] Available at http://www.worldbank.org/en/publication/wdr/wdr-archive. Last accessed January 20, 2017.

[7] Available at http://data.worldbank.org/data-catalog/world-development-indicators. Last accessed January 20, 2017.

[8] Available at http://info.worldbank.org/governance/wgi/index.aspx#home. Last accessed January 20, 2017.

[9] Available at http://www.prsgroup.com/about-us/our-two-methodologies/icrg. Last accessed January 20, 2017.

3.1. Baseline results

Table I presents our baseline results. The coefficients on the control variables are largely as expected. Education is positively, but not significantly, associated with TFP growth in all specifications. The coefficient on Δlog*Pop* is also always positive, although insignificant at conventional levels. Thus, there is some slight but insignificant evidence that greater population growth leads to higher productivity growth either by inducing innovation, producing innovation, or through creating greater economies of scale, specialization or agglomeration (Pritchett, 1996). Trade openness is positively but insignificantly related to TFP growth in developing countries. Finally, *Inflation* is unexpectedly positive but always insignificant.

Turning to the main variables of interest in Table I, we see that the coefficient on *ALLFDI/GDP* in Column (1) is positive and highly significant. However, the results in Columns (2) through (4) indicate that the significant positive effect of total FDI on TFP growth in developing countries is driven by North-South FDI. In column (2), which does not include the North-South FDI measure to allow for the possibility that South-South FDI affects TFP growth indirectly by stimulating North-South FDI, the coefficient on *SSFDI/GDP* is positive but insignificant. In contrast, in Column (3), which includes only the North-South FDI measure, the estimated coefficient on *NSFDI/GDP* is positive and significant at the 1% level. Column (4) contains our preferred specification, which includes both types of FDI to estimate their independent effects. The results do not change qualitatively when the two measures are included jointly in a regression: the measure of South-South FDI is insignificant, while the North-South FDI measure is significant.

Table I. Baseline results

	(1)	(2)	(3)	(4)
Schooling	0.0710	0.0621	0.0702	0.0692
	(0.0543)	(0.0527)	(0.0543)	(0.0542)
Δlog*Pop*	1.3595	1.7935	1.234	1.1561
	(0.9697)	(1.1598)	(0.946)	(0.9647)
Trade	0.0078	0.0151	0.0060	0.0049
	(0.0248)	(0.0233)	(0.0253)	(0.0264)
Inflation	0.0554	0.0558	0.0552	0.0551
	(0.0613)	(0.0602)	(0.0614)	(0.0616)
ALLFDI/GDP (lagged one year)	0.0428***			
	(0.0097)			
SSFDI/GDP (lagged one year)		0.0062		-0.0358
		(0.0490)		(0.0722)
NSFDI/GDP (lagged one year)			0.0470***	0.0482***
			(0.0110)	(0.0129)
No. of observations	643	643	643	643
No. of countries	86	86	86	86
R^2 (within)	0.1475	0.1193	0.1502	0.1509

Notes: The dependent variable is Δlog*TFP*. Coefficients for country and time fixed effects are not reported. Robust standard errors in parentheses. *** (**) [*] indicate significance at the 1% (5%) [10%] level.

More specifically, the coefficient on *NSFDI/GDP* in Column (4) is 0.0482, implying that a 1 percentage point increase in the North-South FDI/GDP ratio leads, on average, to a 0.0482 percentage point increase in the average growth rate of TFP. To evaluate the magnitude of this effect, consider the average change in the North-South FDI/GDP ratio in our sample, 0.8996 percentage points, and the average change in the growth rate of TFP,

0.1371 percentage points. Multiplying the estimated coefficient with the average change in the North-South FDI/GDP ratio yields a value of 0.0434, implying that the increase in the North-South FDI/GDP ratio between 2001 and 2011 has led to an increase in the growth rate of TFP by 0.0434 percentage points for the typical country in our sample. With an average change in the TFP growth rate of 0.1371 percentage points, this means that the increase in the North-South FDI/GDP ratio has been responsible for about 30% of the average increase in the growth rate of TFP. Thus, the effect of North-South FDI on TFP growth in developing countries is not only statistically significant but also economically significant.

