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## Determinants and effects of foreign direct investment in Austria: Spillovers to novel innovative environmental technologies

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# Determinants and Effects of Foreign Direct Investment in Austria:

## Spillovers to Novel Innovative Environmental Technologies

Mahdi Ghodsi and Branimir Jovanovic

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



# Determinants and Effects of Foreign Direct Investment in Austria:

## Spillovers to Novel Innovative Environmental Technologies

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Final report within the project 'Determinants and Effects of Foreign Direct Investment in Austria: Spillovers to Novel Innovative Environmental Technologies' for the Austrian Federal Ministry for Labour and Economy (formerly Austrian Federal Ministry for Digital and Economic Affairs).



# Abstract

This study investigates the determinants of FDI in Austria, as well as their spillovers to innovating technologies, productivity, and employment, using firm-level data, for the period 2008-2018. The findings point out that a decrease in the costs of trade increases investment in foreign-owned subsidiaries in Austria, and that FDI is pre-dominantly carried out in industries characterised by greater capital-intensity, higher wages, more agglomeration and regional concentration. Furthermore, FDI is higher in regions with a larger GDP and with a larger share of the population with upper secondary and post-secondary non-tertiary education. The study also finds that there are positive spillovers of FDI to the domestic economy, which are strongest and most positive for innovative activities in environmental technologies. In other words, FDI helps Austrian firms to become more innovative in major environmental technologies. Such innovative efforts are best supported at the firm-level by supporting the total assets and investment of domestic firms, and at the regional level by increasing the share of the population with higher levels of education and employing more R&D personnel. The active presence of innovative foreign MNEs that enjoy extensive technological capacities, high-skilled labour, experienced management, and large-scale resources are also conducive to innovative activities.

**Keywords:** FDI, Austria, spillovers, innovation, environmental technologies

**JEL classification:** F21, F23, O30, Q55



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## LIST OF ACRONYMS AND ABBREVIATIONS

AIC	Akaike information criterion
AVE	Ad valorem equivalent
BF	Brownfield
BvD	Bureau van Dijk
CIS	Community Innovation Survey
CPC	Cooperative Patent Classification
EEA	European Economic Area
EU	European Union
EU KLEMS	EU level analysis of capital, labour, energy, materials and service inputs
EUR	Euro
FDI	Foreign direct investment
FEs	Fixed effects
GDP	Gross domestic product
GF	Greenfield
GHG	Greenhouse gasses
GUO	Global ultimate owners
GVC	Global value chains
HHI	Herfindahl-Hirschman Index
IDB	Integrated Database
IT	Information and technology
M&A	Mergers and acquisitions
MAR	Marshall-Arrow-Romer
MNE	Multinational enterprise
NACE	Nomenclature of Economic Activities
NTB	Non-tariff barrier
NTM	Non-tariff measures
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Cooperation and Development
PC	Percentage
PPML	Poisson Pseudo Maximum Likelihood
R&D	Research and development
RS	Regional sector
SDGs	Sustainable development goals
TBT	Technical barriers to trade
TRAINS	Trade Analysis Information System
UN	United Nations
US	United States
USD	United States dollar
VA	Value added
WITS	World Integrated Trade Solutions
WTO	World Trade Organisation



# 1. Introduction

Foreign direct investment (FDI) has become a driver of growth in both developed and developing countries (Balasubramanyam et al., 1996; Gao, 2005; Mottaleb, 2007; Iamsiraroj, 2016). It can transfer know-how and advanced technologies owned and developed by multinational enterprises (MNEs) to other countries. However, FDI's impact on growth can vary across sectors (Alfaro, 2003). Technological upgrading and knowledge spillovers are the main channels through which FDI can affect long-run growth in the host economy (De Mello, 1999). As the OECD (2021) reports, FDI can have a substantial impact on the UN Sustainable Development Goals (SDGs) through various channels. FDI can foster innovation and productivity, improve the quality of jobs and skills, ensure a more gender-equal labour market and reduce CO<sub>2</sub> emissions to satisfy global climate goals. These could be achieved because a multinational ownership network can facilitate sourcing intermediate inputs by opening up global value chains, diversifying managerial techniques (Javorcik, 2020) that can comprise various environments and markets, and most importantly, ensuring better access to various financial resources in several countries. FDI can stimulate growth even more in developed economies that are more advanced financially (Alfaro et al., 2010).

