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Foreign direct investment and domestic investment in the host country: evidence from panel study

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Abstract

This article examines the impact of inward Foreign Direct Investment (FDI) on host countries' domestic investment. Utilizing data from 50 countries over the period of 1970 to 2004, we find that inward FDI has a negative contemporaneous effect on domestic investment, while the cumulative effect of FDI over time tends to be positive. In addition, we separately study FDI in Developed Countries (DCs) and Less Developed Countries (LDCs). The effect of contemporaneous FDI on domestic investment is negative in DCs, and the cumulative effect of FDI is neutral. Strong evidence suggests that the contemporaneous effect of FDI on domestic investment is neutral in LDCs, while the cumulative effect of FDI is positive.

I. Introduction

During the past few decades, Foreign Direct Investment (FDI) by Multinational Corporations (MNCs) has become the core of international economic activity. As shown in Table 1, world FDI inflows were $735 billion in 2001, compared to $203 billion in 1990 (United Nations, 2002). The annual average growth rate of world FDI inflows during the second half of the 1990s was 40.1%, up from 23.6% during the second half of the 1980s. In the past few decades, the growth of FDI flows in many countries has exceeded the growth of their exports and imports. Naturally, impacts of FDI in the host country have captured the attention of both academic researchers and policy makers.

Table 1. World FDI flows, 1982–2001

	Value at current prices (billions of US dollars)			Annual growth rate (%)		
	1982	1990	2001	1986–1990	1991–1995	1996–2000
FDI inflows	59	203	735	23.6	20.0	40.1
FDI outflows	28	233	621	24.3	15.8	36.7

Source: United Nations (2002).

Theoretically, FDI is considered to transfer not only physical capital but also intangible assets such as better technology or management skills. While many researchers have studied the impact of inward FDI in terms of economic growth and domestic productivity in the host country (Kokko, 1992; Balasubramanyam *et al*., 1996; Borensztein *et al*., 1998; Aitken and Harrison, 1999; Hejazi and Safarian, 1999; Hubert and Pain, 2001; Chakraborty and Basu, 2002; Choi, 2004; Blonigen and Wang, 2005; Wang and Yu, 2007), few economists have addressed a related issue–the impact of inward FDI on domestic investment.

In this study, we attempt to answer the following question: To what extent does inward FDI affect domestic investment in the host country? If inward FDI decreases the amount of domestic investment, we call this crowding-out, while crowding-in occurs when inward FDI encourages domestic investment in the host country.[1] On the one hand, FDI can crowd out the host country's domestic investment if MNCs, because of their efficiencies, simply replace domestic firms. Crowding-out can also occur if MNCs finance their investment by borrowing in the host country, which would increase the host country's interest rate (Harrison and McMillan, 2003). On the other hand, crowding-in can happen if FDI stimulates backward or forward production linkages in the host country (Markusen and Venables, 1999). For example, if the entry of MNCs in the final product industry increases the demand for domestically produced intermediate inputs, we could observe an increase in the number of domestic firms providing intermediate inputs. Crowding-in can also occur due to the spillover effects of FDI. This happens when foreign firms' more advanced technology spills over to domestic firms, enhancing their competitiveness.

As inward FDI theoretically is considered to bring in better technology and contribute to economic growth, many governments, especially governments of Less Developed Countries (LDCs), are willing to

provide preferential policies toward inward FDI. However, if FDI crowds out domestic investment, there can be long-term costs to the host country, including restraining the development of domestic capabilities and delaying the growth of local firms. If severe enough, inward FDI can reduce, rather than increase, the host country's economic growth. Therefore, it is very important for us to understand the actual impact of inward FDI on domestic investment in the host country.

Among researchers investigating the empirical relationship between FDI and host countries' domestic investment, Van Loo (1977) finds a neutral or crowding-out effect of FDI on domestic investment in Canada. In another study, Driffield and Munday (1998) argue that foreign investment in the United Kingdom increases competition in the product market and decreases the profitability of domestic firms. On the other hand, Borensztein *et al*. (1998), using data from 69 LDCs from 1970 to 1989, find that total investment increases 1.5–2.3 times the increase in FDI, though such a positive effect is not robust to different model specifications. Agrawal (2000) explores the relationship between FDI and domestic investment in five South Asian countries during the period of 1965 to 1996 and finds complementarity between FDI and the nationally owned investment. Similarly, Ang (2008) also concludes that FDI is complementary to private domestic investment in Malaysia over the period of 1960 to 2003 (see also Agosin and Mayer, 2000).

