The Long-run Relationship between Outward Foreign Direct Investment and Total Factor Productivity: Evidence for Developing Countries

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ABSTRACT Outward foreign direct investment (FDI) from developing countries has been growing significantly in both absolute and relative importance in recent years. Nevertheless, there is surprisingly little research on the home-country effects of outward FDI for these countries. This paper examines the long-run relationship between outward FDI and total factor productivity for a sample of 33 developing countries over the period from 1980 to 2005. Using panel co-integration techniques, we find that outward FDI has, on average, a robust positive long-run effect on total factor productivity in developing countries and that increased factor productivity is both a consequence and a cause of increased outward FDI.

I. Introduction

Foreign direct investment (FDI) outflows from developing countries have grown more quickly in recent decades than those from developed economies. The share of developing countries in total world FDI outflows increased more than thirty-fold, from approximately 0.5 per cent in the early 1970s to about 16 per cent in 2008. In 2008, FDI outflows from developing countries reached almost US$300 billion, which is more than three times the value of world FDI outflows in 1970.1

Despite the enormous increase in FDI outflows from developing countries, there is little evidence concerning the potential economic consequences of outward FDI for the home (outward investing) countries. The empirical literature regarding outward FDI consists mainly of firm and industry-level studies on the effects of outward FDI on employment, exports, investment, and productivity in developed economies, while few such micro studies are available on developing countries. Macroeconomic
studies of the overall impact of outward FDI on the home developing countries have not yet been performed. This paper attempts to fill this gap by examining the long-run relationship in developing countries between outward FDI and total factor productivity as a key to economic growth. Specifically, we aim to answer two questions:

1. Does outward FDI reduce or increase total factor productivity in home developing countries on average over the long run?
2. Is outward FDI an exogenous influence on total factor productivity or does the causality run in both directions?

To answer these questions, we apply panel co-integration techniques to a sample of 33 developing countries over the period from 1980 to 2005. Panel co-integration estimators are robust under co-integration to a variety of estimation problems that often plague empirical work, including omitted variables, endogeneity, and measurement errors (Baltagi and Kao, 2000; Pedroni, 2007). Moreover, panel co-integration methods can be implemented with shorter data spans than their time-series counterparts. Our main results are that outward FDI has, on average, a positive long-run effect on domestic total factor productivity in developing countries, and that increased factor productivity is both a consequence and a cause of increased outward FDI.

The remainder of this paper is composed of four sections. In Section II, we discuss the theoretical background and related empirical literature. Section III sets out the basic empirical model and describes the data. The econometric implementation and the estimation results are presented in section IV, while section V concludes.

II. Theoretical Background and Related Empirical Literature

Theoretical Background

As a background for the discussion of the potential theoretical effects of outward FDI on domestic productivity in developing countries, it is useful to briefly describe the characteristics of outward FDI from these countries and to contrast them with the pattern of outward investment from developed economies.

A striking feature of outward FDI from developing countries is the dominance of the service sector, as shown in Table 1. In 2006, 83.7 per cent of the stock of their outward FDI was in services, such as trade, finance, and business activities (UNCTAD, 2006); for developed countries, in contrast, the corresponding share was 61.7 per cent. The second largest sector is manufacturing, which accounted in 2006 for 9.4 per cent of the outward FDI stock of developing countries but 28.5 per cent of the outward FDI stock of developed countries. Outward FDI in the primary sector, in contrast, is of minor importance. In 2006, only 3.4 per cent of the stock of outward FDI from developing countries was in this sector, while the corresponding figure for developed-country outward FDI was 7.9 per cent. Perhaps most striking, however, is that developing countries heavily invest in other developing countries, mostly from the same region (UNCTAD, 2006). In the period from 2000 to 2004, approximately 75 per cent of FDI outflows from developing countries went to the
developing world. The opposite is true for developed countries that tend to predominantly direct their investment towards other developed countries. Finally, it is also worth mentioning that, although the number of developing-country multinationals on the top 100 list has increased in recent years, most of these are relatively small compared to multinationals from developed countries (UNCTAD, 2006).

With this background, we begin our discussion of the potential productivity effects of outward FDI in developing countries by considering possible interactions between domestic and foreign activities of multinational firms. To represent these interactions, suppose that the production function of a multinational firm is given by

$$Q = f(D, F, \theta_d, \theta_f),$$

where $Q$ is the representative firm’s worldwide output, $D$ is domestic input, $F$ is foreign input, $\theta_d$ is a vector of factors that influence domestic production (such as domestic productivity), and $\theta_f$ represents factors that influence foreign production. Assuming that domestic input production is a function of domestic capital, $D(K_d)$, and that foreign input production is a function of foreign capital, $F(K_f)$, the first-order condition that characterises the firm’s profit-maximising choice of domestic inputs is

$$\frac{\partial Q}{\partial D(K_d)} = \lambda,$$

where $\lambda$ is total input cost (the firm’s cost of capital). From Equation 1 it can be seen that domestic and foreign production (or investment) of the multinational firm can be related either through the cost of capital, and thus through the financial side of the firm, if $\lambda$ is somehow a function of $F$, or through the production process, if $\partial^2 Q / \partial D(K_d) \partial F(K_f)$ is nonzero (Desai et al., 2005).