This study investigates the determinants and effects of FDI using firm-level data for Austria, with a special focus on positive spillovers to innovation of novel environmental technologies. Therefore, one part of this study analyses the determinants of FDI in Austria at the firm-level to observe which factors at the firm-, regional-, and industry-level stimulate FDI in Austria. The other part analyses FDI's effects on employment, labour productivity, and innovation in Austria. While the effects on innovation are studied at both the firm-level and regional industrial level, effects on employment and labour productivity are analysed only at the firm-level. The reason is that the aggregated value of employment and labour productivity at the regional sector level already includes foreign-affiliated values of employment, which makes the results biased. However, for patenting activity at the regional level, spillover effects from foreign owners to regional industrial innovation that include those effects partly deriving from foreign affiliates, could also be interesting to show.

To analyse the spillovers of FDI, this study uses two types of measurements of FDI. The first measurement represents the technological and innovative aspect of FDI in Austria, which is measured by the number of published or granted patents owned by foreign-owned firms in Austrian regional industries or by their foreign multinational enterprises (MNEs) or global ultimate owners (GUOs)<sup>1</sup>. One measurement of patents includes patents in all types of technologies and another measurement includes patents in environmental technologies. Environmental technologies are classified by the OECD (Haščič and Migotto, 2015) as technology classes that mitigate climate change, such as those related to energy generation, transportation, buildings, or other technology classes related to environmental management, water management, or storage and disposal of greenhouse gasses (GHG).

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<sup>1</sup> Note that foreign MNE and GUO are used interchangeably in this paper.

The other gauge of FDI consists of financial measurements of FDI. The total assets of foreign-owned firms, the number of greenfield (GF) or brownfield (BF) investment projects, the investment value of GF and BF projects, the number of mergers and acquisitions (M&A), and the investment value of M&A deals are five financial measurements of FDI. These aspects are aggregated to regional industries based on the information available on the investment projects of foreign-owned firms.

The empirical findings indicate that trade policy matters for FDI in Austria. In fact, the stock of FDI measured in total assets of foreign-owned firms in Austria and the flow of FDI in M&A deals increase when the cost of trade to Austria induced by tariffs or technical barriers to trade (TBTs) are reduced. While the imposition of tariffs and the majority of TBTs are decided at the level of the European Union, there are still some TBTs that are imposed by single members of the EU. Due to harmonisation and mutual recognition of regulations and standards in the single market of the EU, all TBTs do not affect intra-EU trade, while they affect imports from extra-EU countries. Therefore, as trade costs associated with these trade policies are presumably zero for intra-EU trade, one can argue that increasing trade costs to Austria from other trading partners would decrease FDI from those countries. This suggests that subsidiaries of foreign MNEs in Austria are heavily participating in global value chains that are importing goods from the home country of the FDI.

Furthermore, the econometric results from the second part of the analysis indicate positive spillovers from FDI to the productivity, employment, and innovation of domestically owned firms in Austria. These positive technological spillovers are most significant from patents in non-environmental technologies published or owned by foreign-owned firms in regional industries. Moreover, granted environmental patents of GUOs which invest in regional industries also induce positive spillovers to novel innovation in environmental technology classes (these patents are filed by domestically owned firms). Results also show that the employment of R&D personnel in regions and a larger share of the population with a higher level of education also positively affect innovation at the firm-level. Therefore, while these two indicators can be supported by policies at the regional level to boost innovation at the firm-level, one can argue that by lowering the trade costs of importing to Austria, foreign high-tech MNEs could be attracted to invest more in firms that are not only participating in the global production networks of MNEs but also stimulate technological spillovers to domestic firms. These policies will also lead to innovation in novel environmental technologies that can support the achievement of SDGs by mitigating climate change and reducing emissions of GHG fundamentally, among other effects.

