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The effect of reverse knowledge spillovers on the total factor productivity in emerging markets

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Abstract

The aim of this paper is to shed the light on the phenomenon and mechanisms of knowledge spillovers from developed economies to emerging markets through the lens of productivity effects. We hypothesize on the impact of foreign R&D stocks on the total factor productivity growth in emerging markets and on the moderating effect of R&D stocks on the knowledge spillover effects. We use panel data from 38 countries for the period of 2001–2014. Our findings suggest that firms investing in developed markets are able to improve TFP growth via reverse spillovers. Two important findings having managerial value are that, on average, the effect of OFDI on productivity becomes apparent three years after the initial investment. The study also indicates that investment efforts have a negative effect on TFP growth in the year of investment. This research contributes to the existing literature by analyzing bilateral FDI stocks between emerging and developed markets and the impact of both traditional and reverse spillovers on TFP growth in developing economies.

Keywords: foreign direct investments (FDI), total factor productivity (TFP), multinational enterprises (MNEs), research and development (R&D), emerging markets.

JEL: F21, F23, F6.

1. Introduction

The birth of emerging market multinational enterprises (EMNEs) occurred during the so-called "second wave" of internationalization in the 1980's. However, the past two decades

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have witnessed a massive increase in outward foreign direct investments (OFDI) from these firms. Although developed countries' MNEs still account for the bulk of OFDI flows (UNCTAD, 2015), EMNEs have gone from relatively insignificant in this sphere to formidable world players in an astoundingly short period. According to the 2015 World Investment Report, between 2000 and 2014, the total value of OFDI from developing countries increased from less than $100 billion (about 7% of the world total) to $468 billion (35% of the world total). This rapid and aggressive internationalization patterns of EMNEs seem to defy the classical internationalization theory used to explain the strategies of developing market firms. The subject has therefore recently drawn significant attention from the academic world which seeks to explain the peculiarities of this type of firms.

The tendency of many EMNEs to establish subsidiaries in developed markets (DM) early in the internationalization process is of particular interest. Dunning's (1977) eclectic paradigm calls for direct investment in a market (as opposed to exports and licensing) in cases when there are clear ownership, location, and internalization advantages for the firm to exploit. For EMNEs operating in developed countries, these advantages, especially ownership-based, are often unclear or non-existent. A compelling explanation of this phenomenon is that the FDI of these firms is knowledge- or strategic asset-seeking (Dunning, 2000). Strategic asset-seeking FDI is less concerned with exploiting existing advantages and more with enhancing firm-specific advantages via acquisition of new, superior knowledge or technology (Dunning, 2000; Chen et al., 2012). Luo and Tung (2007) suggest that EMNEs often use foreign investment as a "springboard" for quick acquisition of resources necessary to compete against more established global market players and to mitigate risks they face in their home markets. In other words, firms from technologically deficient countries invest in technologically advanced countries (Kogut & Chang, 1991; Kuemmerle, 1999) in an attempt to close this technological gap. Accordingly, there is an enhanced performance effects from knowledge spillover mechanisms under industries growth (which is the typical characteristic for dynamic markets, such as BRICS and beyond), and the pace of developments in growth industries increases the importance of access to knowledge (Stanko & Olleros, 2013).

The hypothesis that EMNEs' investments abroad are motivated by knowledge and strategic asset acquisition is well-supported in the literature (Makino et al., 2002; Deng, 2009). Nonetheless, OFDI remains an extremely high-risk approach to obtaining these technological and knowledge-based assets. A decision to invest as opposed to purchasing the rights to these assets in the form of intellectual property (IP) must be justified. Multiple empirical evidences suggest that R&D investment is positively related to economic growth (see, e.g., Wang et al., 2013). Therefore, while understanding the EMNEs' motives for investing abroad remains an important research question, it is equally important to understand whether these investments actually result in increased productivity at home.

The limited literature that deals with answering this question reveals a critical mechanism of obtaining effect known as an R&D, technological, or knowledge spillover. In general terms, knowledge spillover is defined as a process by which one party (firm) uses knowledge created by a second party in order to augment its own productivity without directly or fully compensating the second party (Javorcik, 2004), due to a "free launch" (Eden, 2009). Knowledge spillovers differ from knowledge transfers in that spillovers are an externality, or unintended diffusion of knowledge from one entity to another. Spillovers from a host market to an investing market are known as "reverse spillovers".

In this paper, we seek to analyze the knowledge flows from developed markets to emerging markets (EM) in the form of knowledge spillovers in order to ascertain whether the 'springboard' strategy of EMNEs results in the desired productivity gains. Specifically, we attempt answering two research questions:

1) Are emerging market firms that invest in DM able to take advantage of knowledge spillovers to increase productivity? If so, to what extent?
2) What factors influence the magnitude, direction, or significance of this effect?

The paper is organized as follows. We begin by reviewing existing literature on the subject, both empirical and theoretical. We then develop an empirical model of relationship between spillovers and total factor productivity growth based on the works of van Pottelsberghe de la Potterie and Lichtenberg (2001), and Armann and Virmai (2014). Next, using country-level panel data from 29 emerging markets and 9 developed markets for 2001–2014, we run a fixed-effects generalized least squares regression to empirically estimate this relationship. We then interpret the empirical results and draw conclusions on their managerial and policy implications. We conclude with a description of the limitations of the study and suggest potential avenues for future research.

2. FDI reverse spillovers

2.1. Knowledge spillover literature

Until recently, the bulk of FDI spillover literature focused on transfer of knowledge from investing firms to a recipient company abroad. Indeed, there is an ample body of work dedicated to the topic. This literature identifies four major channels through which the diffusion of technology and knowledge from foreign subsidiaries to local firms is thought to occur (Hoekman & Mattoo, 2006; Zhang et al., 2010). The first channel is a demonstration effect, wherein local firms observe practices and technologies of their foreign competitors and imitate them in their own operations. The second channel is labor turnover; when employees of foreign firms leave in order to work at local counterparts, they bring with them valuable knowledge from their previous employers. Thirdly, spillovers may occur through domestic linkages (Spencer, 2008) or intentional vertical technology transfer from foreign firms to domestic (local) suppliers or distributors which eventually are diffused to other local firms with the same partnerships (Gallego et al., 2013). Finally, increased competition may force domestic firms to increase productivity by adopting new technologies and managerial practices (Blomstrom & Kokko, 1998; Zhang et al., 2010).