Interactions between foreign and domestic activities operating through the financial side of the firm occur in a situation where fixed investments in different locations compete for funds due to costly external financing (Stevens and Lipsey,
In such a scenario, the decision to invest scarce resources abroad inevitably reduces the likelihood of concurrent investments at home, implying that each dollar of outward FDI displaces a dollar of domestic investment. This substitution of foreign for domestic investment, in turn, is likely to also reduce domestic productivity. In particular, when the investments abroad come at the expense of investments necessary to sustain productivity at home (such as new machinery, worker training, and research and development), outward FDI may reduce the domestic productivity of the investing firm in the long run. Some studies, however, suggest that the situation of fixed resources appears to be rather atypical for multinational firms, at least for developed-country multinationals. Desai et al. (2004), for example, analyse how US multinationals capitalise affiliates around the world and find that these affiliates substitute internal borrowing for costly external finance stemming from adverse capital market conditions. Similarly, Desai et al. (2008) show that US parent companies provide affiliates with additional equity to finance profitable investment opportunities during currency crises. However, these findings cannot necessarily be generalised to developing-country multinationals. Since multinationals from developing countries are relatively small compared to their developed-country counterparts, they often do not have internal capital markets and must therefore rely upon external financing to finance their investment projects. In addition, domestic financial markets are undeveloped in many developing countries. Thus, although some developing-country multinational companies have access to foreign capital markets (UNCTAD, 2006), they are generally more likely to face financial constraints than developed-country multinationals. The conclusion from this is that it is also more likely for developing-country multinationals than for developed-country multinationals that outward FDI leads to a reduction in domestic productivity due to potential interactions between domestic and foreign activities through the financial side.

The second source of possible interactions is the production process. Because of production interdependence, outward FDI can affect domestic productivity in several ways, each of which depends on the multinational firm’s investment motive and the respective investment type. In the following, we distinguish four key types of investment: horizontal FDI, vertical FDI, strategic asset-seeking FDI, and resource-seeking FDI.

Horizontal or market-seeking FDI is motivated by the desire to obtain market access and to avoid trade frictions, such as transport costs and import protection in the host country. The decision to engage in horizontal FDI is guided by the proximity–concentration trade-off in which proximity to the host market avoids trade costs but incurs the added fixed cost of building a second production facility. FDI of this type thus occurs when a firm decides to serve foreign markets through local production, rather than through exports, and hence to produce the same product or service in multiple countries. Consequently, horizontal FDI may substitute for exports of the goods that were previously produced in the investor’s home country. This decrease in domestic export production, in turn, may be accompanied by a decrease in domestic productivity, since export intensity and firm productivity may be linked (Baldwin and Gu, 2003). However, such effects occur only if the produced good is tradable. As discussed above, the overwhelming majority of outward FDI from developing countries is in services, most of which are
non-tradable, implying that the bulk of horizontal developing-country FDI cannot substitute for home-country exports.

But even those horizontal investments that are directed to tradable sectors do not necessarily reduce domestic exports and productivity. The reason is because there is rarely a pure case of horizontal production in the sense that there is inevitably some vertical component to a firm; horizontal FDI can boost exports of intermediate goods and services from the home to the host country. For example, headquarters in the home country provide specialised services to foreign affiliates (such as research and development (R&D), design, marketing, finance, and strategic management), even if the same final goods are produced in both the home and foreign country. Thus, in general terms, multinational firms combine home production with foreign production to increase their productivity and hence competitiveness both internationally and domestically (Herzer, 2008). Furthermore, in the long run, horizontal FDI may allow the firm to raise its competitiveness through access to new markets or the successful penetration of existing markets, thereby additionally increasing domestic productivity.

The horizontal motive is the most important for outward FDI from developing countries, followed by the vertical motive (UNCTAD, 2006). Vertical or efficiency-seeking FDI is driven by international factor price differences. It takes place when a firm fragments its production process internationally, locating each stage of production in the country where it can be done at the lowest cost. Such relocations reduce domestic production, at least in the short run (as with horizontal FDI). However, in the longer run, vertical investment may allow the firm to import cheaper intermediate inputs from foreign affiliates and/or to produce a greater volume of final goods abroad at lower cost, thereby stimulating exports of intermediate goods used by foreign affiliates (Herzer, 2008). The new structure of the production chain may thus be associated with increased efficiency and, as a result, the firm may be able to improve its competitive position, thus raising its domestic productivity over the long run. On the other hand, if the firm is not able to adjust over the longer term to the reduction in domestic production by failing to raise its competitiveness (for example, due to labour market rigidities), both vertical and horizontal FDI will substitute foreign activities for domestic activities over the long run, which may also lead to a long-term decrease in domestic productivity (Bitzer and Görg, 2009).

The third most important motive for outward FDI from developing countries is the strategic asset-seeking motive (UNCTAD, 2006). As the name implies, firms undertake strategic asset-seeking FDI to acquire assets that are not available in their own country. Strategic asset-seeking FDI is made, for example, when investors attempt to gain access to internationally recognised brand names and local distribution networks in order to strengthen their international competitive position. Strategic asset-seeking FDI also occurs in the form of technology-sourcing FDI when firms attempt to gain access to foreign technology by either purchasing foreign firms or establishing R&D facilities in ‘foreign centres of excellence’. If foreign affiliates then acquire new knowledge in terms of technological know-how, management techniques, knowledge of consumer tastes, and so forth, this knowledge can be transferred back to the parent company, thus increasing domestic productivity in the long term (Van Pottelsbergh and Lichtenberg, 2001). However, since the ability to absorb knowledge from abroad depends upon the absorptive
capacity of the investing firm, firms with low levels of technological capacity are likely to be unable to effectively access and exploit foreign knowledge through outward FDI. The potential productivity gains for outward investors from developing countries may therefore be smaller than is the case for their developed-country counterparts. Another consideration related to knowledge spillovers through outward FDI is that a substantial percentage of outward FDI from developing markets goes to other developing countries (as shown in Table 1). This south–south outward FDI may not generate significant knowledge spillovers because the bulk of FDI is not located in clusters of specific technological expertise. On the other hand, narrower technological gaps between home and host firms may facilitate absorption of technological knowledge, implying that south–south FDI may generate more spillovers than south–north FDI. In addition, developing-country multinationals have a greater propensity to establish linkages with local firms than do their counterparts from developed countries (UNCTAD, 2006), which in turn enables them to more deeply integrate into the host economies, and this deeper integration could be particularly beneficial in terms of reverse knowledge and technology flows back to the home country.