In our article, we use data from 50 countries over the period of 1970 to 2004 to explore the effect of FDI on host countries' domestic investment. Our study contributes to the existing literature in two respects. First, ours is a multi-country study and, more importantly, we separately examine the crowding-in/out hypothesis for Developed Countries (DCs) and LDCs. Previous papers that concentrate on single-economy analysis are country-specific and the results might be difficult to generalize. Other multi-country studies typically do not compare crowding-in/out effects in DCs and LDCs. As Blonigen and Wang (2005) argue, the nature and volume of inward FDI are quite different in DCs and LDCs, and FDI tends to have different effects in these two categories of countries. Second, we look at not only the contemporaneous effect of FDI, but also the effect of lagged FDI on the host country's domestic investment. We find that contemporaneous FDI crowds out domestic investment in DCs, but has a neutral effect in LDCs. The cumulative effect FDI (total effect of contemporaneous and lagged FDI) is positive in LDCs, while the cumulative effect of FDI is neutral on the domestic investment in DCs.

Our article proceeds as follows: Section II provides theoretical background for our study. Section III presents the empirical specification and data. Econometric results are analysed in Section IV, and Section V concludes.

II. Theoretical Background

In an influential study, Markusen and Venables (1999) theorize the relationship between MNCs and domestic firms. The study emphasizes that the entry of MNCs creates two effects in the host country, a competition effect and a linkage effect. The competition effect states that the entry of MNCs increases competition in the final product industry and reduces the profitability of domestic firms in the same industry. This, in turn, causes domestic firms to exit. However, at the same time, the entry of MNCs could cause the demand for domestic production of intermediate inputs to rise. This possibly can lead to an increased number of domestic firms in the intermediate inputs industry. Taking into consideration both the competition and linkage effects, Markusen and Venables (1999) argue that the net effect of entry of MNCs on domestic firms is uncertain. Another recent theoretical study by Barrios *et al*. (2005) echoes the results in Markusen and Venables (1999), and expands the previous

model by allowing for the coexistence of MNCs and domestic firms in the same industries in the host country.[2] Based on the concepts of competition and linkage effects, Barrios *et al*. (2005) illustrate that, as the number of MNCs increases in the host country, the number of domestic firms might drop first and then rise. The authors assume that MNCs enter the downstream (final product) industry. They point out that an increase in the total number of firms (both foreign and domestic) in the downstream industry will decrease the price level for the final product. This can reduce the profit for all firms and force some domestic firms to exit, given that MNCs are more productive than domestic firms. However, the possible linkage effect can increase the number of upstream domestic firms and then reduce the cost of production in the downstream industry for both MNCs and domestic firms. Consequently, the number of domestic firms in the host country will eventually go up. In the Appendix, we provide a theoretical model following closely Barrios *et al*. (2005) to illustrate the above-mentioned relationship between the number of MNCs and the number of domestic firms.

III. Empirical Specification and Data

Ideally, we would like to obtain information on the number of multinational firms and the number of domestic firms in all host countries across the sample period, or data on plant-level production and investment. Such micro-level data are typically recorded with precision. However, harmonized micro-level data are extremely difficult to collect on a multi-country basis, especially in LDCs. Therefore, we use aggregate domestic investment as a proxy for the number of domestic firms, and inward FDI as a proxy for the number of MNCs in our empirical estimation.[3] These macro-level data are much more readily available. In addition, such macro-data allow us to conduct a cross-country comparison, and our results will be more comparable to previous empirical studies. Consequently, we utilize the following basic formulation:

$$Investment_{it} = f(FDI_{it}, Z_{it}) + \varepsilon_{it} \quad (1)$$

where *i* and *t* are country and time subscripts, respectively; *Investment* represents the domestic investment in the host country; *FDI* is the inward FDI in the host country; *Z* is a vector of control variables and ε_{it} is a stochastic error term.

Based on the micro foundation summarized in the previous section, as we use aggregate data at the macro-level, we further specify a regression equation as follows with the expected signs for individual coefficients:

$$Investment_{it} = \beta_0 + \overset{(?)}{\beta_1} FDI_{it} + \beta_2 \overset{(+)}{Growth_i}, t-1$$

$$+ \beta_3 \overset{(-)}{Lending} Rate_{it} + \beta_4 \overset{(-)}{Volatility_{it}}$$

$$+ \beta_5 \overset{(?)}{Inflation_{it}} + \beta_6 \overset{(?)}{Exchange\ Rate_{it}}$$

$$+ \beta_7 \overset{(?)}{Trend} + \varepsilon_{it}$$

Investment is measured as the ratio of domestic investment to GDP in the host country, where domestic investment is calculated as the difference between Gross Fixed Capital Formation (GFCF) and inward FDI (United Nations, 1999). GFCF measures the total investment in a country.

