MARCH 2022

Working Paper 213

FDI Spillover Effects on Innovation Activities of Knowledge-using and Knowledge-creating Firms:

Evidence from an Emerging Economy

Nina Vujanović, Iraj Hashi, Mehtap Hisarciklilar, Slavo Radošević and Nebojša Stojčić

The Vienna Institute for International Economic Studies
Wiener Institut für Internationale Wirtschaftsvergleiche

FDI Spillover Effects on Innovation Activities of Knowledge-using and Knowledge-creating Firms:

Evidence from an Emerging Economy

NINA VUJANOVIĆ
IRAJ HASHI
MEHTAP HISARCIKLILAR
SLAVO RADOŠEVIĆ
NEBOJŠA STOJČIĆ

Nina Vujanović is Economist at The Vienna Institute for International Economics Studies (wiiw). Iraj Hashi is Professor at the Staffordshire University Business School, Stoke-on-Trent, United Kingdom. Mehtap Hisarciklilar is Assistant Professor at the Centre for Financial and Corporate Integrity, Coventry University, Coventry, United Kingdom.Slavo Radošević is Professor at the University College London, School of Slavonic and East European Studies, London, United Kingdom and National Research University Higher School of Economics St Petersburg, Russia. Nebojša Stojčić is Associate Professor at the University of Dubrovnik, Department of Economics and Business, Dubrovnik, Croatia and Staffordshire University Business School. Stoke-on-Trent, United Kingdom.

Abstract

The beneficial effects of innovation for firms' performance and competitiveness are well documented, but it has been suggested in recent years that innovation regimes differ between advanced and emerging economies. While advanced economies rely on knowledge generation, their emerging counterparts follow mainly a knowledge-use regime through the application of existing knowledge and technology. Climbing up the technological ladder can be helped through spillovers from foreign investors to local firms. We investigate whether FDI spillovers influence different phases of the innovation process (from decision to innovate to productivity) among knowledge-using and knowledge-creating firms in an emerging European economy. The results show that the innovation process in emerging economies is closer to the imitation than the creation of novel products. Local firms benefit from foreign counterparts in the early phase of the innovation process. Stronger FDI effects are found among firms that undertake innovation through knowledge use rather than through knowledge generation.

Keywords: knowledge use; knowledge generation; FDI; innovation; emerging economy

JEL classification: F21, F23, L25, C31, L21

CONTENTS

TABLES AND FIGURES

1. Introduction

The contribution of innovation activities to raising a firm's productivity and competitiveness has been well documented in the literature (Polder et al., 2009; Hashi and Stojčić, 2013; Roud, 2018). However, a number of recent studies have highlighted the difference between the innovation regimes of firms in advanced economies that are driven by R&D investment or knowledge creation, and those of firms in emerging market economies (EMEs) that are mainly driven by investment in machinery and equipment (i.e., non-R&D investment) or knowledge use (Cirera and Maloney, 2017). A recent European Commission report (Radošević, 2016, p. 130) confirms this trend in the context of developed Northern EU countries and the EU's emerging economies of Central and Eastern Europe (CEE). The report shows that almost 72% of innovation spending in the developed parts of the EU's Northern members goes into R&D expenditure, compared with 39% in the CEE members of the EU. The opposite holds true for spending on machinery and equipment, which accounts for 19% and 54%, respectively, of innovation spending in the two groups of countries.

Understanding which factors facilitate or inhibit the innovation process across different innovation regimes is a topic of particular relevance for firms from EMEs. The nature of innovation activities in these economies changes from the 'use of existing knowledge' to the 'creation of new knowledge' only over longer periods of time (Radošević 2015, 2017; Stojčić and Orlić 2020). Several studies suggest that knowledge creation is not a dominant innovation regime in EMEs (Cirera and Maloney, 2017), and innovation models focusing on R&D spending are not particularly useful in such contexts (Stojčić et al., 2020; Radošević and Yoruk, 2018). Firms in EMEs do not possess the technical and scientific knowledge, financial resources and supportive innovation systems to compete at the technological and innovation frontiers. Their growth has been driven by the adoption and assimilation of existing knowledge embodied in imported machinery and equipment rather than by new knowledge generated through investment in R&D (Kravtsova and Radošević, 2012).

Among the sources of foreign knowledge and technology, the literature on EMEs is recognised as particularly important for knowledge and technology spillovers from foreign investment (Mowery and Oxley, 1995; Radošević, 1999; Fujita and Thisse, 2002; Aghion et al., 2009; Vahter, 2011; García et al., 2013; Cheang and Lee, 2014). The presence of foreign competitors facilitates imitation and knowledge flows through labour mobility and exerts competitive pressure to use resources efficiently (Saggi, 2006; Greenaway et al., 2004; Dasgupta, 2012; Haskel et al., 2007; Sinani and Meyer, 2004). Domestic firms in upstream and downstream industries may benefit from the technology and knowledge spillovers of foreign firms by having to improve the quality of their products to meet the standards of their foreign customers or by being able to use better-quality inputs produced by foreign suppliers.[1] The importance of FDI as a vehicle for the introduction of foreign knowledge and technology in host countries and its potential beneficial spillovers to domestic firms is already well established in the literature. However, the

1 These benefits will be more tangible if their investment strategy corresponds to and complements the foreign firms' technology and knowledge, or if there is some cognitive proximity with foreign firms. The impact of any spillover will be rather limited if domestic firms focus their innovation efforts on creating their own technology through investment in R&D. In such cases the opportunities for benefiting from labour mobility, imitation or better-quality inputs will be limited. This is because firms that create new knowledge (R&D-intensive firms) may focus more on exploiting their internal knowledge potential rather than 'free-riding' on other firms' knowledge.

impact of the spillover effects on the innovation process in host countries regardless of the innovation regime has to our knowledge not been investigated at all.

Our paper aims to address these gaps. Using the well-established CDM (Crépon, Duguet and Mariesse, 1998) model of the innovation process, we extend it by exploring the impact of knowledge-creating and knowledge-using innovation regimes[2] on the different stages of the innovation process. We enrich the literature on innovation activities of firms in EMEs by introducing the FDI spillover effects in the CDM model, thus identifying the impact of these spillovers on different stages of the innovation process across analysed innovation regimes. This enables us to identify which innovation regime (knowledge-use or knowledge-creation) can benefit more from FDI spillovers and contribute more effectively to the innovation and productivity of host country firms.

A slightly similar augmentation of the CDM model is employed by Khachoo et al. (2018), who investigate how proximity to the technological frontier influences FDI spillover effects on the innovation process in India. While the CDM model is augmented via the inclusion of FDI spillover measures in the CDM model, the authors base their interest in the dependence of spillovers on technological proximity.

To this end, our paper aims to answer two questions. First, what is the impact of knowledge-using and knowledge-creating innovation regimes on different stages of the innovation process in firms from EMEs? Second, what is the effect of FDI spillovers on different stages of the innovation process in knowledge-using and knowledge-creating firms from EMEs?

Our analysis uses the example of Serbia, a European emerging economy heavily reliant on knowledge use and foreign investment as vehicles of growth and technological catch-up. The share of FDI in Serbia's GDP is more than twice the world average and is similar to that of many other European EMEs, e.g. Bulgaria and Hungary (World Bank, 2018). Serbia makes a particularly interesting case because its integration into regional, European and global production networks has been slower than that of other European EMEs due to sanctions imposed by the UN and the EU in 1990s.

The analysis combines for the first time several high-quality datasets, such as the Community Innovation Survey, which provides information on different types of firms' innovation activities, the Amadeus database, which provides detailed financial information at firm level, and Input-Output Tables, which are used to compute the spillover effects of foreign firms. The results are broadly applicable to other Central, South and East European economies with similar institutional and socioeconomic characteristics inherited from their previous socialist period.

The structure of the paper is as follows. Section 2 provides a conceptual framework. The empirical strategy is laid down in section 3. The results of our investigation are presented in section 4. Section 5 discusses our findings and section 6 concludes.