3.2. Robustness

Our main result so far is that FDI from developing countries has no significant effect on TFP growth in developing countries, whereas FDI from developed countries has a statistically and economically significant positive effect on TFP growth in developing countries. To check the robustness of this result, we augment our baseline model with four additional control variables: government consumption as a percentage of GDP (*Gov*), political instability (*Stability*), institutional quality (*Law*), and scientific and technical journal articles (*Articles*). The results of this exercise are reported in Column (1) of Table II.

As far as the additional control variables are concerned, only institutional quality is significant (at the 10% level) and has the expected positive sign, whereas the coefficients of *Gov*, *Stability*, and *Articles* have unexpected signs and are insignificant, with the exception of the coefficient of *Articles*. Of course, one must be cautious in interpreting these findings given the potential multicollinearity between the explanatory variables. Nevertheless, the results in Column (1) of Table II are consistent with those reported in Table I: while the coefficient on *SSFDI/GDP* is not significantly different from zero, the coefficient on *NSFDI/GDP* is positive and significant.

In Column (2), we augment our baseline specification with two interaction terms: *SSFDI/GDP*×*Articles* and *NSFDI/GDP*×*Articles*.[10] The coefficients of these interaction terms, however, are not statistically significant. Given that the coefficient on *NSFDI/GDP* is still significant and positive, it can be concluded that the level of scientific research in the host country does not affect its ability to absorb the benefits of North-South FDI.

In Column (3) of Table II, the FDI measures are lagged two years. Again, the results show a significant effect for FDI from developed countries but not for FDI from developing countries.

Next, we re-estimate the baseline model using *flows* of FDI from developing and developed countries (as a percentage of GDP), labelled *SSFDIflows/GDP* and *NSFDIflows/GDP*, instead of South-South and North-South FDI *stocks*. As can be seen in Column (4) of Table II, the coefficient on the North-South FDI variable remains positive and significant. The coefficient on the South-South FDI variable, in contrast, is now significantly negative (at the 10% level).

In Column (5) of Table II, we use the residuals (in differences) from a regression of the log of output on the log of capital input and the log of human capital-augmented labor input as an alternative measure TFP growth; this measure is denoted by Δ*RES*. Again, we find no significant effect for South-South FDI, while the effect of North-South FDI is statistically significant and of the same magnitude as in Table I.

[10] We do not use lagged values of the number of scientific and technical journal articles because our baseline specification includes the current values of the number of scientific and technical journal articles and because most studies are available as working papers before they are published in journals. The latter implies that the current values of *Articles* already capture possible lagged effects of scientific research.

Table II. Additional control variables, interaction terms, and different measures of FDI and TFP

Dependent variable	(1) Δlog*TFP*	(2) Δlog*TFP*	(3) Δlog*TFP*	(4) Δlog*TFP*	(5) Δ*RES*
Schooling	0.0412	0.0576	0.0976	0.0734	-0.0049
	(0.0597)	(0.0543)	(0.0593)	(0.0529)	(0.0396)
Δlog*Pop*	1.1837	1.1803	0.9515	1.8579*	-0.4718
	(0.9017)	(0.9528)	(1.0813)	(1.1020)	(0.6846)
Trade	0.0025	0.0102	0.0044	0.0274	-0.0235
	(0.0318)	(0.0277)	(0.0270)	(0.0256)	(0.0238)
Inflation	0.0580	0.0526	0.0923	0.0665	0.0355
	(0.0661)	(0.0615)	(0.0647)	(0.0653)	(0.0536)
Gov	0.3125				
	(0.3623)				
Stability	-1.4772				
	(1.2600)				
Law	2.0108*				
	(1.1020)				
Articles	-227.12**	42.6619			
	(110.8287)	(204.1321)			
SSFDI/GDP (lagged one year)	-0.0021	-0.0300			-0.0113
	(0.0854)	(0.0729)			(0.0441)
NSFDI/GDP (lagged one year)	0.0496***	0.0522***			0.0439***
	(0.0101)	(0.0092)			(0.0068)
SSFDI/GDP (lagged one year)×*Articles*		3.3660			
		(24.3498)			
NSFDI/GDP (lagged one year)×*Articles*		-3.8469			
		(2.7044)			
SSFDI/GDP (lagged two years)			-0.0509		
			(0.0469)		
NSFDI/GDP (lagged two years)			0.0275**		
			(0.0112)		
SSFDIflows/GDP (lagged one year)				-0.4812*	
				(0.2865)	
NSFDIflows/GDP (lagged one year)				0.1726***	
				(0.0363)	
No. of observations	541	641	560	630	643
No. of countries	71	85	82	86	86
R^2 (within)	0.1995	0.1581	0.1473	0.1623	0.1012