FDI is measured as FDI inflows as a share of the host country's GDP. If the coefficient on *FDI* is positive and significant ($\beta_1 > 0$), then an increase in FDI leads to crowding-in with respect to domestic investment. If the estimated coefficient on *FDI* is significantly negative ($\beta_1 < 0$), then an increase in *FDI* is associated with a decrease in the host country's domestic investment, or a crowding-out effect.[4] If the estimated coefficient on *FDI* is not significantly different from zero, it suggests a neutral effect of *FDI* on domestic investment.

We include other control variables commonly used in previous studies (Borensztein *et al*., 1998; Agrawal, 2000). *Growth* represents the annual economic growth rate of the host country, measured as the log difference of per capita real GDP. There might be a potential endogeneity problem if we include the contemporaneous growth in the regression. For instance, a country with faster economic growth rate tends to invest more and a country with large investment may also grow faster. To avoid this problem, we use a one-period lag of *Growth* ($Growth_{t-1}$) in the regression instead of the current economic growth rate. We expect per capita real GDP growth to have a positive impact on the host country's domestic investment. *Lending Rate* is the lending rate in the host country.[5] It enters the regression as a cost of investment. A higher lending rate means a higher cost of investment and we expect the lending rate to have a negative coefficient. *Volatility* is defined as the coefficient of variation of inflation in the host country between period $t - 2$ and period t.[6] The larger is the coefficient of variation, the greater is the volatility experienced by the host country. Similar measures of volatility can be found in Serven and Solimano (1993) and Larrain and Vergara (1993).). The more volatile the economy, the less confident the firms are (due to uncertainty). We would expect to see a fall in domestic investment with a greater amount of volatility in the economy.

Inflation is the annual inflation rate in the host country, measured as the log difference of the consumer price index. Literature suggests that more competition from foreign firms tends to lead to a lower inflation rate in a country (Guerrieri *et al*., 2008). As a result, inflation can serve as a proxy for the competition measure in the host country. On the other hand, inflation can also represent a lower real return on investment. The competition effect indicates that inflation will have a positive coefficient, while the real return argument suggests that inflation will have a negative coefficient. Consequently, we do not have an *a priori* expectation on the variable of inflation. *Exchange Rate*represents the real exchange rate in the form of the host country's local currency per US dollar. Buffie (1986) notes that a currency depreciation causes the investment in tradable products to decrease, but leads to a rise of investment in the nontradable sector. In addition, a depreciation of the local currency raises the foreign debt burden of domestic firms, making it harder for them to invest. Therefore, the net effect of the real exchange rate on investment is uncertain. The last term, *Trend*, is a time trend used to catch other secular changes.

Our sample consists of annual data for 50 countries. A list of countries included in the study is provided in the Appendix. The data set is unbalanced, covering the period of 1970–2004 whenever possible.

Data used in our analysis are obtained from *International Financial Statistics* (IFS), published by the International Monetary Fund, and *World Development Indicators* (WDI), published by the World Bank.

IV. Empirical Results

Whole-sample results

Table 2 reports results from the random effects estimation, fixed effects estimation and Arellano-bond Generalized Method of Moments (GMM) estimation. We apply the Breusch–Pagan Lagrangian multiplier test and its results indicate that panel estimators (random and fixed effects) are preferred to Ordinary Least Squares (OLS). Therefore, OLS results are not reported in our article, but they are available upon request.

Table 2. Impact of FDI on domestic investment

Independent variable	**Random effects 2.1**		**Fixed effects 2.2**		**GMM 2.3**	
FDI	−0.697***	(0.055)	−0.713***	(0.054)	−0.606***	(0.079)
Growth	0.454***	(0.068)	0.431***	(0.067)	0.409***	(0.034)
Lending Rate	0.001	(0.005)	0.0005	(0.005)	−0.0008	(0.004)
Volatility	−0.090	(0.112)	−0.174*	(0.101)	−0.146**	(0.064)
Inflation	−0.018*	(0.010)	−0.014	(0.010)	−0.007	(0.005)
Exchange Rate	0.0001***	(0.00004)	0.0001**	(0.00005)	−0.00001	(0.00006)
Trend	−0.181***	(0.016)	−0.179***	(0.016)	−0.054**	(0.023)
Number of observations	1041		1041		911	
R^2	0.189		0.183			

Notes: SEs are in parentheses. Dependent variable: domestic investment as a share of GDP.
***, ** and * represent 1, 5 and 10% significance levels, respectively.