Finally, the least important, yet still significant, motive for investors from developing countries is the resource-seeking motive (UNCTAD, 2006). Resource-seeking FDI occurs when firms identify specific host country locations as an attractive source of natural resources at the lowest cost. Such FDI is usually associated with exports of resource-based products from the host country and should improve the productivity of domestic production which uses the imported resources as low cost, high quality inputs.

An important point is that outward FDI may affect not only the productivity of the investing firms, but also that of the economy as a whole through productivity spillovers to local firms. For example, local firms may improve their productivity by copying technologies used by domestic multinationals, or likewise, domestic producers may benefit from the knowledge and expertise of the outward-investing firms through labour turnover. Moreover, the increased competition between international firms and their domestically oriented counterparts may force the latter to use their existing resources more efficiently. Outward-investing firms, due to the increased productivity, may be also able to provide higher quality inputs at lower prices to local producers. In addition, if outward FDI allows the investing firms to grow larger than would be possible with production in just one country, both the investing companies and their local suppliers may benefit from economies of scale. Outward FDI may thus enable domestic suppliers to move down their learning curves and, therefore, to realise substantial productivity gains.

As FDI may act as an important vehicle for the transfer of technological and managerial know-how, it is likely to increase the competitiveness of the host economy as well. This may lead to reductions in domestic output and productivity when domestic consumers prefer the foreign competitors. Furthermore, the increased competitiveness may allow domestic firms in the host country to challenge the foreign firms and thereby capture market share from the foreign affiliates of the home country’s multinationals. Outward FDI may therefore enable competitors in the host country to attract demand away from the home country firms, forcing them to reduce their production and to move up their average cost curve in response,
resulting in productivity losses in the home country. In addition, outward FDI can reduce domestic capital accumulation, and thus domestic productivity, when outward investors claim scarce domestic resources, such as domestic financial capital, that could otherwise have been used by domestic investors for investment in their home country (UNCTAD, 2006).

Thus, the net effect of outward FDI on aggregate productivity in (the home) developing countries is theoretically ambiguous and must be determined empirically. Although there are no empirical investigations concerning this overall macro-economic effect on developing countries, some studies do exist on the firm and industry-level effects of outward FDI on domestic productivity for both developing and developed countries. Also, there is some evidence of cross-border R&D spillovers through outward FDI at the macro-level for developed economies.

Available Evidence

Van Pottelsberghe and Lichtenberg (2001) use country-level macro data for a panel of 13 developed countries to examine whether technology-sourcing FDI affects domestic productivity through foreign R&D spillovers. They find a positive long-run relationship between the foreign R&D capital stock weighted by outward FDI and domestic total factor productivity, implying that outward FDI into R&D-intensive countries indeed has beneficial effects upon home-country productivity by transferring technological knowledge from the host country. However, Bitzer and Kerekes (2008) reach a different conclusion. Their findings, based on industry-level data for 17 OECD countries, suggests that the interaction between foreign R&D capital and outward FDI is negatively associated with domestic productivity in non-G7 countries, whereas the evidence of R&D spillovers through outward FDI for the G7 countries is not significant. Both studies investigate only whether outward FDI into major R&D-performing countries acts as a channel for R&D spillovers, thus neglecting all other potential productivity effects of outward FDI.

Braconier et al. (2001), in contrast, investigate both the effect of the outward-FDI-weighted foreign R&D capital stock and the effect of ‘pure’ outward FDI on domestic productivity. Using both firm and industry-level data for Sweden, they find neither evidence of FDI-related R&D spillovers, nor any correlation between outward FDI per se and domestic productivity. These results differ from those of Driffield et al. (2009). In an industry-level study for the UK, the authors distinguish between outward FDI in high-cost, high-R&D-intensive countries and low-cost, low-R&D-intensive countries. They find that both types of FDI generate productivity growth in the UK, suggesting that technology-sourcing and efficiency-seeking FDI increase domestic productivity. A similar result is obtained by Driffield and Chiang (2009), who investigate the effects of outward FDI from Taiwan to China. Based on industry data, they report a positive association between outward FDI to China and labour productivity in Taiwan. Given the fact that labour costs in Taiwan are significantly higher than those in China, the authors conclude that this productivity effect is due to vertical FDI. Vahter and Masso (2007), on the other hand, use firm-level panel data from Estonia to examine the effects of outward FDI on total factor productivity of the investing firms and the rest of the industry. They find that
outward FDI is positively related to the productivity of the parent companies, whereas there is no robust evidence of productivity spillovers to other firms. Since the overwhelming majority of FDI by Estonian firms is horizontal (Masso et al., 2008), the positive productivity effects of Estonian outward FDI appear to be primarily associated with this type of FDI.

In another study, Kimura and Kiyota (2006) analyse Japanese firm-level data. One of their findings is that outward FDI increases firm productivity. More specifically, their results suggest that firms engaging in outward FDI experience, on average, productivity growth 1.8 per cent higher than domestic firms not engaging in outward FDI. Hijzen et al. (2007) criticise this study for failing to control for the endogeneity bias that arises when more productive firms self-select into investing abroad. To deal with this endogeneity problem they apply matching and difference-in-differences analysis to data of Japanese firms for the period from 1995 to 2002. The evidence in their study suggests that the effect of outward FDI on Japanese firm productivity is not significant.