Early studies (Caves, 1974; Globerman, 1979; Blomstrom & Persson, 1983) focus mainly on the internationalization of developed markets (the United States, Canada). They provide some evidence of the spillover effect by showing that industries with higher degrees of foreign presence (as measured by share of foreign investing enterprises in capital, output, or employment (Tian, 2007)) were relatively more productive than other industries. Aitken and Harrison (1999) challenge the results of these studies pointing out an unaddressed endogeneity problem. The correlation between FDI and productivity could very well occur in the opposite direction: high productivity sectors attract more foreign investment. In order to account for this, many recent studies also investigate firm-level impact rather than industry-level.

Since this shift in the literature occurred, results of empirical studies on spillovers became more mixed and ambiguous (Görg & Strobl, 2001; Tian et al., 2015). Gorg and Greenaway's (2004) meta-analysis of spillover literature indicate that out of 40 studies, 20 provide evidence of positive knowledge spillovers, 17 show no compelling evidence, and eight studies even suggest significant negative spillover effects. Notably, in a firm-level study in Morocco, Haddad and Harrison (1993) show that while FDI has a positive level effect on local total factor productivity (TFP), it has no effect on TFP growth rate. More bleakly, in a study of Venezuelan firms, Aitken and Harrison (1999) observe that domestic productivity declines as foreign investment increases. They hypothesize that the competition effect of FDI compels local plants to lower output and forgo economies of scale. Tian et al. (2015) discover that although the net effect of FDI on domestic TFP is positive, in the case of wholly owned foreign enterprises, there is strong evidence of skill- and market-stealing that negatively affects local firm productivity.

2.2. Reverse spillovers

In contrast to the vast body of literature addressing knowledge spillovers from foreign subsidiaries to domestic firms, the one that addresses the opposite phenomenon — "reverse spillover" — is relatively scant. Though Driffield and Love coined the term only in 2003, the idea of host-home knowledge flows as a mechanism to improve productivity had been explored earlier in the context of exporting firms in the form of "learning by exporting" (LBE) hypothesis.

2.2.1. Learning by exporting

This hypothesis states that export activity facilitates knowledge spillovers and ultimately increases productivity via two main mechanisms. First, exporting firms can benefit from linkages with foreign buyers who may provide technical assistance or specify high quality products. Second, exporting firms are exposed to the competitive pressures of an international marketplace forcing them to adopt new technologies and practices in order to survive (Haidar, 2012). The consensus among the authors on this topic is that exporting firms are, with few exceptions, unequivocally more productive and more often than not higher-growth than non-exporting ones (Wagner, 2007). That being said, evidence that this productivity boost stems from LBE rather than self-selection of more productive firms is less conclusive (Fernandes & Isgut 2008). While some studies show knowledge spillovers between exporting firms and foreign buyers (Salmon & Shaver, 2005), Wagner's (2007) a meta-analysis of the extant literature indicates that in most cases, there is no statistically significant post-entry difference in the productivity of exporting and non-exporting firms. However, other authors (Martins & Yang, 2009) suggest and find evidence to support the theory that due to a greater differential in technology between a home country and an export destination, less-developed countries have LBE at a higher incidence.

Over the past decade or so, researchers expanded their understanding of this exploration by examining the impact of OFDI on the TFP of parent companies. Justification of direct investment in order to capture knowledge spillovers is compelling. Physical presence in developed markets is required for EMNEs to access this knowledge for three reasons. First, the authors indicate that the types of networks which foster innovation (comprised of suppliers, competitors, educational centers) are spatially bound and not easily replicable elsewhere (Globerman et al., 2005). Second, technological knowledge tends to be tacit, complex, and highly system dependent (requiring many individuals for knowledge production and adoption) and is thereby not easily transferred in the form of IP (Simonin, 1999). Finally, DM firms are often unwilling to divulge sources of their competitive advantage to their rivals and take great pains to protect those (Feinberg & Gupta, 2009). Therefore, EMNEs must establish themselves within an innovation network to access the knowledge therein.

2.2.2. Reverse FDI spillovers

The sources suggest that mechanisms by which reverse knowledge spillovers can occur are similar to those through which their traditional counterparts occur. First, subsidiaries can access knowledge through local supply chains (Javorcik, 2004). Second, they can acquire technology through interaction with local innovation leaders, such as universities, scientists, and research centers (Chen et al., 2012). Finally, subsidiaries in a foreign market have access to high-quality workers and graduates in the local labor pool (Moen, 2005).

Early empirical studies on reverse spillovers focus on the investment activities of DM MNEs. These studies have yielded mixed results. The inventors of the term, Driffield and Love (2003), were among the first to investigate and find evidence for the knowledge flow that occurred from a subsidiary to a parent firm via outward FDI. In the course of research in the UK, they found that technology generated by the domestic sector spilled over to foreign MNEs. This effect was restricted to R&D-intensive sectors and affected by the spatial concentration of the industry. Castellani and Barba Navaretti (2004) provided more evidence to support the existence of reverse spillovers and established a causal link between OFDI and TFP by showing that Italian MNEs outperformed domestic competitors. Similarly, Iyer, Stevens and Tang (2011) found evidence for reverse vertical knowledge spillovers in New Zealand; specifically, foreign firms were able to absorb knowledge from local suppliers. Kimura and Kyota (2006) examined panel data for Japanese firms in the late 1990s, which suggested that OFDI leads to higher productivity. On the other hand, Iver et al. (2010), along with determining that vertical spillovers may occur through export activity, found no evidence for reverse spillovers facilitated by OFDI in a study of New

Zealand MNEs. In her investigation of managerial knowledge spillovers in the United Kingdom, Fu (2012) did not find any evidence for reverse spillovers despite observing significant practice spillovers between local firms. In a study of 17 OECD countries between 1974 and 2001, Bitzer and Gorg (2009) even found a net negative of OFDI on TFP, albeit with a large degree of country heterogeneity.