The study is organised as follows. The next section gives an overview of the existing literature on these issues, while section 3 presents the research methodology. Section 4 then presents the data and section 5 shows some initial descriptive analysis of the most important indicators of FDI and patent activity in Austria. Section 6 presents the extensive econometric analysis, and section 7 then concludes with policy recommendations.

## 2. Literature review

Several theories and models have been developed to explain the factors that determine FDI (Dunning, 1977, 1981; Markusen, 1984, 1997; Ethier, 1986; Ethier and Markusen, 1996; Helpman, 1984, 1985, 2006; Markusen and Venables, 1998, 2000; Carr et al., 2001; Melitz et al., 2004). The main factors found in the literature nowadays are ownership advantages, industrial organisations, agglomeration economics, market size and other country characteristics, cost factors, wage differentials, transport costs, wealth and asset protection, risk factors, industrial and labour disputes and policy variables (Yang, 2000; Resmini, 2000; Braconier and Ekholm, 2002; Faeth, 2009; Kumari and Sharma, 2017).

Both political stability and economic stability can affect inflows of FDI into a country (Schneider and Frey, 1985). However, using the Orbis database and applying a machine-learning technique, Arel-Bundock (2017) finds that political factors are not significantly related to the decision of MNEs to undertake investment abroad, whereas traditional gravity variables play a major role. Bénassy-Quéré et al. (2007) find that the quality of institutions, such as bureaucracy, corruption, transparency of information as well as the banking sector and the legal institutions of the host economy affect inward FDI, independent of GDP per capita. Furthermore, while the quality of institutions in the home economy does not have a significant impact on FDI, the host's convergence to the quality of institutions in the home country may stimulate bilateral FDI.

Empirical evidence of significant factors affecting FDI is relatively mixed in the literature. Market size measured in real GDP, the growth rate of GDP, financial and infrastructural development and trade openness all usually improve inflows of FDI into countries. However, higher corporate tax rates and the appreciation of the real exchange rate and its high volatility may reduce inflows of FDI (Asiedu, 2002; Ang, 2008). For fast-growing and emerging economies natural resources and the quality of institutions may not necessarily affect FDI inflows (Asongu et al., 2018). In addition low wages, a regime's longer stay in office, and secured property and contractual rights are other major drivers of FDI inflows (Biswas, 2002).

Gravity variables, cultural distance factors, relative labour endowments, trade agreements, investment and trade freedom, economic sentiment indicators and trade-restrictive non-tariff measurements are other factors that can significantly affect bilateral inflows of FDI (Bevan and Estrin, 2004; Blonigen and Piger, 2014; Ghodsi, 2020; Cieřlik and Ghodsi, 2021). Using variants of knowledge capital models of multinationals, Egger and Pfaffermayr (2004) find that the ratification of bilateral investment treaties and their implementation have a significant positive impact on bilateral outflows of FDI. Other factors that affect FDI inflows are the inflation rate and interest rates (Çeviř and Çamurdan, 2007), as well as an abundance of skilled labour, which is an important driver of FDI in many developing countries (Hoang et al., 2021). Mistura and Roulet (2019) find that implementing regulatory reforms to reduce the restrictiveness of FDI in a country by 10% would increase stocks of bilateral FDI by 2.1%. Petroulas (2007) also finds that the monetary union and the introduction of the euro raised inward FDI flows in the euro area. Intra-area flows were more strongly affected than inflows from outside the euro area. Hunady and Orviska (2014) find that FDI in the EU member states is not affected by variations in corporate tax across countries, but this is not in line with the findings of Huizinga and Nicodème (2006), who point to a



significant positive relationship between foreign ownership and tax burdens in Europe. However, other factors, such as labour costs, firing costs, public debt, GDP per capita and openness play a major role. These factors were also found to be significant for FDI across the new member states of the EU prior to their accession, according to the analysis of Janicki and Wunnava (2004).