---

2 The above distinction is well established in innovation studies on developing countries under the notion of production and technology capabilities (Dahlman and Westphal, 1982; Dahlman et al., 1987; Bell and Pavitt, 1993). Production capability refers to the capability to produce industrial goods with a given technology. Technology capability, which includes R&D, design and engineering knowledge, is the capability to generate and manage change in the technologies used by firms. On a broader level, this is similar to the differentiation between technological competences and technological capabilities elaborated by Iammarino et al. (2012). Competences refer to the firm's resources (machinery, equipment and employees' knowledge), which can be used to produce goods reflecting the current state of knowledge. Capabilities, on the other hand, refer to the ability of firms to develop new knowledge that manifests itself in new products.

2. Innovation process and FDI spillovers – a conceptual framework

2.1. FDI SPILLOVERS IN EMERGING ECONOMIES

It has been argued that the lack of indigenous competences and capabilities in emerging economies motivates their search for external knowledge (Eapen et al., 2019). The knowledge spillovers generated by foreign companies are among the most prominent beneficial channels for domestic firms (Radošević and Yoruk, 2016). The multinational corporations operating in emerging economies often possess superior technology and knowledge. Although such knowledge is tacit in its nature (Fujita and Thisse, 2002), its internationalisation is often challenging and can lead to two main types of spillovers to local firms: horizontal spillovers to rival firms and vertical spillovers to upstream and downstream firms in the supply chain.

Both types of channels have been recognised and discussed in the theoretical and empirical literature. Labour mobility (Greenaway et al., 2004; Dasgupta, 2012) and imitation (or reverse engineering) of the production process (Saggi, 2006) are the most commonly identified beneficial horizontal spillover channels. FDI is also found to induce market-access externalities (Crescenzi et al., 2015) or competitive disciplinary effects (Hamida, 2013) by forcing indigenous firms to better utilise existing technology in order to maintain their market shares (Nicolini and Resmini, 2010). The literature, however, lacks consensus on the beneficial effects of FDI spillovers as foreign firms are found to take over market shares of domestic firms in EMEs, increase production costs, reduce local firms' productivity and eventually crowd out domestic firms (Kosová, 2010; Kokko and Kravstova, 2012; Damijan et al., 2013).

Another channel of knowledge transmission runs through the vertically connected enterprises in the supply chain. Evidence suggests that this channel facilitates the exchange of information on product development and adjustment, leading to innovation output (Fu et al., 2013) and increased productivity (Javorcik 2004; Lu et al., 2017; Stojčić and Orlić, 2020). Foreign firms manufacture goods that are more technologically demanding and require more sophisticated knowledge for production than the goods manufactured by local firms in emerging economies. Consequently, domestic suppliers are likely to try to increase their competence and improve the quality of their output to meet new customers' demands by improving their own technology through innovation. This is how backward spillover transmission of knowledge occurs. Multinational corporations (MNCs) were found to help domestic firms improve their innovation process and technology to reach their production requirements in EMEs (Blalock and Gertler, 2008; Du et al., 2011; Gorodnichenko et al., 2014).

Likewise, if foreign firms act as suppliers, they can benefit local customers in downstream industries by supplying better-quality inputs, facilitating forward spillovers. However, the empirical evidence shows that this has generally not been the case in EMEs (Barrios et al., 2006; Javorcik and Spatareanu, 2011; Damijan et al., 2013). Gorodnichenko et al. (2014) argue that the absence of these spillovers is because inputs sourced from foreign firms are too sophisticated, while the local technological competence is inferior.

2.2. FDI SPILLOVERS AND INNOVATION REGIMES IN EMERGING ECONOMIES

The role of FDI spillovers in emerging economies has been analysed mostly from the perspective of their influence on firm or industry productivity (Javorcik, 2004; Halpern and Maruközy, 2007; Lu et al., 2017 among others). One exception is Vahter (2011), who finds positive effects of FDI spillovers on innovation in Estonia. Stojčić (2021) addresses the role of foreign partners in the creation and commercialisation of innovations in emerging economies, but this study does not focus explicitly on the role of FDI spillovers as the facilitator of domestic innovation activities in these economies.

The external stock of knowledge can increase firms' innovation expenditures. These increased innovative activities could eventually increase the innovation output and lead to higher productivity. As financing innovation is very expensive, in particular where the borrowing cost is higher (Vujanović et al., 2021), the role of foreign knowledge gains further importance. The impact of FDI spillovers on the innovation process as a whole – starting from the investment in innovation and ending with the effect on productivity, has remained, somewhat surprisingly, unknown for the emerging economies. Hence, there is a need to fill this gap, especially given widespread expectation of policy makers that FDI will bring not only employment but also improve the innovation capacity of local firms.

The absorption of spillovers is contingent on various factors, particularly in emerging markets. In the first place, without some domestic technological effort, foreign firms' knowledge may not suffice for technological growth (Radošević, 1999). The absence of positive spillover effects is mostly related to the lack of absorptive capacity in emerging economies (Halpern and Muruközy, 2007; Kosová, 2010; Damijan et al., 2013), often measured by the current state of knowledge, the technology they possess and the quality of their human capital. In the context of developed economies, this often implies R&D. However, economies that are far from the innovation and technological frontier grow predominantly through the expansion of production capabilities (Radošević and Yoruk, 2015) because they lack the scientific knowledge and the resources to engage in cutting-edge R&D.

The innovative activity in emerging economies differs from that in the advanced world. Kravtsova and Radošević (2012) explain that innovative activities in these economies are aimed at improving the current production capability through the acquisition of machinery and equipment (*knowledge use*), and not through expenditure on R&D (*knowledge creation*). Hence, the innovation process in these economies is based less on R&D but more on less knowledge-intensive activities such as technology adoption, incremental and cost-oriented innovation through the acquisition of machinery and equipment (Radošević, 2017). The innovation activities in that case are about the most productive use or absorption and assimilation of embedded R&D, and less about the generation of new knowledge.

The success of MNCs in innovation activities has encouraged firms in EMEs to try to build indigenous innovation competence (Cheung and Ping, 2004). Adoption of foreign knowledge, such as that embedded in machinery, equipment and know-how, reduces the risk of innovation failure. At the same time, it paves the way for more sophisticated activities of knowledge generation. Boschma (2005) notes that cognitive proximity, such as that embedded in innovation competencies, increases complementarities that are relevant for the success of the spillover process.

2.3. RESEARCH HYPOTHESES

The above discussion suggests that FDI spillovers provide two types of benefits for firms in emerging economies. First, foreign firms provide domestic firms with spillovers that are relevant for the use of sophisticated technology (knowledge use). Second, the process of gaining innovation competencies lays the foundation for domestic firms to additionally benefit from more sophisticated types of spillovers that are relevant for engaging in knowledge generation. Building on these foundations, we argue that FDI spillovers can induce effects on the innovation process of indigenous firms in emerging economies by developing either their ability to use knowledge or their ability to generate knowledge.[3] Both effects may take place either through horizontal or through vertical spillover channels already recognised in the literature. This allows us to define our first two hypotheses:

H1: FDI spillovers facilitate the knowledge use of domestic firms in emerging economies

H1a: Horizontal FDI spillovers facilitate the knowledge use of domestic firms in emerging economies

H1b: Vertical FDI spillovers facilitate the knowledge use of domestic firms in emerging economies

H2: FDI spillovers facilitate the knowledge generation of domestic firms in emerging economies

H2a: Horizontal FDI spillovers facilitate the knowledge generation of domestic firms in emerging economies

H2b: Vertical FDI spillovers facilitate the knowledge generation of domestic firms in emerging economies.