Recently, the focus in the literature has shifted from developed markets to emerging and developing ones. In particular, in response to the growing internationalization literature on strategic asset-seeking FDI from the developing world, researchers are beginning to investigate investments from EMNEs into developed economies. Exploration in this field indicates that the "backwardness" principle, which predicts greater increases in productivity being associated with investments in comparatively higher technology intensive countries, is of particular importance for reverse knowledge spillovers (de la Potterie & Lichenberg, 2001; Barba Navaretti et al., 2010). The literature on North-South reverse spillovers, which admittedly is still relatively scarce, is summarized below in Table 1.

Table 1. Studies on reverse spillovers to emerging markets

Author	Investing country	Key findings
Debaere et al. (2010)	South Korea	Investment in DM has no impact on productivity or employment, investment in EM has a significant negative effect
Lui and Nunnenkamp (2011)	Taiwan	Foreign investment results in increased domestic production and employment depending on the size of the investment. Larger investments slightly increase the probability of negative outcomes for the firm.
Franco and Kozovska (2011)	Romania and Poland	There is evidence for reverse spillover effects inside clusters in Poland and Romania, even in low-tech sectors.
Hertzer (2011)	33 developing countries	Positive correlation between OFDI and TFP with some degree of heterogeneity is explained by labor regulations
Chen et al. (2012)	34 emerging markets	Investing in technologically advanced markets leads to increased R&D spending and productivity in EM MNEs
Yang et al. (2017)	Taiwan	OFDI raises firm productivity because it improves technological endowments and efficiency
Chen and Tang (2014)	China	OFDI positively impacts productivity, employment, and export performance
Amann and Virmani (2014)	18 emerging markets	OFDI positively impacts TFP in emerging markets, though to a lesser extent than IFDI
Zamborsky and Jacobs (2016)		Foreign EM subsidiaries in OECD countries experience positive knowledge spillover effects with a possibility of benefits to both home and host countries

Source: Authors' compilation.

Most studies indicate that reverse spillovers between EMNEs and their subsidiaries in developed markets not only exist but also result in positive productivity and other gains. As with traditional spillovers, the magnitude of these gains is potentially influenced by various factors, including absorptive capacity (Amann & Virmani, 2014), regulatory factors (Hertzer, 2011), clusters (Franco & Kozovska, 2011), and various measures of proximity (Chen et al., 2012). However, a consensus does not yet exist as other studies indicate that OFDI results in no significant impact on EM parent enterprises (Debaere et al., 2010). Bitzer and Gorg (2009) even observe a net negative impact of OFDI on productivity indicators. Interestingly, this negative impact only occurs in developing markets, whereas developed markets, such as the US and France, experience productivity gains stemming from outward investment. Lui and Nunnenkamp (2011) provide mixed evidence since their results indicate that negative spillover effects are more probable as investment size increases. Chari et al. (2012), and Bertrand and Bertschinger (2012) provide explanations for the seeming inability of EMNEs to capitalize on knowledge spillovers suggesting that in the case of EM firms lack of international experience and limited ownership advantages significantly hinder a firm's ability to benefit from knowledge spillovers.

2.2.3. Research gap

The extant literature on reverse knowledge spillovers and their effects on investing firms and economies is sporadic and inconclusive. There is no consensus even on whether degree reverse spillovers impact productivity measures at all, let alone on magnitude and direction of the impact. Most of the few studies that explicitly address North-South knowledge flows of this nature focus on China or Taiwan and hardly any of them use cross-country data for analysis. Moreover, researchers have yet to thoroughly explore variables that determine magnitude or even existence of reverse spillovers. Additionally, the vast majority of the existing studies investigate OFDI impacts up to the exclusion of traditional knowledge spillovers, despite evidence that both may be important determinants of productivity (a notable exception being Amann and Virmani (2014)). We seek to contribute to the existing literature by addressing these gaps through investigating the effect of both traditional and reverse spillovers at the macroeconomic level and by analyzing FDI flows between emerging and developed markets on TFP growth in those emerging markets.

3. Theory and empirical model

In this study, we examine the impact of bilateral North-South FDI on aggregate TFP growth in emerging markets through knowledge spillovers across borders utilizing the methodology proposed by van Pottelsberghe de la Potterie and Lichtenberg (2001) and further developed by Amann and Virmani (2014). In this model, both inward and outward FDI are examined at an aggregate level.

3.1. Basic model

We follow the basic econometric model of van Pottelsberghe de la Potterie and Lichtenberg (2001) (Figure 1) who represent domestic TFP growth as a function of domestic and various forms of foreign R&D capital stock:

$$\ln\left(TFP_{it}\right)=\alpha_i+\beta_1\ln\left(RD^{f}_{it-2}\right)+\beta_2\ln\left(RD^{d}_{it-2}\right)+\varepsilon_{it}, \qquad (1)$$

where i = 1...29 is a country index, t = 2001...2014 represents the year; ln(*TFP*) is the natural logarithmic of total factor productivity; RD^f is the foreign R&D capital stock; RD^d is the domestic capital stock; α_i is the country-specific intercept; and ε_{it} is the error term. The lagged independent variables account for the fact that spillover effects require time to be capitalized upon.

Foreign R&D capital stock is comprised of two terms, expressed as follows. The first term, RD_f, or the OFDI from emerging country i to developed country j, is given as:

$$RD^{f1}_{it}=\sum_{j=1}^{9}OFDI_{ijt}*\frac{RD^{d}_{jt}}{GDP_{jt}}+\varepsilon_{it}. \qquad (2)$$

Here i represents each emerging economy; j = 1...9 represents each developed economy; *OFDIjt* is the outward stocks from country i to country j during each year (t); $GDPj_t$ is the *GDP* of country j in year t; and *RDd* is the domestic R&D stock of country j in year t. *RDd/GDPjt* can therefore be understood as the R&D intensity of country j in year t. RD^f is the reverse knowledge spillover received in country i expressed as the weighted average of the R&D intensity of the host country j with OFDI outward stocks in country j from country i.

Similarly, RD^d, or *IFDI* from developed economy j to emerging economy i, is given as:

$$RD^{f2}_{it}=\sum_{j=1}^{34}IFDI_{ijt}*\frac{RD^{d}_{jt}}{GDP_{jt}}+\varepsilon_{it}. \qquad (3)$$

Here $IFDI_{ijt}$ is the *FDI* outward stocks from country j to country i in year t; thus, RD^{f2} is the *traditional FDI* spillover from each country j into country i expressed as the weighted average of the R&D intensity of its DM investing partner j with IFDI flow into country i from country j.