Using the data on FDI from German MNEs, Hubert and Pain (2002) find that tax competitiveness, government fixed investment expenditures in locations with less need for EU structural funds and agglomeration externalities are the major drivers of inflows of FDI in the European Economic Area (EEA). Kurtovic et al. (2016) find that the FDI received from Austria changed the organisation of industries in Bosnia and Herzegovina, which resulted in changes in the labour market and higher wages. Higher wages offered by MNEs may also lead to higher average wages and higher skill sets among employees in the host economy (Becker et al., 2020). Analysing the decision of MNEs to engage in FDI in China and using the Taiwanese information and technology (IT) sector as an example, Lin (2010) finds that network linkages, the expansion of markets and China's incentive policies positively affect the intention to engage in FDI. Larger export-oriented firms also have a greater tendency to engage in FDI.

After the recent global financial crisis, a study by Bellak and Mayer (2010) concluded that Austria, thanks to its economic environment and favourable taxation of companies, has the potential to grow its inward FDI stocks. Using Austrian manufacturing firm-level data, Pfaffermayr and Bellak (2002) find that MNEs are relatively larger than domestically owned firms. Compared with non-MNEs, MNEs enjoy greater productivity, a larger investment to sales ratio, a larger investment to employment ratio, larger exports to both EU member states and non-EU partners, a greater market share in the EU and higher annual growth in employment and sales. Austrian domestic firms, by contrast, have slightly greater labour productivity growth than Austrian firms owned by foreign MNEs, which indicates a catch-up effect and spillovers from MNEs to non-MNEs. But most importantly, what these comparisons suggest is that being a member of a foreign MNE's network increases the profitability and productivity of Austrian firms. Such a network can bring advantages to a firm, e.g. access to firm-specific human capital, information exchange, technology transfer, transfer pricing, etc., which is also in line with other studies in the literature (Desai et al., 2008; Alfaro and Chen, 2012). Moreover, Bellak (2004) argues that the higher performance of Austrian firms owned by MNEs is more robust than the performance of firms that are simply owned by a foreign firm.

The literature is abundant with empirical evidence that FDI in the host economy can also improve economic growth, capital accumulation, human capital, competitiveness, development of the financial sector and technological progress, which in the long run can also stimulate tax revenues (Bayar and Ozturk, 2018; Navaretti and Venables, 2006). Pain and Hubert (2002) find that there are two broad spillovers from foreign ownership of firms in the UK. The direct spillovers improve the performance of the firm acquired or owned by the foreign MNE through knowledge and technology spillovers. Indirect spillovers are referred to in the literature as positive externalities of FDI, which could be due to induced vertical and horizontal demand or supply by MNEs for domestic firms (Javorcik, 2004; Blalock and Gertler, 2008; Rojec and Knell, 2018), or by improving the structure of the market in which MNEs operate (Caves, 1996; Blomström and Kokko, 1998; Gorg and Strobl, 2001; Navaretti and Venables, 2006; Crespo and Fontoura, 2007; Smeets, 2008). These indirect spillovers may also induce innovation through greater competition in the host market (Doan et al., 2015), while Marshall-Arrow-Romer (MAR) spillovers (Marshall, 1890; Arrow, 1971 and Romer, 1986) or Porter's (1990) spillovers to other firms

may induce transfer of know-how and knowledge to other firms that are located in close proximity to these foreign-owned firms, or by the movement of labour from MNEs to non-MNEs (Martins, 2011).

Castellani and Zanfei (2007) find that internationalised firms in the Italian manufacturing sector are more productive and innovative. Foreign-owned firms are more productive than firms involved in exporting activities but not necessarily more innovative. Using Community Innovation Survey (CIS) data, Dachs and Peters (2014) find that product innovation by foreign-owned firms in the EU leads to higher job creation than layoffs, with a net positive impact on employment growth. But this type of growth of employment in foreign-owned firms is smaller than in domestically owned firms. However, using data on firms in Austria, Dachs and Ebersberger (2009) find that foreign ownership does not have a significant impact on innovation input and output, although it may overcome some obstacles related to the innovation process such as financial constraints, technological and market information or organisational problems.