In addition to facilitating engagement in different innovation regimes, FDI may help domestic firms in emerging economies in the later stages of their innovation process and by improving their overall performance. In addition to the technology and know-how that are relevant for the development of innovations, foreign firms can act as sources of knowledge that is required to commercialise novel products and services. This knowledge comes in the form of marketing, quality standards and linkages with potential customers and may come either through horizontal channels, such as imitation and labour mobility, or through vertical buyer-supplier relationships. Finally, previous studies (Stojčić and Orlić, 2020) have established that different FDI spillover channels in emerging economies have different effects on firms' productivity. This allows us to define our third and fourth hypotheses:

H3: FDI spillovers facilitate the sales of new products and services of domestic firms in emerging economies

H3a: Horizontal FDI spillovers facilitate the sales of new products and services of knowledge-using domestic firms in emerging economies

H3b: Vertical FDI spillovers facilitate the sales of new products and services of knowledge-generating domestic firms in emerging economies

---

3 Whether each of these effects will materialise and whether they take place through horizontal or vertical channels depends on the proximity between foreign and domestic firms. The Cohen and Levinthal (1989) and Nelson and Phelps (1966) theory implies that the greater the gap between the technological levels of local and foreign firms, the less spillovers will be absorbed, due to local firms' lack of the necessary competences. Moreover, as Boschma (2005) explains, firms purposely search for knowledge 'proximate' to their own, which sets the limitation to how much these firms can learn through FDI spillovers, irrespective of whether they are sourced from horizontal or vertical linkages.

H4: FDI spillovers facilitate the productivity of domestic firms in emerging economies

H4a: Horizontal FDI spillovers facilitate the productivity of knowledge-using domestic firms in emerging economies

H4b: Vertical FDI spillovers facilitate the productivity of knowledge-generating domestic firms in emerging economies.

As noted previously, the ability of indigenous firms to benefit from foreign spillovers to develop the type of competencies that are either relevant for knowledge use or for knowledge generation will depend on the cognitive distance between domestic and foreign firms, but also on the position of domestic firms in the value chain. Firms that are higher up the value chain and are thus better acquainted with sophisticated technologies are more likely to benefit from vertical spillovers in their R&D-driven innovation activity and productivity. Those in the lower segments of the value chain are more likely to benefit from FDI spillovers that are relevant for knowledge use.

In our discussion in the introduction to this study and in this section we have outlined that the innovation regimes of firms in advanced and emerging economies differ. As firms in emerging economies lack the relevant resources to generate new knowledge and their innovation systems are structurally weak (Stojčić, 2020), knowledge use through adoption and assimilation of the existing knowledge may be more important for them than a knowledge-generation innovation regime (Cirera and Maloney, 2017). However, at the same time technologically sophisticated companies may possess the relevant knowledge, skills and other resources to engage in a knowledge-generation innovation regime. Whether both of these channels function in EMEs and what they contribute to the outcome of the innovation process has not been investigated before. With this in mind, we formulate our fifth hypothesis as follows:

H5: Firms in emerging economies innovate through knowledge-using and knowledge-creating innovation regimes

H5a: Firms in emerging economies innovate through knowledge-using innovation regimes (adoption and acquisition of machinery, equipment and software)

H5b: Firms in emerging economies innovate through knowledge-generating innovation regimes (R&D investment)

3. Data and empirical strategy

We test the hypotheses formulated in the previous section by following an empirical approach that originates from Crépon, Duguet and Mariesse (1998). The CDM model is a four-equation system that accounts for the entire innovation process, starting with firms' decision on whether or not to innovate and ending with improvements in productivity. The CDM model was applied in the analysis of firms' innovation behaviour in many countries, including the emerging economies (Damijan et al., 2011; Hashi and Stojčić, 2013; Roud, 2018). What differentiates these studies from this one is the inclusion of the effects of FDI spillovers in the model and the distinction between different innovation regimes, namely knowledge use and knowledge generation. Our analysis is based on the data coming from two sources. Firm-level information on innovation activities, productivity and other characteristics are obtained from the Community Innovation Survey (CIS) for Serbia, covering the period of 2010-2012. The CIS dataset lists 964 firms in the manufacturing industry, of which 37.6% have decided to invest in innovation, while 34.2% have some innovation output.

The industry-level measures of FDI spillovers are calculated using Bureau Van Dijk's Amadeus dataset, which contains firms' balance sheets and other firm- and industry-related information. Industry level variables are extracted from the Amadeus database on the basis of the NACE industrial classification and are used in conjunction with the CIS database.

In its core form, the CDM model consists of the following four equations:

$$g_i^* = \beta_1 x_{1i} + \varepsilon_{1i} \quad (1)$$

$$k_i^* = \beta_2 x_{2i} + \varepsilon_{2i} \quad (2)$$

$$t_i = \beta_3 x_{3i} + \alpha_3 k_i + \delta\lambda_i + \varepsilon_{3i} \quad (3)$$

$$q_i = \beta_4 x_{4i} + \alpha_4 t_i + \varepsilon_{4i} \quad (4)$$

where x_{1i} to x_{4i} represent vectors of independent variables measuring the characteristics of firm i in Eqs (1) to (4); β's, α's, and δ are coefficients to be estimated; and ε's are the residuals. In the CDM equation system given above, Equations (1) and (2) represent inputs into the innovation process, while Equations (3) and (4) represent, respectively, innovation output and productivity. In Eq. (1), g_i^* is a latent variable behind firm i's decision to innovate. Its observable counterpart, g_i, takes value one for firms that decide to innovate and zero for others. The dependent variable in Eq. (2), k_i^*, accounts for the amount spent on innovative activities (i.e. the innovation investment). k_i is its observable counterpart taking positive values only when $k_i^* > 0$. Eq. (2), therefore, models the innovation investment for a selected set of firms that decide to innovate in Eq. (1). The first and second equations together form Type II Tobit model and are jointly estimated using maximum likelihood estimation. The third equation is a knowledge production function (set by Griliches, 1979) which explains the observed innovation output of firm i (t_i) that has been successfully innovated.[4] Finally, the fourth equation models firm i's productivity, q_i. Because Eq. (3) represents a subsample of firms that innovate, an inverse-Mills ratio based on a probit estimation of Eq. (1) is included on the right-hand side. This equation further includes innovation investment (k_i) as one of the determinants of innovation output. Similarly, the productivity regression (Eq. 4) includes innovation output (t_i) as one of the explanatory variables.

Equations (3) and (4) suffer from endogeneity because firms that successfully innovate are more likely to have higher innovation spending. Likewise, firms with higher productivity are often innovators themselves (i.e. they have greater innovation output). We follow the Lööf and Heshmati (2002) (henceforth LH) approach to estimating the CDM model: while we jointly estimate the first two equations by the generalised Tobit model, we limit the third and fourth equations to the sample of innovating firms that successfully sell their innovation output in the market and estimate them jointly in a simultaneous system framework using three-stage least squares (3SLS) (Zellner and Theil, 1962).[5] In Eq. (3), we use predicted values of innovation investment obtained from joint estimation of Equations (1) and (2). Similarly, Eq. (4) includes predicted values of innovation output from Eq. (3). The use of predicted values for innovation input and innovation output, respectively, in Equations (3) and (4) mitigates the endogeneity problem. Further, the use of inverse Mills ratio calculated from innovation input estimations together with the use of predicted innovation spending and output connect the equations within the CDM system.