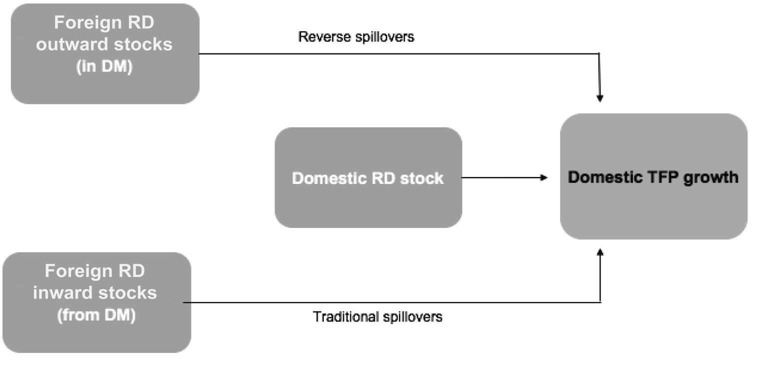

Figure 1. Visual representation of the base empirical model

Regarding expected signs for each coefficient, that for domestic R&D stock is most likely to be positive. Foreign stock coefficients are less straightforward. Both positive and negative relationship between TFP growth and foreign capital stock is plausible. A positive sign for outward foreign stock suggests that reverse knowledge spillovers were successfully captured and utilized. A negative relationship may indicate either that R&D carried out abroad increased the competitiveness of foreign rivals (Bitzer & Gorg, 2009), or that the firms were unable to offset adverse effects of diverting resources abroad with sufficient spillover gains.

Therefore, we suggest the first hypothesis:

H1: Increases in foreign R&D outward stocks positively impact TFP growth in emerging markets.

Inward foreign stock may negatively impact TFP growth as a result of increased competition in the output and input markets (market- and labor stealing). This outcome is more probable when firms are unable to adjust their production process in order to respond to increased competitive pressure (Bitzer & Gorg, 2009). A positive sign indicates that spillover effects predominate over negative factors. The extant literature provides roughly balanced evidence for both scenarios.

Hence, our next hypothesis:

H2: Increases in foreign R&D inward stocks positively or negatively impact TFP growth in emerging markets.

3.2. Adjusted model

3.2.1. Time lag of the independent variables

In order to account for the fact that firms require time in order to reap benefits of knowledge spillovers, we have lagged the independent variables of interest, foreign R&D stocks. Following Mansfield (1985), who shows that spillovers from MNEs into their host markets take four years on average, we choose a lag period of four years. Time lag has an additional benefit of helping to minimize endogeneity within the model. However, other researchers claim that time required for realizing spillover benefits is highly variable and a definitive statement on appropriate lag cannot be made. Therefore, in our robustness checks we test a series of lag values (n = 0–5) for the independent variables.

3.2.2. Moderating variable

The relationship between domestic R&D stocks and TFP growth is clear; firms that invest more in their research and development should be able to reap the benefits of their efforts and increase their productivity. However, we propose that this variable also plays a second, moderating role in the model. The sources believe that direction and magnitude of knowledge spillovers, both traditional and reverse, may depend on various other factors as there is significant empirical evidence for the role of absorptive capacity in spillovers. Firms with higher absorptive capacity theoretically should be better able to capture and implement new knowledge and technologies as they have a knowledge base for development. Although a perfect measure of absorptive capacity does not exist, the sources provide various useful approximations. These approximations fall into three major categories, with many studies using a combination of factors therein. The first category that pertains to research and development activities is the most commonly used. Domestic R&D stock, proxied here as the expenditure on R&D activities, happens to be a measure that falls into this category. This measure is useful in estimating a country's ability to absorb knowledge because it captures its total research effort, not just investments that resulted in registered patents or inventions, i.e., codified knowledge (Gornik-Tomaszewski & Millan, 2005).

The level of domestic R&D stock should therefore influence the magnitude of spillover effects. While theory indicates that firms require some basic level of knowledge in order to capture and deploy more advanced technologies, diminishing returns to additional AC past a certain threshold are quite likely. Counteracting effects of backwardness make this scenario more plausible in the case of knowledge spillovers. Therefore, we expect the relationship between these variables and the dependent variable to be generally positive but nonlinear. In short,

H3: Domestic R&D stocks have a positive moderating impact on both kinds of spillover effect.

3.2.3. Control variables

To better assess the impact of R&D stocks on TFP growth, we controlled four other variables which, according to the sources, may impact TFP. First, we include the commonly used (i.e., by Escribano et al., 2009) level of R&D employment in the country, which is comprised of both the number of technicians and researchers employed in each market. We also control the number of patents filed by residents in each emerging market, which gives some indication of the country's aggregate ability to transform tacit knowledge to codified, as well as the general "innovativeness" of the country (Armann & Virmani, 2014). Finally, in our model we include tax burden measured as corporate tax rate, as higher taxation burdens may limit firms' ability to invest in R&D activity (Chen et al., 2012).

3.2.4. Final model

The adjusted model looks like this:

$$\ln(TFP_{it}) = \alpha_i + \beta_1 \ln\left(RD^{f}_{it-4}\right) + \beta_2 \ln\left(RD^{d}_{it}\right) + \beta_3 MODOUT_{it} + \beta_4 MODIN_{it} + \beta_5 \ln(HC_{it}) + \beta_6 \ln(pat_{it}) + \beta_7 \ln(RDemp_{it}) + \beta_8 \ln(tax_{it}) + \varepsilon_{it}, \quad (4)$$

where HC_{it} represents human capital in country i at time t; pat_{it} denotes number of patents issued to residents; $RDemp_{it}$ denotes the proportion of the population employed in R&D activities; and tax_{it} represents the corporate tax rate. $MODOUT_{it}$ and $MODIN_{it}$ are interaction terms between the domestic stock term and foreign stock terms that encapsulate the moderation effect of domestic R&D stock (Figure 2).