The SDGs and the Paris Agreement's goal of limiting global warming to well below 2° C or preferably 1.5° C should be achieved by 2030, which will require zero-carbon solutions in the economy. While we are approaching this deadline, FDI may stimulate economic growth, which may increase emissions even more as a result of economic integration, as suggested by the literature (Grossman and Krueger, 1991; Porter and Van der Linde, 1995). The pollution haven hypothesis (Selden and Song, 1994; Eskeland and Harrison, 2003) argues that a country which is regulated below the stringency level of other countries' environmental regulations has a comparative advantage in attracting pollution-intensive industries. Grossman and Krueger (1991) claim that development and environmental quality follow an inverted U-curve. Selden and Song (1994) provide seminal evidence that pollution increases in line with the level of income; then, gradually, by addressing the environmental qualities via regulations, new technologies reduce the level of pollution. As the development of such new technologies needs large investments, firms may opt for choosing a location with lax environmental regulations, which entails lower investment costs than what would be needed to develop the new technology at home (Eskeland and Harrison, 2003). In this context, Cole and Elliott (2005) argue that although northern countries are very restrictive with respect to environmental regulative qualities, capital-intensive sectors in the North that are pollution-intensive cannot easily invest in countries in the South because the latter are labour-abundant and do not offer enough capital infrastructure. They test these opposing forces between the pollution haven hypothesis and the capital-labour hypothesis empirically on two pollution haven countries, Mexico and Brazil, and finally show that the US has invested more in capital-intensive sectors that are also more pollution-intensive. Controlling for the endogeneity of environmental regulations and geographical spillovers, Millimet and Roy (2015) find empirical evidence for the fact that states with more stringent environmental regulations across the US attract less FDI. Moreover, this leads to the finding that FDI in developing countries with looser environmental regulations than in developed countries can increase emissions to a greater extent (Hoffmann et al., 2005; Pao and Tsai, 2011; Behera and Dash, 2017; Xu and Li, 2021). However, Li et al. (2019) find no significant impact of FDI on environmental performance at the country level.

By contrast, new technologies, know-how, managerial skills, and technological change brought about by FDI may increase energy and cost efficiencies, introduce new recycling procedures, reduce production waste and emissions, and generally deliver a cleaner and more environment-friendly economy (Pazienza, 2015). In countries with stringent environmental regulations, such as the members of the European Union, firms need to compete in producing low-carbon power and reducing environmental harm (Prag et al., 2018; Ang et al., 2017). Foreign MNEs are usually eager to invest in renewable

energies in countries that support these new energies and their production through external climate-change finance (Hanni et al., 2011). R&D investment by foreign MNEs in such technologies may induce positive spillovers to other firms in a host economy, which may lead to more innovation in environmental technologies.

As reflected in the literature surveyed, the two angles of determinants and consequences of FDI are quite important. However, there is a gap in the literature as far as a comprehensive analysis of these two dimensions of FDI in Austria is concerned. Moreover, the impact of FDI on environmental technologies that leads to a transformation towards a climate-neutral economy and the achievement of climate goals is not well studied in the literature.

Thus, our study undertakes a comprehensive analysis of these two dimensions - determinants and spillovers of FDI - at the firm level. Firm-level analyses are less prone to endogeneity problems than country-level or industrial-level studies, because firms are relatively small and have only a limited effect on macroeconomic outcomes. Consequently, they should produce more precise estimates of the relationships of interest.

In one part of the research we analyse which factors at the three levels of observation - region, industry and firm - determine FDI in firms located in Austria. In the other parts we analyse how different forms of FDI in Austria affect innovation in general, and environmental innovation in particular, at the regional-industrial and firm-level. Furthermore, the impact of different forms of FDI on employment and productivity of domestic firms is also studied. While FDI in Austria may have a direct impact on these variables of interest at a firm that is owned by a foreign MNE, it may also induce positive spillovers to other firms in the same region and industry. Both direct and indirect effects of FDI on firms in Austria will be studied. The direct effect may be more visible in spillovers to regional industries that include both domestic and foreign-owned firms while the indirect effects are through spillovers to domestically owned firms. We also assess the implications of FDI in Austria for the Austrian green economy, aiming to provide concrete policy recommendations for Austria's climate-neutral economy to achieve the SDGs and the targets of the Paris Agreement. Such a policy recommendation is based on the empirical effects of FDI spillovers on innovation in novel environmental technologies at the firm-level in the Austrian economy.