Notes: Coefficients for country and time fixed effects are not reported. Robust standard errors in parentheses. *** (**) [*] indicate significance at the 1% (5%) [10%] level.

We also examine whether our main result is robust to alternative estimation strategies. A potential problem with the OLS estimates of Equation (1) is the possibility that the one-year lags of the South-South FDI measure and the North-South FDI measure are endogenous. To account for this potential problem, we re-estimate Equation (1) using the Blundell and Bond (1998) system GMM (S-GMM) estimator.

As is well known, the S-GMM estimator combines the standard set of equations in first differences with suitable lagged levels as instruments, with an additional set of equations in levels with suitable lagged first differences as instruments.[11] By adding the original

[11] The GMM technique uses internal instruments (that is, lagged realizations of the explanatory variables). An alternative would be the use of external instruments. However, it is well known that instrumental variables regressions may lead to spurious results when the instruments are weak or invalid and that it is difficult

equation in levels to the system and exploiting these additional moment conditions, Blundell and Bond (1998) find a dramatic improvement in efficiency and a significant reduction in finite sample bias compared with the Arellano and Bond (1991) difference GMM (D-GMM) estimator.

To avoid too many instruments,[12] we treat only the FDI variables as endogenous (while all other variables are treated as strictly exogenous) and replace the GMM instruments with their principal components; principal components analysis is run on the correlation matrix of the GMM instruments, and the principal components with the largest eigenvalues are selected as instruments (see, e.g., Bai and Ng, 2010).

The S-GMM results are reported in Column (1) of Table III. Following common practice, we also present the Hansen-J test of over-identifying restrictions (Hansen) and a second-order serial correlation test (AR2). As can be seen, the Hansen-J test fails to reject the validity of the instruments at the 5% level, and the AR2 test indicates that the errors (in the first-difference regression) exhibit no second-order serial correlation. Furthermore, the number of instruments is not too large (less than the number of countries). We thus conclude that the results do not suffer from misspecification. They show that the coefficient of North-South FDI remains significant and positive; in contrast, the coefficient of South-South FDI is significant and negative.

For completeness, we also report results from the standard D-GMM estimator. As can be seen in Column (2), the effect of North-South FDI on TFP is still positive and significant, while that of South-South FDI is negative and significant.

Finally, we estimate the productivity growth effects of FDI from high-income, middle- income, and low-income countries for subsamples of low-income and middle-income countries. The measure of FDI from low-income countries is denoted by *LowFDI/GDP* and that of FDI from middle-income countries by *MiddleFDI/GDP*; FDI from high-income (or developed) countries is again represented by the variable *NSFDI/GDP*. As can be seen in Columns (3) and (4) of Table III, FDI from low-income countries and FDI from middle-income countries are insignificant in both subsamples, and FDI from high-income countries is significant only in the subsample of low-income countries. Thus, we again find that South-South FDI does not promote TFP growth. In addition, the results in Columns (3) and (4) suggest that the positive effects of North-South-FDI on TFP growth occur mainly in low-income developing countries.

(sometimes even impossible) to find variables that qualify as valid external instruments (variables that are correlated with the endogenous variable but uncorrelated with the error term).

[12] A large number of instruments can overfit endogenous variables, failing to expunge their endogenous components and biasing coefficient estimates. Unfortunately, there are no formal tests that can determine the number of lags that should be used as instruments. A rule of thumb is that the number of instruments should be less than the number of countries (Roodman, 2009).