The first two columns in Table 2 present estimated coefficients from random and fixed effects estimations. All independent variables are taken as exogenous in these two regressions. Arellano-bond GMM results are reported in regression 2.3. The GMM estimator is developed for dynamic panel data; it estimates coefficients using lagged dependent variables, lagged predetermined variables (variables which are not exogenous) and differences of exogenous variables. In addition, the GMM controls for time and country fixed effects. For the GMM estimator to provide reliable results, it has to both pass the Sargen test of over-identifying restriction and show that there is no second-order autocorrelation in the residuals. In our case, the null hypothesis of no over-identifying restrictions for Sargen test cannot be rejected. Furthermore, we fail to reject the null hypothesis that there is no second-order autocorrelation in the regression residuals. Therefore, the results from the GMM estimation are reliable.

As shown in Table 2, random effects, fixed effects and the GMM estimation all provide similar results. Per capita real GDP growth positively affects the host country's domestic investment. If the economic growth rate goes up by 1%, domestic investment as a share of GDP increases by 0.4%, holding other things constant. The lending rate does not have the expected sign in the first two regressions, but the coefficients are not significant at conventional levels. Volatility has the expected negative coefficient and is significant in the fixed effects and GMM estimations. The coefficient on inflation is negative, but significant only in the random effects regression.

The estimated coefficient on our main variable of interest, *FDI*, is negative and significant at the 1% level in all regressions. The magnitude of the coefficient on *FDI* ranges from −0.606 in the GMM estimation to −0.713 in the fixed effects estimation. These results suggest that contemporaneous FDI crowds out domestic investment. For example, the GMM estimates indicate that a 1% increase in inward FDI as a share of GDP is associated with a 0.606% decrease in domestic investment as a share of GDP in the host country, holding other things constant. Using the sample average of FDI of 1.98%, this means that the absence of inward FDI will lead to an increase of domestic investment as a share of GDP by 1.199% (1.98 * 0.606 = 1.199), *ceteris paribus*. This result possibly reflects the competition effect described previously. In other words, the entry of MNCs generates more competition in the product market, decreasing the profit margin for domestic firms. In turn, some domestic firms are not able to compete with the MNCs and have to exit the market.

The effect of lagged FDI and IV estimation

Quite often, the impact of inward FDI in period *t* may only partially show in the current period, and last into periods *t* + 1, *t* + 2, etc. For example, the linkage effects may take a few periods to occur. To catch such linkage effects, as well as other possible spillover effects of FDI which could affect domestic investment, we include lagged FDI in the regression. At the same time, inward FDI is taken as endogenous instead of strictly exogenous. The Hausman test indicates that the fixed effects estimation is preferred to the random effects estimation. Therefore, we adopt the Instrumental Variables (IV) fixed effects estimation and the results are reported in Table 3. Our instruments for FDI include lagged FDI, the number of income/investment tax treaties signed by the host country, the land area of the host country, the lagged economic growth and the openness of the host country. Bilateral tax treaties that agree to reduce income tax could possibly encourage the entry of MNCs or more inward FDI. Relevant information on tax treaties is obtained from Diamond and Diamond (1997). A large land area suggests a relatively large domestic market. Given that many MNCs are seeking large markets, we expect a large area is associated with more inward FDI. Data on land area come from Frankel and Romer (1999). Generally, a country open to trade is also likely to be open to inward FDI. Openness is measured as the sum of imports and exports divided by the host country's GDP and is obtained from the WDI. The regression of FDI on its instruments has an *F*-statistic of 264, which indicates the instruments are reliable.[7]

Table 3. Impact of FDI on domestic investment (IV estimation)

	Whole sample				**DCs**				**LDCs**			
Independent variable	**Regression 3.1**		**Cumulative effect**		**Regression 3.2**		**Cumulative effect**		**Regression 3.3**		**Cumulative effect**	
FDI	−0.302***	(0.111)			−0.719***	(0.131)			0.204	(0.197)		
FDI_{t-1}	0.187	(0.134)	−0.115	(−0.814)	0.220	(0.181)	−0.499***	(−2.664)	0.279	(0.216)	0.482**	(2.091)
FDI_{t-2}	0.343**	(0.145)	0.228	(1.497)	0.558***	(0.201)	0.059	(0.299)	0.285	(0.220)	0.767***	(2.918)
FDI_{t-3}	0.095	(0.139)	0.323**	(2.224)	−0.289	(0.207)	−0.229	(−1.303)	0.349*	(0.210)	1.116***	(3.991)