Propensity score matching and difference-in-differences techniques are also used in other studies. Barba Navaretti and Castellani (2004), for example, apply these methods to Italian firm-level data, and find that multinational firms have higher total factor productivity growth after investing abroad than does a counterfactual of national firms. Hijzen et al. (2006), using French firm-level data, report that firms that invest in developed countries increase their productivity, while firms that invest in developing countries experience no productivity effects, which could suggest that productivity effects of outward FDI are primarily associated with horizontal investment, rather than vertical investment. Barba Navaretti et al. (2010) obtain the same result in a sample of French firms. For Italy, however, they find exactly the opposite pattern: firms that invest in developing countries experience an increase in total factor productivity, whereas FDI into developed countries has no productivity effects.

Finally, Bitzer and Görg (2009) examine the effect of outward FDI on domestic total factor productivity using industry-level panel data for 17 OECD countries. Their results suggest that outward FDI has, on average, a negative effect on total factor productivity, but that there are large differences across countries. Outward FDI has the largest negative effect on total factor productivity in South Korea – the only developing country in the sample. In France, Japan, Poland, Sweden, the Czech Republic, the UK, and the United States, in contrast, increased outward FDI is associated with higher total factor productivity.

Given the mixed results, perhaps the only conclusions that can safely be drawn from these studies are that outward FDI can have positive, as well as negative, effects on domestic productivity, that the domestic productivity effects of outward FDI do not necessarily depend upon the investment motive, and that the effects of outward FDI can differ significantly from country to country. This third conclusion may apply in particular to developing countries, which differ widely in terms of country size, income level, economic structure, availability of natural resources, technological capabilities, trade openness, government policies, and other characteristics. Unfortunately, the studies do not provide any information on how outward FDI could affect aggregate productivity in developing countries on average over the long run.
III. Empirical Model and Data

The analysis will examine the long-run relationship between outward FDI and total factor productivity in the home developing countries. In this section, we present the basic empirical model, discuss some econometric issues, and describe the data (further detail can be found in the Online Appendix).

We assume that the correct specification of the long-run relationship between total factor productivity and outward FDI is given by

$$\log(TFP_{it}) = a_i + \delta_i t + b \log(OFDI_{it}) + \epsilon_{it},$$

where $i = 1, 2, \ldots, N$ is the country index, $t = 1, 2, \ldots, T$ is the time index, $\log(TFP_{it})$ represents the log of total factor productivity, and $\log(OFDI_{it})$ is the log of outward FDI. Following Bitzer and Görg (2009), we use outward FDI stocks rather than outward FDI flows because stocks, due to the accumulation of flows, may more effectively capture long-run effects. The size of the long-run effect of outward FDI on total factor productivity is measured by the coefficient $b$, which can be interpreted as the long-run elasticity of total factor productivity with respect to outward FDI. Finally, any country-specific omitted factors which are relatively stable in the long run or which evolve smoothly over time are captured by country-specific fixed effects, $a_i$, and country-specific time trends, $\delta_i t$.

Equation 2 assumes a long-run bivariate relationship between permanent movements in the log level of outward FDI and permanent movements in the log level of total factor productivity. Necessary conditions for this assumption to hold (and thus for our model to be a correct description of the data) are that both the individual time series for the log of total factor productivity and the individual time series for the log of outward FDI are nonstationary or, more specifically, integrated of the same order and that $\log(TFP_{it})$ and $\log(OFDI_{it})$ form a co-integrated pair. A regression consisting of two co-integrated variables has a stationary error term, $\epsilon_{it}$, in turn implying that no relevant integrated variables are omitted; any omitted nonstationary variable that is part of the co-integrating relationship would enter the error term, thereby producing nonstationary residuals and thus leading to a failure to detect co-integration.

Another assumption inherent in Equation 2 is that total factor productivity is endogenous in the sense that, in the long run, changes in outward FDI cause changes in total factor productivity. Although the existence of co-integration implies long-run Granger causality in at least one direction, long-run causality may also run from total factor productivity to outward FDI. The rationale for this is that recent theoretical work on firm heterogeneity and FDI suggests that the establishment or acquisition of foreign affiliates involves the additional costs of overcoming legal, cultural, and social barriers, so that only firms above a certain productivity threshold can cope with these fixed costs and thus engage in outward FDI (Helpman et al., 2004). That is, only the most productive firms self-select into investing abroad. Since an increase in aggregate productivity is generally associated with an increase in average firm productivity and, consequently, with an increase in the number of firms reaching the critical productivity level necessary for FDI, a macroeconomic implication of heterogeneous-firm models is that the aggregate amount of outward
FDI should increase as total factor productivity increases. On the other hand, given that total factor productivity growth is generally associated with domestic output growth and higher demand, and therefore, better profit opportunities for domestic investment, an increase in total factor productivity can also lead to a reallocation of scarce funds to more profitable domestic investment opportunities in place of less profitable outward investment. Consequently, increased factor productivity may be the cause of both reduced and increased outward FDI activity. The empirical implication is that it is crucial to not only examine the time-series properties of the variables and test whether the variables are co-integrated, but also to deal with this endogeneity problem and investigate the direction of causality.