Table III. Alternative estimators and different samples

Sample	(1) Total sample	(2) Total sample	(3) Low-income country sample	(4) Middle-income country sample
Estimator	S-GMM	D-GMM	OLS	OLS
Schooling	0.1083	0.1022	-0.0267	0.0510
	(0.1007)	(0.1051)	(0.1065)	(0.0635)
Δlog*Pop*	-3.7323***	-3.5222***	3.1555**	-1.5740*
	(1.1261)	(1.2289)	(1.2243)	(0.8980)
Trade	-0.0574	-0.0551	0.0184	-0.0245
	(0.0535)	(0.0558)	(0.0389)	(0.0354)
Inflation	0.0302	0.0349	0.0681	0.0049
	(0.0649)	(0.0641)	(0.0677)	(0.0819)
SSFDI/GDP (lagged one year)	-0.3450***	-0.3137**		
	(0.1143)	(0.1223)		
NSFDI/GDP (lagged one year)	0.0889***	0.0886***	0.0496***	-0.0120
	(0.0072)	(0.0075)	(0.0085)	(0.0385)
LowFDI/GDP (lagged one year)			0.2821	-0.112
			(1.3000)	(0.3206)
MiddleFDI/GDP (lagged one year)			-0.0141	0.0115
			(0.0612)	(0.1169)
Hansen (p-value)	0.118	0.0820		
AR2 (p-value)	0.553	0.548		
No. of instruments	31	30		
No. of observations	643	552	232	382
No. of countries	86	81	31	55
R^2 (within)			0.2867	0.2045

Notes: The dependent variable is Δlog*TFP*. Coefficients for country and time fixed effects are not reported. Robust standard errors in parentheses. The reported GMM results are two-step estimates. *** (**) [*] indicate significance at the 1% (5%) [10%] level.

4. Conclusions

In this study, we used a unique dataset to examine not only the effect of total FDI on TFP growth in a sample of 86 developing countries over the period 2001-2011, but also to examine the productivity growth effects of South-South and North-South FDI. The latter was the focus of this study. It was found that total FDI is associated with TFP growth in a significant and positive manner, but this effect is driven by North-South FDI. More specifically, our results suggest that South-South FDI has an insignificant and sometimes negative effect on TFP growth in developing countries, while North-South FDI exerts a statistically and economically significant positive effect on TFP growth in these countries, specifically in low-income developing countries.

Appendix

Table A.I. Countries in the sample, 2001-2011

Albania	Guatemala	Niger
Argentina	Honduras	Pakistan
Armenia	Hungary	Panama
Bangladesh	India	Paraguay
Belize	Indonesia	Peru
Bolivia	Iran, Islamic Rep.	Philippines
Botswana	Iraq	Poland
Bulgaria	Jamaica	Rep. of Congo
Burundi	Jordan	Romania
Cambodia	Kazakhstan	Russian Federation
Cameroon	Kenya	Sierra Leone
Central African Republic	Kyrgyz Republic	Slovak Republic
Chile	Lao PDR	South Africa
China	Latvia	Sri Lanka
Colombia	Lesotho	Sudan
Costa Rica	Liberia	Swaziland
Cote d'Ivoire	Lithuania	Syrian Arab Republic
Croatia	Malawi	Tajikistan
Czech Republic	Malaysia	Tanzania
Dem. Rep. of Congo	Maldives	Thailand
Dominican Republic	Mauritania	Tunisia
Ecuador	Mauritius	Turkey
Egypt, Arab Rep.	Mexico	Uganda
El Salvador	Moldova	Ukraine
Estonia	Mongolia	Uruguay
Fiji	Morocco	Venezuela
Gabon	Mozambique	Yemen, Rep.
Gambia, The	Namibia	Zimbabwe
Ghana	Nepal	

Table A.II. Summary statistics

	Mean	Max.	Min.	Std. Dev.	Observations
$\Delta \log TFP$	1.548	50.93	-34.87	4.900	643
ALLFDI/GDP	23.99	464.8	-8.488	41.52	643
SSFDI/GDP	5.036	88.63	-0.189	10.85	643
NSFDI/GDP	18.96	376.3	-80.94	34.42	643
Schooling	66.72	109.4	6.948	26.90	643
$\Delta \log Pop$	1.373	4.975	-2.258	1.263	643
Trade	83.39	202.9	21.67	36.41	643
Inflation	8.090	74.30	-20.63	7.904	643

References

Arellano M. and S. Bond (1991) "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations" *Review of Economic Studies* **58**: 277-297.