Our augmented CDM model additionally includes horizontal, backward vertical and forward vertical spillover variables as well as the Hirshman-Herfindahl Index (HHI), which measures market competition:

$$g_{ij}^* = \beta_1 x_{1ij} + \phi_1 HH_j + \gamma_1 Horizontal_j + \theta_1 Backward_j + \xi_1 Forward_j + \varepsilon_{1ij} \quad (1')$$

$$k_{ij}^* = \beta_2 x_{2ij} + \phi_2 HH_j + \gamma_2 Horizontal_j + \theta_2 Backward_j + \xi_2 Forward_j + \varepsilon_{2ij} \quad (2')$$

$$t_{ij} = \beta_3 x_{3ij} + \alpha_3 k_{ij} + \delta\lambda_{ij} + \phi_3 HH_j + \gamma_3 Horizontal_j + \theta_3 Backward_j + \xi_3 Forward_j + \varepsilon_{3ij} \quad (3')$$

$$q_{ij} = \beta_4 x_{4ij} + \alpha_4 t_{ij} + \phi_4 HH_j + \gamma_4 Horizontal_j + \theta_4 Backward_j + \xi_4 Forward_j + \varepsilon_{4ij} \quad (4')$$

The horizontal spillovers variable presents the within-industry knowledge transmission from foreign to domestic firms. It can be proxied by the weighted share of foreign firms in total industry employment (or sales), averaged over all firms within an industry (Aitken and Harisson, 1999):

$$Horizontal_j = \frac{\sum_{i\ for\ all\ i \in j} Foreign\ Share_{ij} {*} Y_{ij}}{\sum_{i\ for\ all\ i \in i} Y_{ii}} \quad (5)$$

where Y_{ij} represents the level of employment of firm i in industry j capturing the knowledge transmission mainly through labour mobility. $Foreign\ Share_{ij}$ is the share of foreign equity within a firm. Foreign firms are being defined as those in which at least 10% of the equity belongs to foreign entities.

---

4 In the original Crépon et al. (1998) paper t^* refers to unobserved, true innovation output. However, in most empirical papers (Lööf and Heshmati, 2002, 2006; Griffith et al., 2006; Hashi and Stojčić, 2013) t^* represents observed innovation output. The latter literature in defining the third stage's dependent variable is followed in our model and labelled with *t.*

5 The 3SLS estimation allows for the correlation of the disturbance terms across the two equations, although assuming homoscedasticity, and is used when outcome variables in multiple equations are jointly dependent or endogenous.

Vertical FDI spillovers refer to the knowledge transmitted between firms in upstream and downstream industries. As explained, backward FDI spillovers account for the knowledge local suppliers absorb through supplying foreign customers. Forward FDI spillovers, on the other hand, refer to the knowledge local customers absorb via buying inputs from foreign suppliers. These FDI spillovers are defined as follows:

$$Backward_j = \sum_{k\ if\ k \neq j} \alpha_{jk} {}^* Horizontal_k \quad (6)$$

$$Forward_j = \sum_{k\ if\ k \neq j} \alpha_{kj} {}^* Horizontal_k \quad (7)$$

where α_{jk} represents the proportion of industry *j*'s output supplied to industry *k*. α_{kj} is the proportion of inputs of industry *j* purchased from industry *k*. These industry-specific parameters reflect the customer-supplier relationship prevailing between all sectors. α_{jk} and α_{kj} are calculated using 2010 Input-Output (IO) tables for Serbia from the Eora multi-region input-output table (MRIO) database[6] and then multiplied with the corresponding horizontal FDI spillovers, resulting in backward and forward spillovers. Unlike horizontal spillovers, vertical spillovers are aggregated at either one- or two-digit NACE industry level (a combination of these two levels of aggregation), which is dictated by the available IO tables. Hence, instead of accounting for learning through vertical linkages between firms operating in closely related industries, these measures account for learning at a more aggregated level. It is also argued that firms that do not share very similar technological content have a lot to learn from one another as the scope for learning between them increases (Autant-Bernard and LeSage, 2011).

Competition is proxied by the Hirshman-Herfindahl Index (HHI), which is the sum of the squared shares of firms' sales in total industry sales, aggregated at 3-digit NACE industry level. Controlling for competition is important because FDI influences innovation through the increased competition too, in which case not controlling for it may lead to a biased estimate on FDI spillovers.

It is important to note that the three spillover measures enter in (time-)lagged form and refer to the year 2009. This is to circumvent the endogeneity issue caused by the fact that foreign firms may target more productive and more innovative local firms to obtain a better initial market position. This can potentially cause positive bias on the spillovers' coefficient estimates. By lagging the main variables of interest and thus following a similar line of research (Girma et al., 2008; Fu, 2008; Ning et al., 2016; Zhang, 2017), we attenuate this issue.

The CDM model examines the link between R&D activities and innovation outcomes. This has led to some criticism regarding its applicability to the modelling of the innovation process in emerging economies. Such criticism is based on the fact that the original CDM model does not capture non-R&D drivers of productivity, which are important in emerging economies (Radošević and Yoruk, 2016). Our study fills this gap in the literature by adopting a modelling approach that specifically takes into account these additional drivers of innovation, which are recognised as important in the emerging economies literature. We introduce two specifications that aim to distinguish between two innovation regimes. The first specification (a) uses R&D investment as measure of innovation input, while the second specification (b) uses investment in other innovative activities that comprise of investment in machinery and equipment and the purchase of know-how and training. Hence, the first measure refers to 'knowledge creation', while the latter refers to 'knowledge use'. This allows us to assess in the next

6 Source: http://worldmrio.com

stage whether any or both of these regimes contribute to the commercialisation of existing products and services (as expected among firms that use predominantly knowledge) or the commercialisation of new products and services (as expected from knowledge generators). Table 1 provides definitions of dependent variables used for each of the equations in the CDM model.

Table 1 / Definitions of dependent variables

Specification a: Innovation input equations (Equations 1 and 2)		
Eq.1:	g_i	$= 1$ if firm invested in R&D (external or internal); $= 0$ otherwise
Eq.2:	k_i	logarithm of R&D spending
Specification b: Innovation input equations (Equations 1 and 2)		
Eq.1:	g_i	$= 1$ if firm invested in machinery, equipment, purchase of know-how and training; $= 0$ otherwise
Eq.2:	k_i	logarithm of spending on machinery, equipment, purchase of know-how and training
Specification a & b: Innovation output and productivity equations (Equations 3 and 4)*		
Eq.3:	t_i	logarithm of percentage of sales from innovation output
Eq.4:	q_i	logarithm of sales per employee (labour productivity)

* Note that although the variable definitions in Equations (3) and (4) are the same as for specifications a and b, different subsamples of firms are used in our estimations.

Turning to the explanatory variable vectors x_{1ij} to x_{4ij}, the following variables are included in all equations in the CDM system: logarithm of the number of employees in the firm (included as a proxy of firm's size); a binary variable taking value one if the firm sells products to the EU and/or a regional market (as a measure of international competition); and four dummy variables (high-tech, med-high, med-low or low-tech) referring to the technology level of the manufacturing sector in which the firm operates. Additional explanatory variables included in each equation are as follows. In Equation (1) x_{1ij} contains two variables referring to detrimental factors preventing firms from achieving their goals due to lack of knowledge[7] and market factors[8]. In Equation (2) x_{2ij} includes three dummy variables referring to the level of education of employees (the three dummies take value one if 25-49%, 50-74% and 75-100% of employees have a university degree), a dummy variable taking value one for firms producing innovation through cooperation with external partners; three dummy variables indicate subsidies sourced from local authorities, EU authorities and governmental authorities. In Equation (3) x_{3ij} includes labour productivity (total revenue divided by the number of employees); one dummy variable showing whether the firm is a member of a group, three dummy variables referring to the level of education of employees. In Equation (4) x_{4ij} includes innovation output and the three education dummies as human capital controls.

Additionally, what is common to the vectors of control variables in Equations (2) to (4) is a dummy variable referring to firms that carry out some other innovative activities (*innov_other*) in addition to R&D (in Specification a) and a dummy referring to firms that carry out R&D (*innov_rd*) in addition to spending on machinery and equipment and training (in Specification b). Thereby we control for the effect of firms that engage in both – knowledge creation as well as knowledge use.

7 The importance of rivals' dominant market share as an obstacle to meeting goals. This variable has values ranging from 0 (negligible importance) to 3 (high importance).

8 This variable is created through factor analysis. It represents the variation of two variables taking values 0 to 3 and showing the importance of unpredictable demand as an obstacle to meeting goals and the importance of rivals' innovation as an obstacle to meeting goals.