## 3. Methodology

### 3.1 DETERMINANTS OF FDI IN AUSTRIA AT THE FIRM LEVEL: WHAT FACTORS AT THE REGIONAL, SECTOR AND FIRM LEVEL STIMULATE FDI IN AUSTRIA?

This part of the research analyses how the number of GF and BF projects and M&A deals completed by foreign MNEs in Austrian industries each year is influenced by the characteristics of industries, regions, and firms in Austria. A set of regressions is run using the dyadic combination of firms (i.e. subsidiary-GUO dyad) to infer conclusions on firm-level characteristics that can affect an increase in investment in a foreign-owned firm in Austria by the foreign GUO. The estimation equation is as follows:

$$K_{frgjsqt+1} = \exp[\gamma + \gamma_1 S_{ft} + \gamma_2 profit_{ft} + \gamma_3 cl_{ft} + \gamma_4 ncl_{ft} + \gamma_5 cf_{ft} + \gamma_6 \arctan T_{Afst} + \gamma_7 \arctan T_{jAst} + \gamma_8 prod_{st} + \gamma_9 kl_{st} + \gamma_{10} wage_{rst} + \gamma_{11} HHI_{rst} + \gamma_{12} agg_{rst} + \gamma_{13} GDP_{rt} + \gamma_{14} edu_{rt}^{0-2} + \gamma_{15} edu_{rt}^{3-4} + \gamma_{16} RD_{rt} + \gamma_f + \gamma_g + \gamma_{js} + \gamma_{t+1}] \times \varepsilon_{frgjsqt+1} \quad (1)$$

where  $K_{frgjsqt+1}$  is the amount of investment of the subsidiary  $f$  operating in sector  $s$ , in the NUTS 2 region  $r$  in which the Austrian firm operates, in year  $t + 1$  that is owned by GUO  $g$  that operates in sector  $q^2$  in country  $j$ .

The dependent variable  $K_{frgjsqt+1}$  could be either of these five financial FDI measurements:

- 1) total assets of foreign-owned firms located in Austria as a measurement of FDI stocks;
- 2) the number of GF and BF projects;
- 3) GF and BF invested capital;
- 4) the number of M&A deals;
- 5) M&A capital for acquired firms.

$S_{ft}$  is the operating revenue in US dollars of the Austrian subsidiary to control for the size of firms (in logarithmic form);  $profit_{ft}$ ,  $cl_{ft}$ ,  $ncl_{ft}$ ,  $cf_{ft}$  are respectively current profit-loss after tax, current liabilities relative to total assets, non-current liabilities relative to total assets, and cash flow relative to total assets of firm  $f$  in year  $t$  that are used as proxies for financial constraints of the subsidiary. These firm-level variables are included when estimating FDI stocks, number of M&A deals, and capital of M&A deals. For GF and BF projects these firm-level variables are excluded, because GF projects are the first investments in a new project and firm-level variables are not observable at the time of the project initiation.

<sup>2</sup> It is important to note that using firm dyadic data, the sector of activity of the Austrian subsidiary could differ from the sector of activity of the foreign MNE.