Growth	0.542***	(0.079)			0.504***	(0.117)			0.635***	(0.122)		
Lending Rate	0.003	(0.004)			0.006	(0.011)			0.005	(0.007)		
Volatility	−0.268**	(0.114)			−0.081	(0.156)			−0.384**	(0.168)		
Inflation	−0.03**	(0.013)			−0.008	(0.017)			−0.047**	(0.021)		
Exchange Rate	0.0001	(0.00009)			0.00007	(0.002)			0.0003	(0.008)		
Trend	−0.303***	(0.022)			−0.283***	(0.025)			−0.346***	(0.046)		
Number of observations	866				493				361			
R^2					0.178		$F(1, 457) = 1.7$				$F(1, 329) = 15.93$	
	0.179						Prob. > F = 0.1973		0.281		Prob. > F = 0.0001	

Notes: For regressions, SEs are in parentheses. For cumulative effect of FDI, *t*-statistics are in parentheses. Dependent variable: domestic investment as a share of GDP.
***, ** and * represent 1, 5 and 10% significance levels, respectively.

Regression 3.1 in Table 3 represents the results from the IV estimation for the whole sample. As we can see, contemporaneous FDI again has a negative and significant coefficient, indicating that contemporaneous FDI crowds out domestic investment. Lagged FDI variables (FDI_{t-1}, FDI_{t-2}, FDI_{t-3}) have positive coefficients, suggesting a possible crowding-in effect. The estimated coefficients on FDI_{t-1} and FDI_{t-3} are positive but not significant at conventional levels. The strongest crowding-in effect occurs 2 years after the initial investment. The estimated coefficient on FDI_{t-2} is 0.343 and significant at the 5% level. This shows that FDI may contemporaneously crowd out domestic investment, but over time, the effect of inward FDI on domestic investment could be positive.

More detailed or disaggregated data are required to detect the exact mechanisms of the crowding-in/out effect. A possible explanation for our results is that if the host country already has a sufficient level of domestic investment, MNCs will tend to replace domestic firms due to stronger competition. However, as different types of production linkages are generated over time, domestic investment would increase in upstream industries (through the backward linkage) or downstream industries (through the forward linkage).[8] The positive effect of FDI on domestic investment can also come from the fact that MNCs can hire and train local workers, thereby increasing domestic labour productivity. In turn, more domestic firms will enter the market. For instance, the Korean Daewoo International Corporation built a textile establishment in Bangladesh in 1979 and trained 130 Bangladeshi workers in Korea. Eventually, 115 of these Bangladeshi workers left the original Korean factory to set up their own garment plants in Bangladesh and succeeded (Alfaro *et al*., 2004).[9]

Cumulative effect of FDI

In addition to focusing on individual coefficients, we study the sum of the point estimates of coefficients on all FDI variables. This helps us to understand the cumulative effect of inward FDI on the host country's domestic investment. We provide the sum of coefficients with *t*-statistic in parentheses

for the whole sample in the second column in Table 3.[10] For example, the sum of estimated coefficients on contemporaneous FDI and one year lag of FDI (FDI_{t-1}) is −0.302 + 0.187 = −0.115. Given our sample size, −0.115 is not significantly different from zero, as shown by the *t*-statistic of −0.814. This represents a change from a crowding-out effect to a neutral effect of inward FDI over time. The sum of estimated coefficients on FDI_{t}, FDI_{t-1}, FDI_{t-2} and FDI_{t-3} is 0.323, which is positive and significant at the 5% level. This number indicates that a 1% increase in FDI as a share of GDP leads to an increase of 0.323% in domestic investment as a share of GDP over 4 years. The result suggests a cumulative crowding-in effect of inward FDI on domestic investment in the whole sample.

Different contemporaneous and cumulative effects in DCs and LDCs

Another interesting question should be addressed–does inward FDI have the same effects on domestic investment in DCs and LDCs? Blonigen and Wang (2005) point out that inward FDI in DCs and LDCs is quite different in nature and in volume, and is very likely to have different impacts. Pooling data from DCs and LDCs might disguise the true effects of inward FDI in these two groups of countries. To explore this issue, we apply sub-sample regressions for DCs, represented by Organization for Economic Co-operation and Development (OECD) countries and LDCs, represented by non-OECD countries.[11]

Generally speaking, LDCs might not have a sufficient level of domestic investment. As a result, we expect that MNCs' entry occurs more often in sectors that are different from the ones occupied by domestic firms in LDCs. In other words, without foreign investment, it is unlikely that the investments will be made by domestic firms in LDCs at all. For example, in the 1990s, Intel built a microprocessor plant in Costa Rica, which did not replace any local firms in Costa Rica because there were no local firms in that industry. Similarly, we also expect the linkage effect and the spillover effect of FDI to be more evident in LDCs (Barro and Sala-i-Martin, 2004). Therefore, a stronger crowding-in effect of inward FDI could occur in LDCs than in DCs.