A final econometric issue is the potential cross-country heterogeneity in the relationship between outward FDI and total factor productivity. As discussed in Section II, individual country studies based on firm and industry-level data tend to find different results for different countries. In particular, the study by Bitzer and Görg (2009) suggests that the productivity effects of outward FDI are not constant across countries. Thus, we face a dilemma regarding the optimal estimation strategy. On the one hand, efficiency gains from the pooling of observations over the cross-sectional units can be achieved when the individual slope coefficients are the same \((b_i = b)\). On the other hand, pooled within-dimension estimators produce inconsistent and potentially misleading point estimates of the sample mean of the heterogeneous co-integrating vectors when the true slope coefficients are heterogeneous. Although a comparative study by Baltagi and Griffin (1997) concludes that the efficiency gains from pooling more than offset the biases due to individual country heterogeneity, we nonetheless try to solve this dilemma by using both homogeneous (within-dimension-based) and heterogeneous (between-dimension-based) estimators. The latter allows us, in addition, to analyse the potential heterogeneity in the effects of outward FDI across countries.

The data used in the empirical analysis are described fully in the Online Appendix. Total factor productivity is defined as \(TFP = \frac{Y}{K^{1-\alpha}L^\alpha}\), where \(Y\) is output (real GDP in constant 2000 US$), \(K\) denotes the capital stock (constructed), \(L\) stands for labour input (working age population), \(1 - \alpha\) is the capital share of income, and \(\alpha\) is the labour share of income (assumed to be 0.6667).

All data used to calculate TFP are from the World Development Indicators (WDI) 2008 CD-ROM. The data on outward FDI stocks are derived from the UNCTAD FDI database. The empirical analysis covers the period from 1980 to 2005 with a representative sample of 33 developing countries (four in North Africa, nine in Sub-Saharan Africa, three in Central America, nine in South America, five in East Asia and three in South Asia and the Middle East). The countries with summary statistics are listed in Online Appendix Table A1 and Figure A1 (see Online Appendix) illustrates the cross-country relationship between TFP and outward FDI. The next section examines this relationship in more detail using panel co-integration and causality techniques.

IV. Empirical Analysis

The pre-tests for unit roots and co-integration, which are reported in the Online Appendix, suggest that the variables are nonstationary and co-integrated, as
assumed in Equation 2. In this section, we provide estimates of the co-integrating relationship between outward FDI and total factor productivity and test the robustness of the estimates. We also investigate the direction of causality between the two variables and examine the degree of heterogeneity in the effects of outward FDI on total factor productivity across countries.

**Long-run Relationship**

In order to estimate the long-run elasticity of total factor productivity with respect to outward FDI, we use the dynamic ordinary least squares (DOLS) estimator. This estimator is asymptotically unbiased and normally distributed, even in the presence of endogenous regressors (Stock and Watson, 1993), thus allowing us to control for the potential endogeneity of outward FDI, as discussed in section III. Furthermore, the DOLS estimator performs well in finite samples, compared with other co-integration estimators (such as the fully modified estimator), both in time-series and panel data (Stock and Watson, 1993; Kao and Chiang, 2000), and is robust (under co-integration) to the omission of variables that do not form part of the co-integrating relationship. The within-dimension-based DOLS model used in this paper and following Kao and Chiang (2000) is

$$\log(TFP_{it}) = a_t + \delta t + b \log(OFDI_{it}) + \sum_{j=-k}^{k} \Phi_{ij} \Delta \log(OFDI_{it-j}) + \varepsilon_{it}, \quad (3)$$

where $\Phi_{ij}$ are coefficients of current, lead, and lag differences, which account for possible serial correlation and endogeneity of the regressor(s), thus yielding unbiased estimates.

The results of this estimation procedure are presented in the second column of Table 2 where, for brevity, we report only the estimated $b$ coefficients. The estimated coefficient is highly significant and positive. More precisely, the elasticity of total factor productivity, with respect to outward FDI, is estimated to be 0.024, implying that, in the long run, a 10 per cent increase in the outward FDI stock is associated

<table>
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<th>Within-dimension DOLS estimator (Kao and Chiang, 2000)</th>
<th>DOLS mean group estimator (Pedroni, 2001)</th>
<th>CCE mean group estimator (Pesaran, 2006)</th>
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<tr>
<td>Adjusted $R^2$</td>
<td>0.024** (2.97)</td>
<td>0.014** (3.42)</td>
<td>0.050** (4.61)</td>
</tr>
<tr>
<td>Observations</td>
<td>759</td>
<td>759 (average)</td>
<td>858 (average)</td>
</tr>
</tbody>
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*Notes: The dependent variable is $\log(TFP_{it})$. $t$ statistics in parenthesis. ** indicates significance at the 1 per cent level. The dynamic ordinary least squares (DOLS) regressions were estimated with one lead and one lag.*
with an increase in total factor productivity by 0.24 per cent. From this it can be concluded that developing countries benefit in general or on average from outward FDI due to the increased productivity of the investing companies and associated productivity spillovers to local firms.