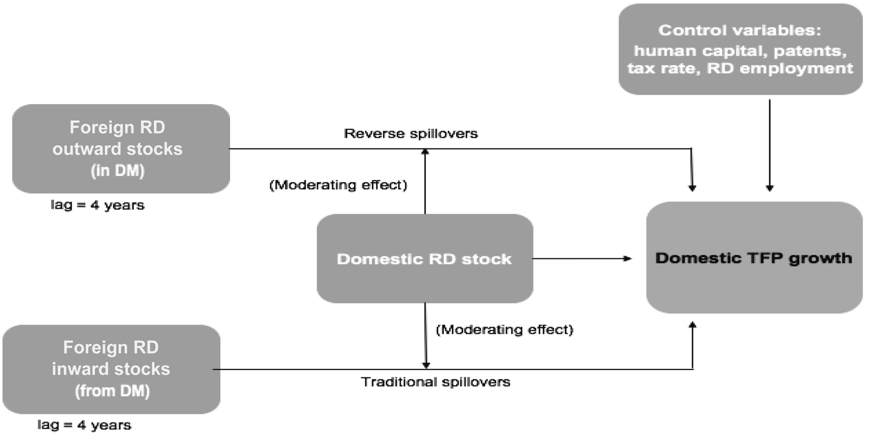

Figure 2. Visual representation of the adjusted model

4. Data description

The data used in this study is comprised of the panel data from 38 different markets for the period from 2001 to 2014. The first step in composing the dataset was to determine which countries belong to which category. The terms emerging market and, to a lesser degree, developed market are quite nebulous and significantly vary in different papers. In order to identify 62 emerging market economies[1], we follow the EM classification outlined in Chen et al. (2012), which bases on the financial indexes Morgan Stanley Capital International (MSCI) and the Financial Times Stock Exchange (FTSE). We define developed markets as high-income OECD countries as of 2012[2]. Due to lack of data on the dependent variable of interest, FDI stocks, the final dataset includes 29 emerging markets and nine developed markets (See Appendix A for a list of countries analyzed).

Data on the independent variable, TFP growth for 2001–2014, is taken from the *2015 Conference Board Total Economy Database*. The values are expressed as a Tornqvist index, a commonly used mechanism in the TFP literature which prevents loss of observations when using growth rates (i.e., ln(X), X<0 is undefined). Data on FDI stocks (defined as aggregate cross-border participation in the capital or voting rights of an enterprise in the amount of at least 10% according to international standards) expressed in millions of USD comes from UNCTAD's Bilateral FDI Statistics 2014. Data on R&D intensity,

[1] Albania, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Bosnia and Herzegovina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Cote d'Ivoire, Croatia, Czech Republic, Ecuador, Egypt, Estonia, Georgia, Ghana, Hungary, India, Indonesia, Israel, Jamaica, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Latvia, Lithuania, Macedonia, Malaysia, Mauritius, Mexico, Moldova, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, Slovenia, Slovak Republic, South Africa, South Korea, Sri Lanka, Taiwan, Tajikistan, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, Uzbekistan, Venezuela, and Zimbabwe.

[2] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States.

as well as absorptive capacity measures, are obtained and constructed from *The World Bank Database,* and data on corporate tax rate comes from the KMPG Global Tax Survey. As is common for statistics on emerging markets, there are some missing data on the control variables. As the proportion of missing observations is relatively small (51 missing values out of 1044 total) and occurs sporadically throughout the dataset, we use the mean of nearby points to replace the missing values and avoid significant reduction of the sample. However, not all the observations can be replaced. Specifically, the data on FDI stocks are only available through 2012. Therefore, the result is an unbalanced panel. However, since the theory indicates that this variable should be lagged, this will not affect the final number of observations.

Table 2 contains summary statistics on the untransformed control variables and the dependent variable.

4.1. Dependent variable

The overall trend in the average TFP growth index value is its steady but modest increase in 2001–2007, followed by a significant decline in 2007–2008 due to the financial crisis of that time. The period between 2010 and 2012 is characterized by a year-to-year decline in TFP growth. This measure displays a high degree of variability, with the disparity between the lowest and the highest TFP-growth markets each year reaching up to 19.02 points. In this regard, it should be noted that Azerbaijan had the highest TFP growth in the entire sample in 2005–2007.

4.2. Control variables

Trends revealed by these statistics include an overall increase in average R&D expenditure, patent applications by residents and total R&D employment, no major change in education expenditure as a percentage of GDP, and a slight decrease in the average corporate tax rate in 2001–2012. The average number of patent applications in these markets increased from 4505.69 in 2002 to over 5 times this amount – 24 828.10 – in 2012. Meanwhile, the average R&D employment roughly doubled from 85 640.11 workers in 2001 to 161 431.43 in 2012. The increase in the average value appear to be driven by the increase in outliers as opposed to a general increase across countries: while the minimum values for patent applications and R&D employment remain pretty static in this time period, the maximum values (consistently held by China) increased dramatically. Therefore, these statistics also draw attention to increasing time discrepancies between the sample countries. Even more time-consistent variables, such as tax rate and education expenditure levels, demonstrate a high degree of variability. By 2012, corporate tax rates in this sample ranged from 10 to 35%, with the narrow majority of observations clustering at each end of the spectrum.

All control variables, except corporate tax rate, have the same skew in distribution over time. To correct the bias introduced by this, we build on previous literature using the natural log of variables in the estimate. Additionally, as a robustness check, we omit major outliers (China) from the dataset as exceptional cases.