4. Results

Table 2 presents estimation results for the first two equations of the CDM approach that models inputs into the innovation process, while Table 3 presents results for the last two equations, which model, respectively, the innovation output and productivity. As explained in the previous section, each of these equations is estimated for two subsamples of firms: firms that are predominantly knowledge creators and firms that are predominantly knowledge users. The former subsample includes firms that engage in a knowledge-generation innovation regime by investing mainly in R&D, while the latter includes firms that engage in a knowledge-use innovation regime mainly through investment in machinery and equipment and the purchase of know-how. For expositional convenience the results for the main variables of interest are presented in Table 2, while the full estimation results can be found in the appendix.

The results in Table 2 (marginal effects) show positive horizontal spillover effects in the earlier stages of the innovation process in both subsamples, although the effect is larger (stronger) on firms that invest in knowledge use (Specification b) than on firms that invest in knowledge creation (Specification a).[9] The positive effect from horizontal spillover on the likelihood of firms introducing innovation through knowledge use is around three times higher than the positive effect on the firms conducting R&D. Likewise, the presence of foreign rival firms induces further spending on R&D and other innovation activities (Eq. 2), but the latter effect is approximately four times larger, judging by the size of the coefficient estimate. If foreign rivals' presence increases by 0.01 units the R&D spending increases by 0.5%, but spending on other innovative activities increases by 2.1%.

Table 2 / Type II Tobit estimation results for Equations 1 and 2 (marginal effects)

	Innovation regime			
	Knowledge creators		Knowledge users	
	Decision to innovate	Innovation investment	Decision to innovate	Innovation investment
Horizontal spillovers	0.077**	0.460**	0.242***	2.102***
	(0.0341)	(0.223)	(0.039)	(0.334)
Forward vertical spillovers	-0.074	1.260	1.396***	9.814***
	(0.311)	(2.047)	(0.351)	(2.961)
Backward vertical spillovers	-3.537***	-30.50***	-4.623***	-41.87***
	(0.399)	(2.742)	(0.458)	(3.900)
Market concentration	-0.062	-0.523*	-0.092	-0.888*
	(0.040)	(0.278)	(0.048)	(0.456)
Observations	964	251	964	350

Note: * p<0.1, ** p<0.05, *** p<0.01; detailed specifications and model diagnostics are available in the online appendix. Standard errors are in parentheses. The decision to innovate and innovation investment in a knowledge-creation regime refer to investment in R&D. The decision to innovate and innovation investment in a knowledge use regime refer to investment in machinery, equipment, software, training and know-how.

9 In Equation 1 the 95% confidence intervals for the horizontal spillover effect are, respectively, [0.011, 0.144] and [0.166, 0.318] for specification a and specification b, while respective confidence intervals are [0.023, 0.897] and [1.447, 2.757] for Equation 2.

The market competition effects are positive in the early phase of the innovation process for both knowledge-using and knowledge-generating firms.[10] Vertical spillovers have different impacts, depending on whether the foreign firm is a supplier or a customer. Forward spillovers (from foreign customers) have a positive and significant effect only for firms that invest in knowledge use (Specification b) but not for firms that invest in knowledge creation (Specification a). Backward spillovers (foreign firms' presence in the downstream sector) are negative and significant in both models, irrespective of the innovation regime. The results of the estimations of Equations 3 and 4 (which refer to innovation output and productivity, respectively) for firms that follow a knowledge-generation innovation regime (Specification a – columns I and II) and firms that follow a knowledge-use innovation regime (Specification b – columns III and IV) are presented in Table 3.

Table 3 / 3SLS estimation results for Equations 3 and 4

	Innovation regime			
	Knowledge creators		Knowledge users	
	Sales from new products	Productivity	Sales from new products	Productivity
Horizontal spillovers	-1.111***	2.212	-1.235***	3.837***
	(0.276)	(5.190)	(0.270)	(1.471)
Forward vertical spillovers	0.651	-17.24	0.223	-5.033
	(2.893)	(36.42)	(2.008)	(6.530)
Backward vertical spillovers	-11.25	4.084	6.984	-49.24**
	(8.452)	(55.75)	(5.278)	(22.40)
Market concentration	1.357***	-1.289	1.786***	-2.259*
	(0.366)	(4.486)	(0.245)	(1.190)
R&D investment (predicted)	-0.235*	-	-	-
	(0.132)			
Machinery, equipment etc. investment (predicted)	-	-	-0.201**	-
			(0.098)	
Sales from new products (predicted)	-	2.514	-	1.559***
		(4.659)		(0.529)
Observations	212	212	284	284

* p<0.1, ** p<0.05, *** p<0.01; Detailed specifications and model diagnostics are available in in the online appendix. Standard errors in parentheses.

In the latter phases of the innovation process, too, horizontal spillovers have a stronger effect on knowledge users than knowledge creators for both Equations 3 and 4. Surprisingly, the sign of horizontal spillover effects differs. Despite greater innovative efforts prompted by foreign rivals' presence (Table 2), knowledge creators and knowledge users incur negative effects from foreign horizontal spillovers. There are positive horizontal spillover effects on productivity only among the knowledge users, but not the knowledge creators. Vertical spillovers cease to have an effect on the latter phases of the innovation process. Local customers' innovation sales and productivity are not affected by the presence of foreign suppliers and foreign customers. Considering the negative backward spillover effects in the early phase of innovation, it comes as no surprise that manufacturing firms enjoy neither market nor productivity benefits through backward linkage. Only knowledge users incur negative productivity effects through backward linkage. Forward spillovers have no effect on the innovation output or productivity of firms, irrespective of their innovation regime. Finally, we find negative coefficients from both knowledge-use and knowledge-generation regimes on the sales of new products and services, and positive effects of the sales of new products and services on productivity among knowledge users.

[10] The HH index is a measure of market concentration, as presented in the table of results. If the effect of market concentration is positive/negative, the effect of market concentration is reversed, i.e. negative/positive.

5. Discussion of findings

Our results offer several interesting findings that deserve to be discussed in greater detail. The results show clearly that the scope of learning from foreign rival firms is greater among firms following a knowledge-use innovation regime than those involved in knowledge generation. It is possible that firms in Serbia are lower down the ladder of the global value chain, less knowledge-intensive and with lower innovation capabilities. The greater the presence of foreign suppliers, the greater the chance that firms in the downstream industry will innovate through the purchase of machinery and equipment and the better use of existing human resources, but not via R&D. This signals that improved quality or new types of inputs from foreign suppliers require improved or new embedded technology to make use of it.

The overall negative effect of backward spillovers in the early phases of the innovation process (decision to innovate and innovation investment) could result from inputs being sourced globally rather than locally (Ito et al., 2012) because of low transport costs, the inability of domestic firms to meet their demand, or the success of foreign firms in preventing the leakage of knowledge to domestic firms (Newman et al., 2015). As with horizontal spillovers, the effect is larger (stronger) for firms that invest in knowledge use than for those that invest in knowledge generation. This may imply that local firms do not have sufficient absorptive capacity to meet the needs of foreign customers demanding better inputs, or that they lack sufficient capital to invest in compatible embedded technology to meet the needs of foreign-owned customers. This is particularly true for firms that innovate via knowledge use, possibly because firms conducting R&D are better able to fight off negative productivity shocks. The effects of vertical spillovers, and in particular backward ones, are strong in size. This is because vertical spillovers are measured at a higher level of industry aggregation, and their coefficient represents spillover effects in broader terms.[11]

The sign of horizontal spillovers differs across innovation regimes in the latter phases of the innovation process. The sales from innovation are negatively affected, regardless of positive innovation spending, possibly because firms face market entry barriers, including poor marketing and commercial skills that are needed for the sale of new or differentiated products and services. Judging by the greater negative effects from horizontal spillovers, we may infer that high market entry barriers and marketing skills are particularly weak among the firms that use knowledge, rather than those that create it. The reasoning may lie in the negative and significant effect of market competition (positive effect of market concentration). Based on the coefficient size, this effect is stronger among knowledge users. One more explanation of the effect of market concentration that is negative on innovation spending (Eq. 2) but positive on innovation sales (Eq. 3) may also lie in the survey limitation – the absence of the time dimension in the data to incorporate the lag between spending on innovation and success from innovation (both referring to the same year).