To assess the robustness of this conclusion, we perform several sensitivity checks. First, we investigate whether the positive relationship between outward FDI and total factor productivity is robust to alternative estimation methods. Specifically, a potential problem with the above estimation procedure could be that it assumes a homogeneous $b$, which assumption is likely to be empirically incorrect. To allow the slope coefficients to vary across countries, we use the between-dimension, group-mean panel DOLS estimator suggested by Pedroni (2001). This estimator involves estimating separate DOLS regressions for each country and averaging the long-run coefficients, $b = N^{-1} \sum_{i=1}^{N} b_i$. The $t$ statistic for the average is the sum of the individual $t$ statistics divided by the root of the number of cross-sectional units, $t_b = \sum_{i=1}^{N} t_{bi} / \sqrt{N}$. We present the DOLS group-mean point estimate of the effect of outward FDI on total factor productivity in the third column of Table 2. As the DOLS estimates could be biased in the presence of cross-sectional dependence, we also report (in the fourth column) the result of the common correlated effects (CCE) mean group estimator suggested by Pesaran (2006). This estimator allows for cross-sectional dependencies potentially arising from multiple unobserved common factors by using the cross-sectional averages of the dependent and independent variables as proxies for the unobserved factors. As can be seen, all three estimators produce similar results, suggesting that the positive relationship between outward FDI and total factor productivity is due neither to potentially restrictive homogeneity assumptions nor to possible cross-sectional dependence. However, given the relatively short time span of our data, the mean group results (which are based on individual time-series regressions) should be interpreted with caution. In addition, the CCE mean group estimator is intended for the case in which the regressors are exogenous, so that we lose the ability to account for the likely endogeneity of outward FDI. Therefore, we continue our robustness analysis with the pooled within-dimension panel DOLS estimator. As noted in section III, there is evidence to suggest that the efficiency gains from pooling are likely to more than offset the potential biases due to individual heterogeneity (Baltagi and Griffin, 1997).

We re-estimate the DOLS regression, excluding one country at a time from the sample in order to verify that the positive effect of outward FDI is not due to individual outliers. The sequentially estimated long-run coefficients and their $t$ statistics are presented in Figure A2 (see Online Appendix). As they are relatively stable between 0.017 and 0.035 and always significant at the 5 per cent level, we conclude that the positive productivity effect is not the result of individual outliers.

Next, we examine whether the positive long-run relationship between outward FDI and total factor productivity is due to sample-selection bias. Sample-selection bias occurs when the selected sample is not random and thus not representative. A potential problem with our sample could be that it includes only six low-income countries (Benin, Burkina Faso, Kenya, Mali, Pakistan, Senegal), while the rest of the countries are classified by the World Bank as middle or high-income countries. Another possible problem is the distribution of outward FDI among the countries.
In fact, our sample is dominated by six countries (Argentina, Brazil, Hong Kong, Mexico, Panama, and South Africa) that invest more than the sample average. We therefore re-estimate the DOLS regression for four subsamples: low-income countries, middle and high-income countries, countries with outward FDI above the sample average, and countries with outward FDI below the sample average. The resulting coefficients are listed in Table 3. Regardless of which subsample is used, the long-run relationship between outward FDI and total factor productivity remains positive and significant at least at the 5 per cent level. From this, it can be concluded that the positive coefficient on \( \log(OFDI_{it}) \) is not due to sample-selection bias. Clearly, it would be desirable to also assess whether there are significant differences in the effects of outward FDI on total factor productivity between low-income and middle-to-high-income countries or between countries with low levels of outward FDI and those with high levels of outward FDI. However, the small sample sizes do not allow statistically meaningful comparisons in this regard.

We also examine whether the estimated coefficient on outward FDI is sensitive to the model specification. To this end, we combine the definition of total factor productivity, \( TFP = \frac{Y}{[K^{(1-\alpha)}L^\alpha]} \), with Equation 2 to obtain (after some rearrangements):

\[
\log \left( \frac{Y_{it}}{L_{it}} \right) = a_{it} + \delta_{it} + (1 - \alpha) \log \left( \frac{K_{it}}{L_{it}} \right) + b \log(OFDI_{it}) + \varepsilon_{it},
\]

where \( \left( \frac{Y_{it}}{L_{it}} \right) \) is labour productivity, \( \left( \frac{K_{it}}{L_{it}} \right) \) is capital per worker, and \( \alpha \) is (as before) the labour share of income, which is assumed to be 0.6667. Since the elasticity of labour productivity with respect to outward FDI, \( b \), is equal to the elasticity of total factor productivity with respect to outward FDI, Equation 4 allows us to test whether there are systematic biases in the calculated factor productivity and the estimated coefficient on outward FDI. If there are no systematic biases, Equation 4 should, on the one hand, produce approximately the same outward FDI coefficient as Equation 2 (and thus a \( b \) value of about 0.024) and, on the other hand, a coefficient on \( \log \) capital per worker of about \((1-0.6667 =) 0.3333\). The DOLS

<table>
<thead>
<tr>
<th>Sub-sample</th>
<th>( \log(OFDI_{it}) )</th>
<th>Number of countries in the sub-sample</th>
<th>Adjusted ( R^2 )</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-income countries</td>
<td>0.079* (2.16)</td>
<td>6</td>
<td>0.99</td>
<td>138</td>
</tr>
<tr>
<td>Middle- and high-income countries</td>
<td>0.028** (3.08)</td>
<td>27</td>
<td>0.98</td>
<td>621</td>
</tr>
<tr>
<td>Countries with outward FDI above the sample average</td>
<td>0.056* (2.19)</td>
<td>6</td>
<td>0.97</td>
<td>138</td>
</tr>
<tr>
<td>Countries with outward FDI below the sample average</td>
<td>0.021* (2.38)</td>
<td>27</td>
<td>0.98</td>
<td>621</td>
</tr>
</tbody>
</table>

Notes: ** and * indicate significance at the 1 per cent and 5 per cent level, respectively. \( t \) statistics in parentheses. FDI, foreign direct investment.
estimates for these two parameters are given in Table 4. The coefficient on log capital per worker is indeed close to 1/3 and the estimated $b$ coefficient is close to 0.024. In addition, the last row of Table 4 shows that simple Wald tests do not reject the restrictions that $(1 - \hat{z}) = 0.3333$ and $b = 0.024$. This suggests that the sign and magnitude of the coefficient on outward FDI is robust to the specification of the empirical model.