Results for sub-sample regressions are reported by regressions 3.2 and 3.3 in Table 3. Regression 3.2 shows that in DCs, the inward FDI has a negative and significant coefficient (−0.719), which indicates a significant contemporaneous crowding-out effect. In 3 years, the cumulative effect of FDI on domestic investment becomes 0.059 with a *t*-statistic of 0.299, which is not significant at conventional levels. The cumulative effect of inward FDI over a 4-year period is −0.229, but again not significantly different from zero. This suggests that for DCs, although contemporaneous inward FDI crowds out domestic investment, the magnitude of the possible linkage and spillover effects over time overcomes the initial competition effect. The cumulative effect of FDI on domestic investment in DCs is neutral.

For LDCs, the coefficient on contemporaneous FDI is 0.204, not significantly different from zero. This represents a neutral effect of current period FDI on domestic investment. The cumulative effect of FDI_{t} and FDI_{t-1} on domestic investment in LDCs is 0.482 and significant at the 5% level. The next two sums are 0.767 and 1.116, both significant at the 1% level. A 1% increase in inward FDI as a share of GDP is associated with a 0.767% increase in domestic investment as a share of GDP over 3 years, and a 1.116% increase over 4 years holding other things constant. The results are statistically and economically meaningful. It suggests that over time, domestic investment in LDCs increases on a one-to-one basis with an increase in inward FDI. In addition, a Wald test of coefficient constraint is applied. The null hypothesis of the Wald test is that the sum of coefficients on all FDI variables is zero, indicating that the cumulative effect of FDI on host countries' domestic investment is neutral. Based on test statistics, for DCs, we fail to reject the null hypothesis. For LDCs, the null hypothesis is rejected at

the 5% significance level. Together with the positive number, it confirms a crowding-in effect of inward FDI over time. The result has important policy implications for LDCs. A cumulative positive effect in LDCs provides support for policies which encourage inward FDI, especially inward FDI that leads to the long-run establishment of MNCs in LDCs.

V. Conclusion

Focusing on FDI and the domestic investment in the host country, our study looks at not only contemporaneous FDI but also FDI in previous periods in order to catch the cumulative response. Interestingly, using data for 50 countries from 1970 to 2004, we find that contemporaneous FDI crowds out domestic investment in DCs, while having a neutral effect in LDCs. Over time, an increase in inward FDI neither increases nor decreases domestic investment in DCs. In other words, the cumulative effect of FDI in DCs is neutral. However, in LDCs, the cumulative effect is positive and significant, suggesting that inward FDI helps to increase domestic investment in LDCs over time. Governments face possible policy tradeoffs when encouraging the activities of MNCs if the crowding-out effect of FDI is persistent. The empirical findings in our study suggest that FDI could be beneficial to domestic investment, especially in LDCs, because of the cumulative crowding-in effect. Government policies should aim to help domestic firms improve efficiency so that the positive effect of FDI can occur within a relatively short period of time after the entry of MNCs. However, exactly what types of government policies would make inward FDI contribute most to the domestic economy is beyond the scope of this article and might be an interesting issue for further exploration.

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Appendix: Theoretical Model

In this section, we provide a theoretical model that follows closely Barrios *et al*. (2005).

In the domestic country, a representative consumer's utility depends on his/her consumption of manufacturing product (*M*) and agricultural product (*A*). To be more specific, the utility function of the representative consumer is as follows:

$$V = C_M^{\alpha} C_A^{1-\alpha}, 0 < \alpha < 1 \quad \text{(A1)}$$

where the manufacturing sector is a constant-elasticity-substitution aggregate of individual varieties or $C_M = \left(\sum_{i=1}^{N} \chi_i^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}$ with $\sigma > 1$; x_i represents the consumption for manufacturing product *i*; C_A is the consumption of agricultural product.

The agricultural sector experiences perfect competition and uses capital *K* as the only factor of production. The manufacturing sector consists of two industries–the upstream industry and the downstream industry. Both the upstream and the downstream industries are monopolistic

competitive. The upstream industry uses only *K* to produce intermediate inputs (*U*). Each downstream industry firm then uses *K* and the intermediate inputs, *U*, to produce a final manufacturing product.