Table 2. Summary statistics (less FDI variables)

Variable	Year	Min.	Max.	Mean	Std. Dev.	Variable	Year	Min.	Max.	Mean	Std. Dev.
R&D Exp. (millions USD)	2001	19.41	12594.81	1736.01	3280.86	Corporate Tax Rate	2001	15.00%	36.89%	25.31%	7.21%
	2002	18.80	15556.29	1905.26	3794.42		2002	15.00%	36.89%	25.28%	7.16%
	2003	23.64	18601.30	2241.46	4464.01		2003	15.00%	36.89%	25.28%	7.16%
	2004	25.89	23757.06	2734.12	5565.98		2004	15.00%	36.89%	25.28%	7.16%
	2005	29.13	29898.55	3378.33	6942.41		2005	15.00%	36.89%	25.28%	7.16%
	2006	36.02	37663.92	4102.99	8635.55		2006	15.00%	36.89%	25.28%	7.16%
	2007	56.21	48770.90	5205.34	10911.80		2007	10.00%	36.89%	24.63%	7.22%
	2008	80.87	66430.02	6184.22	13574.60		2008	10.00%	35.00%	24.00%	6.99%
	2009	110.62	84932.99	6671.36	16486.77		2009	10.00%	35.00%	23.54%	6.70%
	2010	115.58	104316.98	8250.24	20390.14		2010	10.00%	35.00%	23.21%	6.78%
	2011	139.05	134442.70	10132.18	26007.41		2011	10.00%	35.00%	23.14%	6.78%
	2012	149.31	163148.56	11400.96	31139.71		2012	10.00%	35.00%	22.51%	6.55%
Patent Applications	2001	18	73714	4505.69	14431.24	RD Employment (Total)	2001	592.12	699121.34	85640.11	165186.29
	2002	19	76570	4790.72	15606.87		2002	596.55	774514.92	88548.30	174172.93
	2003	18	90313	5871.69	19294.63		2003	609.32	912989.64	96286.21	193922.37
	2004	27	105250	6827.69	22455.53		2004	622.99	1089352.62	103890.17	220489.67
	2005	23	122188	8366.97	27842.23		2005	621.00	1216950.15	110176.92	240163.47
	2006	36	125476	9502.90	31714.15		2006	636.34	1246356.94	112768.49	246356.74
	2007	44	153060	10739.79	36220.03		2007	643.60	1289907.62	116591.79	254423.46
	2008	62	194579	12113.76	42193.87		2008	657.26	1423369.19	123978.63	276204.34
	2009	76	229096	13379.59	47660.39		2009	662.10	1739455.87	139381.20	331263.79
	2010	84	293066	15845.41	58587.09		2010	651.91	1750786.30	146128.15	336009.37
	2011	62	415829	20313.38	80209.07		2011	678.81	1757505.02	151330.23	339685.42
	2012	20	535313	24828.10	101907.30		2012	687.89	1939241.36	161431.46	372225.05
Education Expenditure (%GDP)	2001	0.02	0.27	0.08	0.07	TFP growth index	2001	-7.30	9.17	1.79	3.74
	2002	0.03	0.27	0.09	0.07		2002	-6.47	10.99	1.88	3.48
	2003	0.03	0.25	0.09	0.07		2003	-2.05	7.57	2.60	2.50
	2004	0.02	0.26	0.08	0.07		2004	-1.92	8.59	2.77	2.85
	2005	0.03	0.26	0.08	0.07		2005	-3.01	12.68	2.15	3.14
	2006	0.03	0.27	0.08	0.06		2006	-2.59	18.96	3.25	3.75
	2007	0.03	0.29	0.08	0.06		2007	-2.33	11.94	2.34	2.75
	2008	0.02	0.30	0.08	0.06		2008	-11.22	6.36	-1.20	3.43
	2009	0.02	0.30	0.08	0.07		2009	-17.82	1.20	-4.89	4.22
	2010	0.02	0.31	0.09	0.07		2010	-1.49	8.10	1.91	2.43
	2011	0.02	0.31	0.09	0.07		2011	-4.88	5.43	0.73	2.24
	2012	0.02	0.31	0.09	0.08		2012	-5.34	4.59	-0.52	2.56

4.3. Independent variables

Table 3 summarizes statistics on the cumulative OFDI and IFDI stock, expressed in millions of USD, for each of the 29 emerging markets and 9 developed markets in the sample. In general, the average level of investment between these two groups increased in 2001–2012, with a dramatic jump in OFDI stock from the emerging markets in 2006–2007. Average cumulative IFDI stock quadrupled from $133.4 billion in 2001 to $466.7 billion in 2012, while average cumulative OFDI stock rose 6 times in the same period (from $1.4 billion to $7.97 billion). Also of note is the disparity between levels of FDI inward and outward stocks; in 2001, average inward stocks were 10 times higher than average outward stocks. However, this disparity has somewhat lessened over time. As with the control variables, the rise in stocks seems to be driven by upward outliers. Also of interest are the negative minimum values experienced in some years. According to UNCTAD, a negative FDI stock is typically recorded when continuous losses in the FDI enterprise result in negative reserves.

Table 3. Summary statistics, cumulative FDI stocks, millions USD, 2001–2012

	Cumulative OFDI				Cumulative IFDI			
Year	Min.	Max.	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.
2001	-74.71	17867.27	1390.31	3570.22	6.00	68209.54	13394.06	18004.79
2002	-0.78	19047.80	1579.91	3888.84	0.00	80190.71	14231.09	19335.86
2003	0.00	16651.48	1510.72	3526.00	0.00	87950.76	15964.85	20754.63
2004	0.00	17541.38	1941.45	3853.50	0.00	97024.49	19125.74	23508.16
2005	1.62	19760.45	2119.55	4279.54	13.00	111752.07	21365.84	26902.79
2006	-16.11	24591.55	3479.29	6579.11	116.73	126382.50	25210.68	30500.82
2007	-11.47	48336.00	6014.94	12384.32	169.10	145847.35	31496.74	36026.35
2008	1.00	67017.88	7098.07	14625.12	367.72	143411.89	32795.55	38441.09
2009	-1.37	71960.50	7941.15	15632.49	429.21	152195.87	35905.95	41956.85
2010	-2.00	49239.38	7750.88	13298.00	508.62	177383.34	39738.45	49100.91
2011	-3.00	53320.67	7150.76	12272.30	387.85	200465.76	43455.88	56136.63
2012	-4.00	54051.69	7972.53	13493.84	338.84	224904.90	46670.83	59951.38

Note: N = 407.