Ashraf, A., D. Herzer, and P. Nunnenkamp (2016) "The effects of greenfield FDI and cross-border M&As on total factor productivity" *World Economy*, early view, available at: http://onlinelibrary.wiley.com/wol1/doi/10.1111/twec.12321/full.

Bai, J. and S. Ng (2010) "Instrumental variable estimation in a data rich environment" *Econometric Theory* **26**: 1577-1606.

Blundell, R. and S. Bond (1998) "Initial conditions and moment restrictions in dynamic panel data models" *Journal of Econometrics* **87**:115-143.

Chintrakarn, P., D. Herzer, and P. Nunnenkamp (2012) "FDI and income inequality: evidence from a panel of US states" *Economic Inquiry* **50**: 788-801.

Crespo, N. and M.P. Fontoura (2007) "Determinant factors of FDI spillovers - what do we really know?" *World Development* **35**: 410-425.

de Mello, L.R. Jr. (1999) "Foreign direct investment-led growth: evidence from time series and panel data" *Oxford Economic Paper* **51**: 133-151.

de Sousa, J. and J. Lochard (2011) "Does the single currency affect foreign direct investment?" *Scandinavian Journal of Economics* **113**: 553-578.

Feenstra, R.C., R. Inklaar, and M.P. Timmer (2015) "The next generation of the Penn World Table" *American Economic Review* **105**: 3150-3182.

Görg, H. and D. Greenway (2004) "Much ado about nothing? Do domestic firms really benefit from foreign direct investment?" *World Bank Research Observer* **19**: 171-197.

Hall, R.E. and C.I. Jones (1999) "Why do some countries produce so much more output per worker than others?" *Quarterly Journal of Economics* **114**: 83-116.

Kaufmann, D., A. Kraay, and M. Mastruzzi (2010) "The worldwide governance indicators. Methodology and analytical issues" World Bank Policy Research Working Paper 5430. The World Bank, Washington, D.C.

Kim, H.H., H. Lee, and J. Lee (2015) "Technology diffusion and host-country productivity in South-South FDI flows" *Japan and the World Economy* **33**: 1-10.

La Porta, R., F. Lopez-de-Silanes, and A. Shleifer (2008) "The economic consequences of legal origins" *Journal of Economic Literature* **46**: 285-332.

Pfeiffer, B., H. Görg, and L. Perez-Villar (2015) "The heterogeneity of FDI in sub-Saharan Africa – how do the horizontal productivity effects of emerging investors differ from those of traditional players?" Kiel Working Papers 1981. Kiel Institute for the World Economy, Kiel.

Pritchett, L. (1996) "Population growth, factor accumulation, and productivity" World Bank Policy Research Working Paper 1567, The World Bank, Washington, D.C.

Psacharopoulos, G. (1994) "Returns to investment in education: A global update" *World Development* **22**: 1325-1343.

Rodríguez-Clare, A. (1996) "Multinationals, linkages and economic development" *American Economic Review* **86**: 852-173.

Roodman, D. (2009) "A note on the theme of too many instruments" *Oxford Bulletin of Economics and Statistics* **71**: 135-158.

UNCTAD (2006) "World investment report 2006: FDI from developing and transition economies: implications for development" United Nations, New York.

Wang, J.Y. and M. Blomström (1992) "Foreign investment and technology transfer: a simple model" *European Economic Review* **36**: 137-155.

Wang, M. and M.C.S. Wong (2009) "Foreign direct investment and economic growth: the growth accounting perspective" *Economic Inquiry* **47**: 701-710.

Woo, J. (2009) "Productivity growth and technological diffusion through foreign direct investment" *Economic Inquiry* **47**: 226-248.

World Bank (2006) "Global development finance 2006: the development potential of surging capital flows" The World Bank, Washington, D.C.