[11] In this study vertical spillovers represent combined learning between various industries engaged in customer-supplier relationship, aggregated together, regardless of how closely related they are technologically and in terms of the markets they serve. With lower levels of aggregation one can distinguish learning through vertical linkages occurring between closely related industries. However, when a higher level of aggregation is used, vertical spillovers reveal an aggregated learning effect emerging between different industries (with different technological intensities and production) engaged in a customer-supplier relationship. This may explain the strong combined effect of backward spillovers, in particular. Considering this, and the nature of this measure overall, the economic significance of vertical spillovers will not be discussed.

Turning again to vertical spillovers, local customers' innovation sales and productivity are not affected by the presence of foreign suppliers. This was expected for knowledge-generating firms that were not increasing their innovation efforts in the first place through forward linkage (see Table 2). However, even those manufacturing firms that rely on a knowledge-use regime do not successfully grasp further market and productivity benefits through forward linkage. Only knowledge users incur negative productivity effects through backward linkage. These results may indicate that FDI operates primarily as an enclave and does not extend to local supply chains. Alternatively, these results may reflect short-term costs, as demonstrated in the context of the automotive parts industry in India, for example (Kumaraswamy et al., 2012).

Finally, in cases of both knowledge users and knowledge generators we find that greater innovation spending does not increase the percentage of sales revenue from new products and services. This implies that innovation spending contributes to the percentage of sales revenue from existing products and services.[12] These results support our hypothesis that innovation in an emerging economy takes place mostly through the use of existing knowledge and embedded technology rather than through the generation of new knowledge and technology. However, we also find that sales of new products and services matter for the productivity of domestic firms among those that rely on a knowledge-use regime. This suggests that emerging economies can very successfully catch up with the technology frontier through applying the current state of their knowledge. The presence of foreign firms, however, helps this process only partially when decisions on innovation spending are being taken; this applies to a lesser extent to firms which carry out R&D.

Yet none of the firms reap the real financial and technological benefits through FDI spillovers. This can be explained in two ways. First, firms investing in R&D obtain benefits from their internal innovation efforts rather than by copying those of foreign firms. This is clearly shown by the small effects that FDI spillovers have in the early phases of the innovation process and no effects on innovation sales and productivity. The case is different for knowledge users who, through the purchase of machinery, equipment and further training, increase their innovation efforts. Negative effects on innovativeness and positive effects on productivity in the presence of horizontal spillovers suggest that FDI hinders the investments of local firms and induces them to achieve productivity by confining themselves to their existing products as a way to improve productivity. Results from vertical spillovers reflect a higher level of aggregation and thus hide individual differences among firms, which is a crucial feature of the FDI effects. Our evidence shows that the average net effects are either insignificant or negative on both innovation sales and productivity. However, it may be expected that the overall effects are highly differentiated across different firms.

The research finds partial support for our hypotheses. We find support for H1a, H2a and H4a (for horizontal spillovers) and partially for H2b (for forward spillovers). Our findings also show that knowledge-using firms increase their share of sales coming from established products with embedded technology, thus providing support to H4a.

---

[12] The dependent variable in Equation 3 is the percentage of sales revenue coming from new products and services. If innovation spending affects the percentage of sales revenue coming from *new* products and services negatively, then it should affect the percentage of sales revenue coming from *existing* products and services positively.

6. Conclusion

European emerging economies are still in transition from production to innovation-based systems. Foreign firms entering these markets can help this catch-up process through knowledge spillovers, promoting further innovation and productivity improvement among indigenous firms. But the question is: to what extent do firms benefit from these spillovers, and which firms? This paper contributes to the literature by shedding more light on the effects of spillovers on innovation, which have been rarely investigated, especially not in the context of emerging economies. Scholarly research related to FDI spillovers in the context of innovation is still at a nascent stage and has focused on innovation output only, neglecting the stages that precede and succeed the innovation output. This paper fills this gap by investigating how each stage of the innovation process – from a firm's decision to innovate to its labour productivity – is affected by FDI spillovers in an emerging economy. To this end, our study has theoretical, practical and policy implications.

6.1. THEORETICAL IMPLICATIONS

The positive effects of innovations on firm performance and competitiveness are well established in the literature (Stojčić et al., 2020). The common narrative suggests that firms develop novel products and processes through R&D efforts, and subsequently sales of new products lead to better productivity. However, R&D is not the only channel for the development of innovations. Firms in many parts of the world do not possess the relevant knowledge and resources to engage in R&D. Somehow this issue went unnoticed in the innovation literature, despite the fact that statistical data from many – mostly emerging – economies point to the disproportionate representation of investment in existing technology embodied in machinery, equipment and know-how over R&D. Finally, an innovation process does not always yield novel products and services. That said, there are two important theoretical implications of our study.

The first theoretical implication of our study comes from the assessment of different innovation regimes in emerging economies. There is substantial evidence that innovation investment patterns differ between advanced and emerging economies, but whether – and in what way – this has an impact on the innovation outcomes of firms in two settings has not been the subject of previous investigations. The innovation activities in EMEs may be about the most productive use or absorption and assimilation of embedded R&D, not about the generation of new knowledge. Another theoretical contribution of our investigation comes from augmenting the innovation literature with the analysis of FDI spillovers. That FDI spillovers matter for firms' performance is another well-established fact, but the literature has so far not explored which spillover channels facilitate different stages of the innovation process, and in what way. Our study disentangles three main spillover channels and shows how each of them influences different stages of the innovation process across the analysed innovation regimes.

6.2. PRACTICAL IMPLICATIONS

Our investigation provides novel findings on the outcomes of different innovation regimes in emerging economies. We show that firms in emerging economies follow two distinctive paths of innovation. However, both these paths are used by firms not to generate truly novel products but to improve the sales of existing ones. What this signals is that innovation activities of firms in emerging economies are not about the generation of new knowledge but about the most productive use or absorption and assimilation of embedded knowledge and technology in existing products.

We hypothesised that local firms in these countries can benefit from foreign firms' knowledge, but mostly through the application and imitation of existing practice, rather than through R&D. In other words, we tested the hypothesis that absorbing FDI spillovers will differ significantly between firms that compete based mainly on production capabilities (or embedded technology) or technology use as compared to those that invest in disembodied technology or R&D. This is because emerging economies are still far from the technology frontier and have limited resources and abilities to engage in radical innovation. Their innovation efforts usually translate into the imitation of products, services and technological processes that have already been successfully 'tested' elsewhere. R&D firms are more inclined to rely on their internal resources when innovating, rather than 'free-riding' on others.

The results show that foreign firms' presence affects mostly the early phase of the innovation process, namely the decision to innovate and the amount of innovation spending. This reflects the changed competitive position of local firms vis-à-vis FDI and determines the nature of their interaction and their strategic behaviour. This initial shift also determines the commercial and innovation impact of investments into either R&D or embedded technology. Accordingly, the true success of innovation, manifested in higher revenue (sales) from innovation and productivity, is not affected or only marginally affected. These FDI spillover effects also differ among the knowledge users and the knowledge creators.

Foreign rivals affect positively firms' decision to innovate and their innovation spending through horizontal spillovers, but the effect is a lot greater for knowledge users than for knowledge creators. A similar story applies to forward spillovers. Sourcing more inputs from foreign suppliers prompt innovative efforts by knowledge using-firms but not those undertaking knowledge generation. Only backward spillovers have negative and significant effects on the decision to innovate and the innovation spending of both knowledge users and knowledge creators.

In the latter phase of the innovation process there are no positive spillovers effects from either foreign rival firms or foreign firms linked (with the indigenous ones) through the supply chain. Despite greater innovative efforts undertaken through FDI horizontal and forward linkage, no significant market and productivity benefits are accrued. Finally, the larger positive effect on firms which undertake innovation through the purchase of machinery, equipment etc. rather than through R&D indicates that the true innovation process in emerging economies such as Serbia is mirrored in imitation, rather than the creation of novel products. It is these innovative processes that are further promoted by foreign firms, but only in the early phase of the innovation process. The manufacturing firms in Serbia increase their innovation efforts by learning from foreign rivals, mainly because many of them are further away from the technological frontier and have greater knowledge gaps. R&D firms, on the other hand, absorb some knowledge spillover (horizontal) but to a much smaller extent than those that implement innovative activities already tested elsewhere.