Solving the problem of consumer utility maximization generates the demand function for each individual manufacturing product

$$x_i = p_i^{-\sigma} GP^{\sigma-1} \quad \text{(A2)}$$

where

$$P = \left(\sum_i p_i^{1-\sigma}\right)^{1/(1-\varrho)}.$$

which is the price index in the downstream industry in the manufacturing sector; *G* represents consumer's income spent on manufacturing products; and p_i is the price for manufacturing product *i*. The price index indicates that an increase in the number of firms in the downstream industry will decrease the price level for the manufacturing product, namely the competition effect.

Suppose the price for factor *K* is *r* and the price index for upstream intermediate inputs is *Q*, then the cost function for each downstream industry firm in the manufacturing sector is:

$$C(M)_i = Q^{\theta} r^{1-\theta} (\lambda x_i + f) \; \lambda > 0, f > 0 \quad \text{(A3)}$$

where

$$Q = \left(\sum_j q_j^{1-\varepsilon}\right)^{1/(1-\varepsilon)}$$

with ϵ > 1; and q_j represents the price for each individual upstream intermediate input. ϑ is the share of aggregate intermediate inputs in the production of each final manufacturing product.
Equation A3 shows that an increase in the number of firms in the upstream industry would decrease the production cost for downstream firms.

Profit maximization, or equivalently marginal revenue equals marginal cost, leads to the following expression for price of each manufacturing product *i*:

$$p_i = \frac{\sigma}{\sigma-1} \lambda Q^{\theta} r^{1-\theta} \quad \text{(A4)}$$

From Equations A3 and A4, we can see that price of the downstream manufacturing product is set as a mark-up over the marginal cost of production. Since the downstream industry in the manufacturing sector is monopolistic competitive, at equilibrium each individual firm obtains zero economic profit. Therefore, the equilibrium production level for individual firm *i* in the downstream industry in the manufacturing sector is:

$$x_i = \frac{(\sigma-1)f}{\lambda} \text{ (A5)}$$

Now, suppose the cost function for firm *j* in the upstream industry in the manufacturing sector is:

$$C(U)_j = r(\omega u_j + \phi)\omega > 0, \phi > 0 \text{ (A6)}$$

where u_j is the production level for firm *j*. Then the price for an upstream intermediate input charged by firm *j* is:

$$q_j = \frac{\varepsilon}{\varepsilon-1} r\omega \text{ (A7)}$$

At equilibrium, firm *j* should break even. So, the equilibrium level of production for firm *j*in the upstream industry is:

$$u_j = \frac{(\varepsilon-1)\phi}{\omega} \text{ (A8)}$$

For simplicity, MNCs are assumed to enter only the downstream industry in the manufacturing sector and have the same cost function as domestic firms. The number of MNCs is n_m , the number of domestic firms in the downstream industry is n_d and the number of upstream firms is n_u . In addition, the entry of each multinational firm brings in the host country Ω unit of *K*. This reflects the idea that FDI can transfer physical capital into the host country. The equilibrium condition in the factor *K* market gives:

$$(n_d + n_m)\frac{\vartheta C(M)_i}{\vartheta r} + n_u \frac{\vartheta C(U)}{\vartheta r} + K_A = K + \Omega n_m \text{ (A9)}$$

where K_A represents the capital factor used in the agricultural sector; *K* represents the total endowment of the factor in the domestic country. Based on Equations A3, A6 and equilibrium values provided above, Equation A9 can be rewritten as the following:

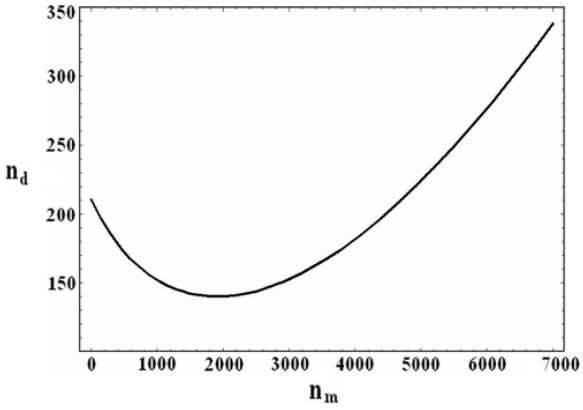
$$(n_d + n_m)\left(n_u^{1/(1-\varepsilon)}\frac{\varepsilon\omega}{\varepsilon-1}\right)^{\theta}\sigma f + \varepsilon\phi n_u = \alpha K + \Omega n_m \text{ (A10)}$$