Figures 3 and 4 disaggregate net FDI inward stocks from the sample EMs in each developed market and net FDI outward stocks from each DM to the sample EMs, respectively. The figures indicate that the recipients of the highest level of EM FDI from this sample are the United States, by a wide margin, followed by the United Kingdom. The most significant investors are the United States, the United Kingdom, and Japan. The charts also indicate a yearly significant decrease in OFDI from EMs to the majority of the developed markets following the global financial crisis of 2008–2011. OFDI from DM to EM in that period is less noticeable and somewhat delayed, with apparent reductions beginning only in 2009 or even in 2010. This is an indication that emerging markets are more susceptible to exogenous macroeconomic shocks than developed markets. In terms of the investment activities of the sample emerging markets, relatively small investors in DMs include Belarus, Colombia, Estonia, and Latvia, while large investors include BRICS economies and Mexico. These countries also represent the economies with the smallest and largest amounts of foreign capital stock, respectively.

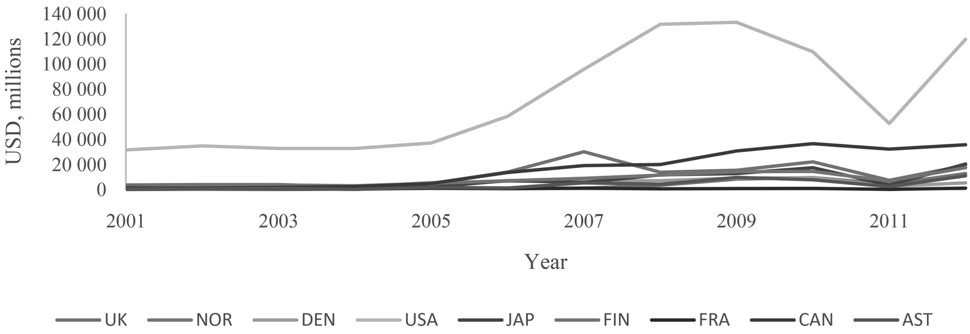

Figure 3. Total FDI from EMS by DM, 2001–2012

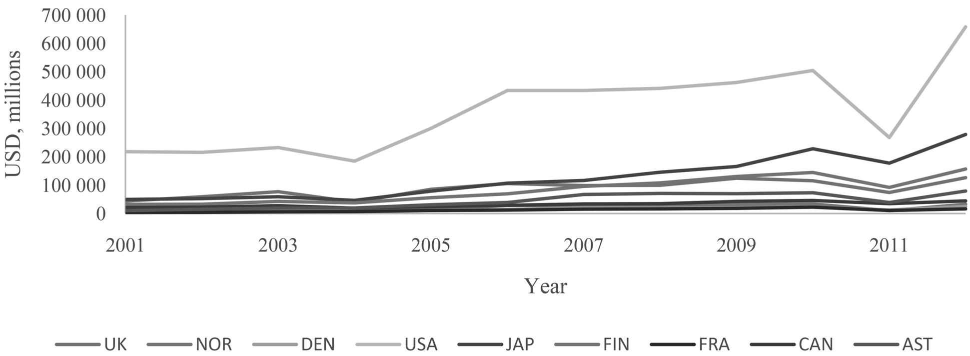

Figure 4. Total OFDI to EMS by DM, 2001–2012

6. Findings

6.1. Main results

With the adjustments outlined above, we ran fixed-effects within linear regression to ascertain the effects of traditional and reverse knowledge spillovers on total factor productivity. Table 4 contains the result of the regression analysis.

The relationships between the dependent variable and the independent variables are all statistically significant. A 1% increase in foreign R&D outward stocks is associated with a 3.53 point increase in the TFP growth index value four years later. Meanwhile, a 1% increase in domestic R&D stock and foreign R&D inward stocks corresponds to a 3.5 point increase and a 2.46 point decrease, respectively. These results can be interpreted as evidence in support of the hypothesis (H1) that emerging market firms investing in developed markets are able to benefit from reverse knowledge spillovers to increase their productivity. The negative effect of foreign R&D inward stocks from developed markets suggests that, in general, the negative competition effects of investments from developed to developing markets prevail and outweigh any positive effects of knowledge spillovers that might be gained by EM firms. As it was identified at the stage of evaluation of the problems of the empirical analysis, domestic R&D stocks have a statistically significant moderating effect on both reverse and traditional spillover channels. According to these results, the direction of this moderation is positive for both variables. Augmenting the knowledge stock of domestic EM firms appears to enhance the ability of those firms to acquire and implement new knowledge and thereby increase productivity.

Table 4. Regression results

Independent variables	
ln(FDRO)(lag = 4)	3.53***
	3.55
(FRDI)(lag = 4)	(–2.46)***
	–2.86
ln(DRD)	3.5***
	3.03
Moderation effect	
FDROxDRD	0.44***
	3.00
FDRIxDRD	0.68**
	2.98
Control variables	
ln(HC)	–1.99
	–0.96
ln(pat)	–1.27
	–1.57
ln(tax)	4.23
	1.29
Constant	30.85
	1.71

Note: *** significant at 1%, ** significant at 5%.

Table 5 contains the results of this regression analysis. Of the five subgroups included in the analysis, three (Europe, Asia, Africa) indicate that OFDI stocks are positively associated with TFP growth to a statistically significant degree. Asia and Africa exhibit stronger than average effects meaning that reverse spillovers seem to be more beneficial to the productivity of these markets. Regarding foreign R&D inward stocks, African and European countries experience stronger than average negative spillover effects while Asian and Latin American countries experience positive spillover effects. These results may indicate that in Africa and Europe, the negative competitive effect of new foreign entrants is stronger than positive knowledge spillover benefits. That is, due to lack of required resources or rigid production practices, firms in these countries are unable to adapt enough to compete with foreign-owned enterprises. Meanwhile, Asian and Latin American firms are perhaps better able to respond to the new competition by increasing their own productivity.