6.3. POLICY IMPLICATIONS

The heterogeneous results from foreign spillover effects hint at two important aspects (or weaknesses) of the national innovation systems in emerging economies. The results show that innovation sales are either negatively affected or not affected by spillovers, depending on whether they are sourced from a rival firm or a customer/ supplier firm. Productivity is unaffected by spillovers, apart from some positive effects on knowledge users. On the other hand, innovation investment in both innovation regimes increases the percentage of sales revenue from existing products. Both findings can be taken as evidence that firms in emerging economies encounter barriers when trying to commercialise their innovation efforts and improve productivity through innovation activities. These findings may also reflect the position of producers from emerging economies in global production networks at lower levels of the value chain, where standardised products dominate.

Our analysis shows that governments in these countries should complement their policies on FDI with policies designed to foster learning and improve technology and innovation because there is scope for learning through spillovers. Policy makers should try to stimulate the commercialisation of innovation output, using market-oriented strategies to reduce market-entry barriers by organising fairs and exhibitions where innovation outputs could be promoted. Businesses should focus on marketing their innovation too, to sell their products to a wider audience. Our research shows that integrating domestic suppliers with foreign firms in the downstream sector is important. National authorities should consider encouraging the integration of domestic suppliers and customers of foreign firms, which can increase their capabilities further. Better integration of foreign firms into local economies could be achieved via various incentive schemes, such as human capital training and assistance with the inputs foreign firms need, or attracting global value chain-oriented investors. Greater emphasis should be placed on building trust with local supply chains.

6.4. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

No study is without limitations, and the same goes for our investigation. The main limitation is that our analysis is based on a single emerging economy. Future research should strengthen the theses presented in our research by extending the analysis to different countries. Furthermore, some results in our study may differ when observed at a single point in time from findings over the longer run. Lack of longitudinal data is a common barrier in innovation research, and it remains an open challenge for the future. Our analysis is based on the assessment of the average spillover effects for industry as a whole. Deeper insight into these mechanisms should be obtained through surveys that focus on exact practices through which spillovers occur. Finally, studies such as ours have value for policy makers who are interested in raising the innovation potential of their economies. Their success depends on the ability of academics to provide evidence-based inputs in the formulation of innovation policies. It remains for the researchers of tomorrow to address these challenges.

References

Aghion, P., Blundell, R., Griffith, R., Howitt, P., & Prantl, S. (2009). The effects of entry on incumbent innovation and productivity. *The Review of Economics and Statistics*, *91*(1), 20-32.

Aitken, B. J., & Harrison, A. E. (1999). Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. *American Economic Review*, 89(3), 605-618.

Autant-Bernard, C., & LeSage, J. P. (2011). Quantifying knowledge spillovers using spatial econometric models. *Journal of Regional Science*, 51(3), 471-496.

Barrios, S., Bertinelli, L., & Strobl, E. (2006). Coagglomeration and spillovers. *Regional Science and Urban Economics*, 36(4), 467-481.

Bell, M., & Pavitt, K. (1993). Technological accumulation and industrial growth: Contrasts between.

Blalock, G., & Gertler, P. J. (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of international Economics*, 74(2), 402-421.

Boschma, R. (2005). Proximity and innovation: a critical assessment. *Regional Studies*, 39(1), 61-74.

Cirera, X. & Maloney, W.F. (2017). The Innovation Paradox. Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up, World Bank, Washington.

Crépon, B., Duguet, E., & Mairessec, J. (1998). Research, innovation and productivity: an econometric analysis at the firm level. *Economics of Innovation and new Technology*, 7(2), 115-158.

Crescenzi, R., Gagliardi, L., & Iammarino, S. (2015). Foreign multinationals and domestic innovation: Intra-industry effects and firm heterogeneity. *Research Policy*, *44*(3), 596-609.

Cheung, K. Y., & Ping, L. (2004). Spillover effects of FDI on innovation in China: Evidence from the provincial data. *China Economic Review*, 15(1), 25-44.

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: the two faces of R & D. *The Economic Journal*, 99(397), 569-596.

Dahlman, C., & Westphal, L. (1982). an interpretative survey of recent research. *The Economics Of New Technology In Developing Countries*, 105.

Dahlman, C. J., Ross-Larson, B., & Westphal, L. E. (1987). Managing technological development: lessons from the newly industrializing countries. *World development*, *15*(6), 759-775.

Damijan, J. P., Kostevc, Č., & Rojec, M. (2011). Innovation and firms’ productivity growth in Slovenia: Sensitivity of results to sectoral heterogeneity and to estimation method. In: Nijkamp, P. & Siedschlag, I. (eds.) *Innovation, Growth and Competitiveness* (pp. 165-193). Springer, Berlin, Heidelberg.

Damijan, J. P., Rojec, M., Majcen, B., & Knell, M. (2013). Impact of firm heterogeneity on direct and spillover effects of FDI: Micro-evidence from ten transition countries. *Journal of Comparative Economics*, *41*(3), 895-922.

Dasgupta, K. (2012). Learning and knowledge diffusion in a global economy. *Journal of International Economics*, *87*(2), 323-336.

Du, L., Harrison, A. E., & Jefferson, G. H. (2011). Do Institutions Matter for FDI Spillovers? The Implications of China's " Special Characteristics". World Bank Policy Research Working Paper (5757).

Eapen, A., Yeo, J. & Sasidharan, S. (2019), Finance constraints and technology spillovers from foreign to domestic firms, *Economic Modelling*, 76, 50–62.

Fu, X. (2008). Foreign direct investment, absorptive capacity and regional innovation capabilities: Evidence from China. *Oxford Development Studies, 36*(1), 89-110. https://doi.org/10.1080/13600810701848193

Fu, W., Diez, J. R., & Schiller, D. (2013). Interactive learning, informal networks and innovation: Evidence from electronics firm survey in the Pearl River Delta, China. *Research Policy*, 42(3), 635-646.

Fujita, M., & Thisse, J. (2002). *Economics of agglomeration: Cities, industrial location, and regional growth* (1. publ. ed.). New York: Cambridge University Press.

García, F., Jin, B., & Salomon, R. (2013). Does inward foreign direct investment improve the innovative performance of local firms?, *Research Policy*, *42*(1), 231-244.

Sourafel, G., Yundan, G. & Görg, H. (2008). Foreign direct investment, access to finance, and innovation activity in Chinese enterprises. *The World Bank Economic Review, 22*(2), 367-382. https://doi.org/10.1093/wber/lhn009

Gorodnichenko, Y., Svejnar, J., & Terrell, K. (2014). When does FDI have positive spillovers? Evidence from 17 transition market economies. *Journal of Comparative Economics*, 42(4), 954-969.

Greenaway, D., Sousa, N., & Wakelin, K. (2004). Do domestic firms learn to export from multinationals?. *European Journal of Political Economy*, *20*(4), 1027-1043.

Griffith, R., Huergo, E., Mairesse, J., & Peters, B. (2006). Innovation and productivity across four European countries. *Oxford Review of Economic Policy*, 22(4), 483-498.

Griliches, Z. (1979). Issues in assessing the contribution of research and development to productivity growth. *The Bell Journal of Economics*, 92-116.

Halpern, L., & Muraközy, B. (2007). Does distance matter in spillover? *Economics of Transition*, 15(4), 781-805.

Hamida, L. B. (2013). Are there regional spillovers from FDI in the Swiss manufacturing industry?. *International Business Review*, *22*(4), 754-769.

Hashi, I., & Stojčić, N. (2013). The impact of innovation activities on firm performance using a multi-stage model: Evidence from the community innovation survey 4. *Research Policy, 42*(2), 353-366.