Finally, we examine whether the results are robust to alternative measures of total factor productivity and outward FDI. Young (1995), for example, measures total factor productivity as the residual from a regression of the log of output per worker on the log of capital per worker (as Equation 4 implies), while Herzer (2008) employs the percentage ratio of net FDI outflows to GDP as a measure of outward FDI. Table 5 presents the results of the DOLS regressions using these two different measures, labelled $\log(TFP_{diff_{it}})$ and $OFDIdiff_{it}$, both separately and jointly. As can be seen, all coefficients are positive and statistically significant. Thus, it can be concluded that the positive productivity effect of outward FDI is robust to different estimation techniques, potential outliers, sample selection, the specification of the empirical model, and different measures of total factor productivity and outward FDI.

### Causality

Recent theories on firm heterogeneity and FDI suggest that only those firms with productivities above a certain threshold find it profitable to locate production or other activities abroad (Helpman et al., 2004). Since it is reasonable to assume that an increase in aggregate productivity is associated with an increase in the number of firms reaching this threshold, it follows that economy-wide productivity gain should lead to increased FDI outflows. Consequently, causality may run in both directions – not only from $\log(OFDI_{it})$ to $\log(TFP_{it})$, but also from $\log(TFP_{it})$ to $\log(OFDI_{it})$.

To test the direction of causality, we use a two-step procedure. In the first step, we employ the DOLS estimate of the long-run relationship to construct the disequilibrium term

$$ec_{it} = \log(TFP_{it}) - [\hat{a}_t + \hat{\delta}_i + 0.024 \log(OFDI_{it})].$$

### Table 4. Dynamic ordinary least squares (DOLS) estimates of the coefficients on log capital per worker, $(1 - \hat{z})$, and log outward foreign direct investment (FDI), $b$

<table>
<thead>
<tr>
<th></th>
<th>log($K_{it}/L_{it}$)</th>
<th>log($OFDI_{it}$)</th>
<th>Adjusted $R^2$</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.368^{**}$ (14.14)</td>
<td>0.019** (2.99)</td>
<td>0.99</td>
<td>759</td>
<td></td>
</tr>
</tbody>
</table>

Wald tests

<table>
<thead>
<tr>
<th>Restriction: $(1 - \hat{z})=0.3333$</th>
<th>Restriction: $\hat{b}=0.24$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\chi^2(1)$ [p-values]</td>
<td></td>
</tr>
<tr>
<td>1.81 [0.18]</td>
<td>0.52 [0.47]</td>
</tr>
</tbody>
</table>

Notes: The dependent variable is $\log(Y_{it}/L_{it})$. ** indicates significance at the 1 per cent level. $t$ statistics in parentheses. The DOLS regression was estimated with one lead and one lag. The number of degrees of freedom $v$ in the $\chi^2(v)$ tests correspond to the number of restrictions.
In the second step, we estimate the vector error correction model (VECM)

\[
\Delta \log(\text{TFP}_{it}) = c_{1i} + a_1 \varepsilon_{it-1} + \sum_{j=1}^{k} \varphi_{11ij} \Delta \log(\text{TFP}_{it-j}) \\
+ \sum_{j=1}^{k} \varphi_{12ij} \Delta \log(\text{OFDI}_{it-j}) + e^{\text{TFP}}_{it}
\]

\[
\Delta \log(\text{OFDI}_{it}) = c_{2i} + a_2 \varepsilon_{it-1} + \sum_{j=1}^{k} \varphi_{21ij} \Delta \log(\text{TFP}_{it-j}) \\
+ \sum_{j=1}^{k} \varphi_{22ij} \Delta \log(\text{OFDI}_{it-j}) + e^{\text{OFDI}}_{it}
\]

(6)

where the error-correction term, \(\varepsilon_{it-1}\), represents the error in, or deviation from, the equilibrium, while the adjustment coefficients \(a_1\) and \(a_2\) capture how \(\log(\text{TFP}_{it})\) and \(\log(\text{OFDI}_{it})\) respond to deviations from the equilibrium relationship. From the Granger representation theorem, we know that at least one of the adjustment coefficients must be nonzero if a long-run relationship between the variables is to hold. A significant error-correction term also suggests long-run Granger causality, and thus long-run endogeneity (Hall and Milne, 1994), whereas a non-significant adjustment coefficient implies long-run Granger non-causality from the independent to the dependent variable(s), as well as weak exogeneity. In the following, we test for weak exogeneity of total factor productivity and outward FDI, and thus for long-run Granger non-causality between \(\log(\text{TFP}_{it})\) and \(\log(\text{OFDI}_{it})\), by first successively eliminating the insignificant short-run dynamics with the lowest \(t\) values. We then test the significance of the adjustment coefficients. In doing so, we

### Table 5. Dynamic ordinary least squares (DOLS) estimates using different measures of total factor productivity and outward foreign direct investment (FDI)