At equilibrium in the manufacturing sector, quantity demanded for the intermediate inputs should be equal to the quantity supplied, which indicates:

$$(n_d + n_m)\left(n_u^{1/(1-\varepsilon)}\right)^{\theta}\left(\frac{\varepsilon\omega}{\varepsilon-1}\right)^{\theta-1}\theta\sigma f = \frac{\phi(\varepsilon-1)}{\omega} \text{ (A11)}$$

Equations A10 and A11 are nonlinear and n_m and n_d cannot be solved explicitly. However, given certain parameter values, the relationship between n_m and n_d can be shown in Fig. A1.[12]

Fig. A1. Numerical simulation of the relationship between $\boldsymbol{n_m}$ and $\boldsymbol{n_d}$



List of countries included in the sample

Argentina	Denmark	Iran	Netherlands	South Africa
Australia	Ecuador	Ireland	Nigeria	Spain
Austria	Egypt	Israel	Norway	Sweden
Belgium	Finland	Italy	Pakistan	Switzerland
Brazil	France	Japan	Philippines	Thailand
Canada	Germany	Kazakhstan	Poland	Turkey
Chile	Greece	Korea	Portugal	United Kingdom
China, P.R.: Mainland	Hungary	Malaysia	Russia	United States
Colombia	India	Mexico	Saudi Arabia	Venezuela
Czech Republic	Indonesia	Morocco	Singapore	Vietnam

Figure A1 illustrates that as the number of MNCs (n_m) increases in the host country, the number of domestic firms (n_d) goes down first and then goes up. As mentioned above in Equation A2, an increase in the number of firms in the downstream industry will decrease the price level for the manufacturing product. This can reduce the number of domestic firms. However, according to Equation A3, possible backward linkage effect can increase the number of upstream firms and then reduce the cost of production in the downstream industry. Furthermore, in this model, the entry of MNCs is accompanied by an addition of the factor of production, *K*. Such an addition decreases the price of *K* and also reduces the cost of production for domestic firms, holding other things constant. The backward linkage, lower cost of production, and possibly other spillover effect in terms of technology transfer all can lead to an increased number of domestic firms. Such a positive impact could overcome the negative competition effect. As a result, we observe a positive relationship between n_d and n_m as n_m gets larger in Fig. A1.

Notes

[1] The phrases 'crowding-in' and 'crowding-out' are used in the existing empirical literature and the United Nations (1999) to represent the relationship between inward FDI and domestic investment. To be consistent with the literature, we use these same phrases throughout our article.

[2] In Markusen and Venables (1999), foreign firms and domestic firms cannot coexist in the same industries.

[3] A better proxy for the existing number of foreign firms is the FDI stock at a certain point of time, instead of FDI flows over a certain period. However, stock values are typically not available for LDCs. Similarly, domestic capital stock values are not readily available from different countries. As a result, we use flow data.

[4] Two different dependent variables have been used in previous studies of FDI and host country's domestic investment: one is the total investment in the host country (Agosin and Mayer, 2000) and the other is the domestic investment (Agrawal, 2000). The choice of dependent variable does not change our results qualitatively. It only changes the magnitude of the estimated coefficient on FDI. If we choose total investment to be the dependent variable, then crowding-in will require $\beta_1 > 1$; crowding-out will indicate $\beta_1 < 1$.

[5] The lending rate is the bank rate that usually meets the short- and medium-term financing needs of the private sector. For countries without information on the lending rate, the Treasury bill rate is used.

[6] The coefficient of variation = $s_x/\bar{x}$, where s_x is the Standard Deviation (SD) of a sample and $\bar{\chi}$ is the sample mean.

[7] The correlation between actual FDI and the instrumented FDI is 0.73.

[8] If MNCs enter the intermediate inputs industries, it can encourage more domestic firms in the final product industry given lower prices of the intermediate inputs. This is an example of forward linkages.

[9] Our empirical specification does not distinguish between the linkage effects and other positive spillover effects of inward FDI. This is not the emphasis of our article, but maybe a useful future extension.

[10] The *t*-statistic is constructed as $\frac{coeff1 + coeff2 - 0}{\sqrt{\mathrm{var}(coeff1) + \mathrm{var}(coeff2) + 2\mathrm{cov}(coeff1,\ coeff2)}}$ which is to test whether the sum of the coefficients is significantly different from zero.

[11] Dividing the whole sample into high-income and middle/low-income groups gives similar results to dividing the whole sample into OECD and non-OECD countries.

[12] Parameter values used in Fig. A1 are from Barrios *et al*. (2005).

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