Table 5. Robustness check, regional disaggregation

Independent variables	Latin America	Europe	CIS	Asia	Africa
ln(FDRO)(lag = 4)	–4.57	3.6**	–2.26	4.88**	5.64**
	–1.52	2.02	–0.45	2.81	2.15
(FRDI)(lag = 4)	3.34*	(–4.1)**	4.00	1.73***	(–5.81)*
	1.92	–3.56	0.68	3.83	–1.84
ln(DRD)	1.3*	2.51*	–2.37	0.65**	2.47*
	0.74	1.87	–0.45	2.72	1.77
Moderation effect					
FDROxDRD	0.75	(–0.61)**	0.56	0.59**	–2.02
	1.71	–2.17	0.71	1.91	–1.74
FDRIxDRD	0.68*	1.34***	–0.33	0.05	1.35
	1.9	3.29	–0.41	0.09	1.66
Control variables					
ln(HC)	–13.88	–7.7	18.37	1.05	2.02**
	1.32	–0.46	0.74	0.36	2.80
ln(pat)	14.5	–2.87	17.79	–1.72	1.75
	1.43	–1.34	1.47	2.41	0.84
ln(tax)	–0.3	–3.26	9.50	2.77	–1.90
	–0.15	–1.05	0.86	0.24	–0.32
ln(rdemp)	–0.16	–4.36	–0.94	0.00	0.73***
	–0.03	–1.62	–0.07	0.00	3.40
Constant	2.3	69.82	–41.66	2.77	45.11***
	1.46	1.62	–0.23	0.11	4.15

Note: * significant at 10%, ** significant at 5%, *** significant at 1%.

CIS (abbreviation for the Commonwealth of Independent States, post Soviet Union countries) countries are the only subgroup that apparently does not experience spillover effects at any time. One reason for these results may be a relative economic instability in this region during the period of this study. While all regions suffered from the effects of the 2008 financial crisis (albeit to varying degrees), Russia, the largest economy in the CIS group, survived a financial crisis in the late 1990s and another one in 2014, which probably had lingering consequences throughout the studied period.

The moderating effect of domestic R&D stocks also differed across regions. Of particular interest is the negative moderating effect of this variable on reverse spillovers observed in Europe. Though this effect seems counterintuitive, it is not outside the scope of theoretical feasibility. As outlined in the literature review, absorptive capacity measures are at odds with the "backwardness" measure that provides greater opportunity for spillover benefits.

In sum, though the robustness checks support the initial findings of the study in general, they highlight the degree of heterogeneity of knowledge spillovers. The magnitude and even direction of the relationship between knowledge spillovers and TFP vary depending on the regions and time — phenomena that require further investigation.

7. Conclusion

The EMNEs' tendency to establish subsidiaries in developed markets was identified and empirically linked to the strategic asset-seeking motive for FDI. These firms significantly increased their presence on developed markets over the past 20 years. An important consideration in their decision to invest in these markets is the reverse knowledge spillover defined as an unintentional transfer of knowledge or technology from advanced domestic firms to foreign subsidiaries. In this paper, we analyze the effects of these spillovers on the growth of total factor productivity in emerging markets at the aggregate level. We consider spillover effects generated by both outward foreign investment to the DM and inward foreign investment from these markets, as well as the role of several control variables. In order to do so, we employ a model based on the one developed by Van Pottelsberghe de la Potterie and Lichtenberg (2001), and Armann and Virmani (2014). We contribute to the development of this model by considering the impact of FDI stocks instead of flows, including control variables, and introducing a time lag to the dependent variable, which is not only theoretically justified but also addresses, at least in part, the endogeneity problem, which brings bias into the results of spillover studies. We follow our initial regression analysis with a series of robustness checks that generally confirm the original results but add a nuance to their interpretation.

The results of this analysis provide evidence in support of the hypothesis that by investing in developed markets, emerging markets are able to increase their total factor productivity growth over time due to positive reverse spillover effects. Additionally, this paper shows that the net impact of IFDI spillovers on TFP growth is negative. This finding supports the hypothesis in some previous studies that IFDI leads to a negative competition effect that negates any positive gains from potential spillovers. Both of these effects vary over time, with increases in OFDI associated with a decrease in TFP growth in the year of investment, and increases in TFP growth starting only 3 years after the investment. The negative effects of IFDI spillovers similarly begin to accrue only after 3 years. These findings suggest that knowledge spillovers of either type take time to manifest. The effects of FDI in varying geographic subgroups of this sample indicate a large degree of heterogeneity; with some markets (e.g. CIS) apparently experiencing no spillover effects whatsoever.

Our findings have two main implications for emerging market firms' practices of strategic asset-seeking outward FDI. First, in general, EM firms that wish to enhance their productivity should invest in economies that are rich in technological and knowledge resources. Our findings indicate that firms that invest in developed markets are able to improve TFP growth via reverse spillovers. However, when making a decision to pursue the "going out" strategy, it is necessary to take into account the fact that positive spillover effects do not occur immediately. On average, the effect of OFDI on productivity becomes apparent only 3 years after the initial investment. Moreover, our findings indicate that OFDI efforts have a negative effect on TFP growth in the year of investment.

Second, in order to maximize the positive effects of reverse spillovers, these firms should also increase investment in their domestic R&D stock. Investing in R&D not only positively affects TFP directly, but also insofar as it augments the firm's ability to absorb new knowledge. Furthermore, increased R&D stock helps to mitigate the negative influence of IFDI from developed markets.

Though this study makes several constructive contributions to spillover literature, there are several limitations to keep in mind when interpreting these results. First, pertinent data for all emerging and developed markets were not available, so the sample analyzed was not comprehensive. Moreover, available data did not cover all potentially significant variables. Future studies should consider the impact of such measures as industry and the nature of the FDI, i.e., vertical vs. horizontal FDI.

Secondly, the heterogeneity of emerging markets makes it difficult to generalize the findings in this paper. In a sense, we address this heterogeneity by analyzing geographic subgroups within the data set. However, a deeper investigation of emerging market subcategories is needed in order to fully understand the nature of knowledge spillovers. We believe that this is a promising avenue for future research.

Another limitation of this paper is that it does not address the impact of macroeconomic shocks on spillovers. For instance, the findings of this study may no longer be relevant for Russia, Ukraine, and the economies that depend on them given the economic crisis that began in 2014 and sanctions levied since that time by European and other Western countries. This particular situation provides a compelling basis for future investigation.

Appendix 1. Countries included in dataset

Emerging markets	Developed markets
Argentina, Azerbaijan, China, Colombia, Czech Republic, Belarus, Brazil, Bulgaria, Egypt, Estonia, Hungary, India, Indonesia, Kazakhstan, Latvia, Lithuania, Malaysia, Mexico, Poland, Romania, Russia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Thailand, Tunisia, Ukraine	Austria, Canada, Denmark Finland, France, Japan, Norway, the United States, the United Kingdom

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