Haskel, J. E., Pereira, S. C., & Slaughter, M. J. (2007). Does inward foreign direct investment boost the productivity of domestic firms?. *The Review of Economics and Statistics*, *89*(3), 482-496.

Iammarino, S., Piva, M., Vivarelli, M., & Von Tunzelmann, N. (2012). Technological capabilities and patterns of innovative cooperation of firms in the UK regions. *Regional Studies*, *46*(10), 1283-1301.

Ito, B., Yashiro, N., Xu, Z., Chen, X., & Wakasugi, R. (2012). How do Chinese industries benefit from FDI spillovers?. *China Economic Review*, 23(2), 342-356.

Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review*, 94(3), 605-627.

Javorcik, B. S., & Spatareanu, M. (2011). Does it matter where you come from? Vertical spillovers from foreign direct investment and the origin of investors. *Journal of Development Economics*, 96(1), 126-138.

Khachoo, Q., Sharma, R., & Dhanora, M. (2018). Does proximity to the frontier facilitate FDI-spawned spillovers on innovation and productivity?. *Journal of Economics and Business*, *97*, 39-49.

Kokko, A., & Kravtsova, V. (2012). Regional characteristics and effects of inward FDI: the case of Ukraine. *Organizations and Markets in Emerging Economies*, *3*(2), 91-118.

Kosová, R. (2010). Do foreign firms crowd out domestic firms? *The Review of Economics and Statistics, 92*(4), 861-881.

Kravtsova, V., and Radošević, S. (2012). Are systems of innovation in Eastern Europe efficient?. *Economic Systems,* 36:1: 109−126.

Kumaraswamy, A., Mudambi, R., Saranga, H. and Tripathy, A. (2012). Catch-up Strategies in the Indian Auto Components Industry: Domestic Firms' Responses to Market Liberalization. *Journal of International Business Studies*, 43, 368-395.

Lööf, H., & Heshmati, A. (2002). Knowledge capital and performance heterogeneity: A firm-level innovation study. *International Journal of Production Economics*, 76(1), 61-85.

Lööf, H., & Heshmati, A. (2006). On the relationship between innovation and performance: A sensitivity analysis. *Economics of Innovation and New Technology*, 15(4-5), 317-344.

Lu, Y., Tao, Z., & Zhu, L. (2017). Identifying FDI spillovers. *Journal of International Economics*, *107*, 75-90.

Mowery, D. C., & Oxley, J. E. (1995). Inward technology transfer and competitiveness: the role of national innovation systems. *Cambridge Journal of Economics*, *19*(1), 67-93.

Nelson, R. R., & Phelps, E. S. (1966). Investment in humans, technological diffusion, and economic growth. *The American Economic Review*, 56(1/2), 69-75.

Newman, C., Rand, J., Talbot, T., & Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. *European Economic Review, 76*, 168-187. https://doi.org/10.1016/j.euroecorev.2015.02.005

Nicolini, M., & Resmini, L. (2010). Which firms create them and which firms really benefit? FDI spillovers in new EU member states. *Economics of Transition*, *18*(3), 487-511.

Ning, L., Wang, F., & Li, J. (2016). Urban innovation, regional externalities of foreign direct investment and industrial agglomeration: Evidence from Chinese cities. *Research Policy, 45*(4), 830-843. https://doi.org/10.1016/j.respol.2016.01.014

Polder, M., Van Leeuwen, G., Raymond, W. I. & Mohnen, P. (2009). Productivity effects of innovation modes. MPRA Paper No. 18893. Retrieved from http://econpapers.repec.org/paper/pramprapa/18893.htm

Radošević, S. (1999), International technology transfer policy: from 'contract bargaining' to 'sourcing'. *Technovation*, *19*(6-7), 433-444.

Radošević, S. (2015). Synthesis report: WP3. Innovation, entrepreneurship and industrial dynamics. Technology upgrading and innovation policy in Central and Eastern Europe (GRINCOH Working Paper Series, Paper No. 3).

Radošević, S. (2016). The role of public research in economic development. In European Commission, Science, Research and Innovation performance of the EU. A contribution to the Open Innovation, Open Science, Open to the World agenda, DG for Research and Innovation, pp119-139. Available at: https://op.europa.eu/en/publication-detail/-/publication/744d5735-e1d4-11e5-8a50-01aa75ed71a1.

Radošević, S. (2017). Upgrading technology in Central and Eastern European economies. *IZA World of Labor*. 338.

Radošević, S., & Yoruk, E. (2018). Technology upgrading of middle income economies: A new approach and results. *Technological Forecasting and Social Change*, *129*, 56-75.

Radošević, S., & Yoruk, E. (2016). Why do we need a theory and metrics of technology upgrading?. *Asian Journal of Technology Innovation*, 24(sup1), 8-32.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5), 1002-1037.

Roud, V. (2018). Understanding the heterogeneity of innovation modes: Performance effects, barriers, and demand for state support. *Technological Forecasting and Social Change*, *133*, 238-253.

Saggi, K. (2006). Foreign direct investment, linkages, and technology spillovers. *Global Integration and Technology Transfer. 2006, pp. 51-65.*

Sinani, E., & Meyer, K. E. (2004). Spillovers of technology transfer from FDI: the case of Estonia. *Journal of Comparative Economics*, *32*(3), 445-466.

Stojčić, N. (2021). Collaborative innovation in emerging innovation systems: Evidence from Central and Eastern Europe. *The Journal of Technology Transfer*, 46(2). 531-562.

Stojčić, N., & Orlić, E. (2020). Spatial dependence, foreign investment and productivity spillovers in new EU member states. *Regional Studies*, *54*(8), 1057-1068.

Stojčić, N., Srhoj, S., & Coad, A. (2020). Innovation procurement as capability-building: Evaluating innovation policies in eight Central and Eastern European countries. *European Economic Review*, *121*, 103330.

Vahter, P. (2011). Does FDI spur productivity, knowledge sourcing and innovation by incumbent firms? Evidence from manufacturing industry in Estonia. *The World Economy*, 34(8), 1308-1326.

Vujanović, N., Stojčić, N., & Hashi, I. (2021). FDI spillovers and firm productivity during crisis: Empirical evidence from transition economies. *Economic Systems*, https://doi.org/10.1016/j.ecosys.2021.100865.

World Bank (2020) Foreign direct investment, net inflows (% of GDP) https://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS?end=2019&start=1970

Zhang, L. (2017). The knowledge spillover effects of FDI on the productivity and efficiency of research activities in China. *China Economic Review, 42*, 1-14. https://doi.org/10.1016/j.chieco.2016.11.001

Zellner, A., & Theil, H. (1992). Three-stage least squares: simultaneous estimation of simultaneous equations. In Theil, Henri, *Contributions to Economics and Econometrics* (pp. 147-178). Springer, Dordrecht.

IMPRESSUM

Herausgeber, Verleger, Eigentümer und Hersteller:
Verein „Wiener Institut für Internationale Wirtschaftsvergleiche“ (wiiw),
Wien 6, Rahlgasse 3

ZVR-Zahl: 329995655

Postanschrift: A 1060 Wien, Rahlgasse 3, Tel: [+431] 533 66 10, Telefax: [+431] 533 66 10 50
Internet Homepage: www.wiiw.ac.at

Offenlegung nach § 25 Mediengesetz: Medieninhaber (Verleger): Verein "Wiener Institut für Internationale Wirtschaftsvergleiche", A 1060 Wien, Rahlgasse 3. Vereinszweck: Analyse der wirtschaftlichen Entwicklung der zentral- und osteuropäischen Länder sowie anderer Transformationswirtschaften sowohl mittels empirischer als auch theoretischer Studien und ihre Veröffentlichung; Erbringung von Beratungsleistungen für Regierungs- und Verwaltungsstellen, Firmen und Institutionen.

wiiw

wiiw.ac.at

https://wiiw.ac.at/p-6121.html