<table>
<thead>
<tr>
<th>Different TFP measure</th>
<th>Different outward FDI measure</th>
<th>Different TFP and different outward FDI measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>[regressand: (\log(\text{TFP}<em>{\text{diff},it})), regressor: (\log(\text{OFDI}</em>{it}))]</td>
<td>[regressand: (\log(\text{TFP}<em>{it})), regressor: (\log(\text{OFDI}</em>{\text{diff},it}))]</td>
<td>[regressand: (\log(\text{TFP}<em>{\text{diff},it})), regressor: (\log(\text{OFDI}</em>{\text{diff},it}))]</td>
</tr>
<tr>
<td>Adjusted (R^2)</td>
<td>0.029** (3.34)</td>
<td>0.007* (2.06)</td>
</tr>
<tr>
<td>Observations</td>
<td>0.98</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Notes: \(\log(\text{TFP}_{\text{diff},it})\) is the residual from individual country regressions of the log of output per worker on the log of capital per worker. \(\text{OFDI}_{\text{diff},it}\) is the ratio of net FDI outflows to GDP. Given that UNCTAD does not report complete data on net FDI outflows for Benin, Botswana, Mali, Morocco, Pakistan, Paraguay, Peru, and Tunisia over the period 1980–2005, these countries were excluded from the sample. \(t\) statistics in parenthesis. ** and * indicate significance at the 1 per cent and 5 per cent level, respectively. The DOLS regressions were estimated with one lead and one lag.
reduce the number of parameters (according to Hendry’s general-to-specific methodology) and thereby increase the precision of the weak exogeneity tests on the a-coefficients. Since all variables in the model, including \( ec_{it-1} \), are stationary (because the level variables are integrated of order 1 and co-integrated), a conventional likelihood ratio test can be used to test the null hypothesis of weak exogeneity, \( H_0: a_{1,2} = 0 \).

However, the above model assumes that the long-term effects are the same for all countries. To account for heterogeneous long-run elasticities, we replace the error-correction term given by Equation 5 with the residuals from the individual DOLS long-run relationships:

\[
ec_{it} = \log(TFP_{it}) - [\hat{a}_i + \hat{c}_i t + \hat{b}_i \log(OFDI_{it})].
\]  

This model allows the log-run coefficients to differ across countries.

Table 6 presents the results. Regardless of which model is employed, the null hypothesis of weak exogeneity is rejected for both \( \log(TFP_{it}) \) and \( \log(OFDI_{it}) \) at least at the 5 per cent level. From this it can be concluded that the statistical long-run causality is bidirectional, suggesting that increased factor productivity is both a consequence and a cause of increased outward FDI.

To test the robustness of this conclusion, we finally compute the impulse-response functions from the VECM residuals applying a standard Choleski decomposition (with \( \Delta \log(TFP_{it}) \) ordered first and \( \log(OFDI_{it}) \) ordered last). The responses of total factor productivity to a one-standard-deviation innovation in outward FDI, as well as the responses of outward FDI to a one-standard-deviation impulse in total factor productivity over a 10-year horizon are shown in Figure 1, where the dashed lines mark plus and minus two standard errors obtained through Monte Carlo simulations using 1000 replications. From the figure, it is seen that a one-standard-deviation innovation in outward FDI leads to a gradual and sustained increase in total factor productivity, while a one-standard-deviation innovation in total factor productivity produces an immediate increase in outward FDI, reaching a maximum after three years. Consequently, the impulse response functions are consistent with the Granger causality tests reported above. Thus, this study also supports the macroeconomic implication of heterogeneous-firm models that outward FDI tends to increase when a country’s aggregate productivity increases.

### Table 6. Long-run causality tests

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Weak exogeneity of log(TFP(_{it})) (significance of ( z_1 ))</th>
<th>Weak exogeneity of log(OFDI(_{it})) (significance of ( z_2 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogeneous long-run coefficients</td>
<td>( \chi^2(1) ) (p values) = 186.01 (0.000)</td>
<td>10.58 (0.001)</td>
</tr>
<tr>
<td>Heterogeneous long-run coefficients</td>
<td>( \chi^2(1) ) (p values) = 91.14 (0.000)</td>
<td>6.12 (0.013)</td>
</tr>
</tbody>
</table>

Note: The number of degrees of freedom \( v \) in the standard \( \chi^2(v) \) tests correspond to the number of zero restrictions. The number of lags was determined by the general-to-specific procedure with a maximum of three lags.
Cross-country Heterogeneity

The results reported thus far indicate that outward FDI has, on average, a positive long-run effect on total factor productivity in developing countries (and vice versa). This finding for the sample as a whole does not imply, however, that outward FDI exerts positive productivity effects in each individual country. Although estimates of the coefficient on log($OFDI_{it}$) from the group-mean panel DOLS estimator must be interpreted with caution given the short sample period, there is considerable heterogeneity in the effects of outward FDI on total productivity across countries (Online Appendix Figure A3 and discussion). The coefficients range from −0.29 in Paraguay to 0.60 in Algeria; although the average long-run effect of outward FDI is positive, for some countries the long-run effect on total factor productivity is negative (these include South Korea; as noted above, this is also found by Bitzer and Görg, 2009). Overall, the negative effects tend to be smaller in absolute value than the positive effects so the general effect is positive.

V. Conclusion

In this study, we examined the macroeconomic relationship between outward FDI and total factor productivity for home (outward investing) developing countries, a relationship that has not yet been explored in the published literature. Our results suggest that outward FDI has, on average, a positive long-run effect on domestic total factor productivity in developing countries, and that increased factor productivity is both a consequence and a cause of increased outward FDI. Developing countries are increasingly important sources of FDI, and outward FDI is important for a number of developing countries. We show that these countries tend to benefit themselves from outward FDI, and as their productivity increases so too does outward FDI. For many countries it is therefore a virtuous cycle. However, there are also countries for which an increase in outward FDI is associated with a decrease in total factor productivity. A natural question therefore is: What factors determine the long-run effect of outward FDI on domestic productivity and how can...
governments in developing countries restructure their economies to make positive effects more likely? We leave this question for future research.

Acknowledgement

We thank two anonymous referees for helpful comments on an earlier draft of this paper.

Note

1. The figures are based on data from the UNCTAD FDI database (http://stats.unctad.org/FDI/ReportFolders/reportFolders.aspx).

References