$\text{arc} T_{A,jst}$ <sup>3</sup> is the hyperbolic sine transformation of average tariffs imposed by Austria against the imports of six-digit products in sector  $s$  from country  $j$  in year  $t$ ;  $\text{arc} T_{j,Ast}$  is the hyperbolic sine transformation of average tariffs imposed by country  $j$  against the imports of six-digit products from Austria in sector  $s$  in year  $t$ . The reason for using the hyperbolic sine transformation of tariff is due to having zero tariffs and also because the sine transformation gives an asymptotic elasticity, as logarithmic transformation does in regressions (Bellemare and Wichman, 2020). A priori, the tariff-jumping motive – or, in the context of non-tariff measures (NTMs), rather the regulatory barrier-jumping motive – is one of the main determinants of horizontal FDI. This motive is mainly the case for extra-EU inward FDI to Austria, which also suggests that when the cost of bilateral trade from the home to Austria increases, MNEs intend to invest more in Austria as a host of their investment. It should also be noted that the market-seeking factor is one of the major reasons behind horizontal FDI. However, when stages of production are integrated across borders due to efficiency-seeking in vertical FDI to make production cheaper, trade costs have to be sufficiently low, so that the production could be fragmented in several countries. Therefore, for foreign-owned firms in Austria that are heavily participating in the global production networks of MNEs, lower trade costs between Austria and home countries could increase their capital and investment in Austria. Following these two motives behind FDI, one can assume that a higher tariff or ad-valorem equivalent of NTMs in the host country can increase horizontal FDI. However, a negative impact of such trade costs imposed by either home or host country on FDI could indicate the vertical integration of production.

$\text{prod}_{st}$  is the logarithm of labour productivity calculated using the value added in sector  $s$  in year  $t$  in Austria;  $kl_{st}$  is the logarithm of capital to labour intensity in sector  $s$  in year  $t$  in Austria;  $\text{wage}_{rst}$  is the logarithm of average wage per employee in sector  $s$  in region  $r$  in year  $t$  in Austria;  $HHI_{rst}$  is the Herfindahl-Hirschman Index in sector  $s$  in region  $r$  in year  $t$  that is calculated using the sum of the squared market share of Austrian firms in their sectors in their regions, which measures the concentration or diversification of the market in each regional sector in a given year;  $\text{agg}_{rst}$  indicates the agglomeration of employed labour in sector  $s$  in region  $r$  in year  $t$  relative to the total employed labour in that region, which measures MAR or Porter's externalities associated with knowledge spillovers in Austrian sectors (see, e.g. Cieřlik and Ghodsi, 2015);  $GDP_{rt}$  measures the logarithm of GDP of the Austrian region  $r$  in year  $t$ ;  $\text{edu}_{rt}^{0-2}$  measures the share of the population with less than primary and lower secondary education (levels 0-2) relative to all graduates in region  $r$  in year  $t$ ;  $\text{edu}_{rt}^{3-4}$  measures the share of the population with upper secondary and post-secondary non-tertiary education (levels 3-4) relative to all graduates in region  $r$  in year  $t$ ;  $RD_{rt}$  measures gross domestic expenditure on R&D (GERD) in all sectors of activity in the region  $r$  of the Austrian firm.

$\gamma_f$  and  $\gamma_g$  are, respectively, firm fixed effects (FEs) for the Austrian subsidiary and the foreign GUO;  $\gamma_{t+1}$  and  $\gamma_{js}$  are, respectively, time and bilateral sector FEs (sector of subsidiary) that control for multilateral resistance, following the gravity model of trade literature;  $\varepsilon_{frgjsqt+1}$  is the error term that is clustered by bilateral sector.

The dependent variable is denoted with  $t+1$ , while the explanatory variables with  $t$ . The reason for a one year forward of the dependent variable is twofold. First, decisions on FDI are taken for the long term and some policy changes might affect decisions not in the same period but after some time. Second,

<sup>3</sup> In addition to tariffs, the annual ad-valorem equivalent of non-tariff measures that were recently estimated by Adarov and Ghodsi (2021) could also be used here to draw some conclusions regarding their impact on FDI in Austria.

using one lag of the independent variables is a common practice to reduce the reverse causality and control for endogeneity bias in the estimation. In the results shown in the Appendix, we re-do the estimations with contemporaneous values of dependent and explanatory variables.

Since the dependent variable is a count measure including zero values, equation (1) is estimated using the Poisson Pseudo Maximum Likelihood (PPML) method proposed by Silva and Tenreyro (2006) for gravity models (see also Head and Ries, 2008; Head and Mayer, 2014; Larch et al., 2019; Ghodsi, 2020) and incorporated in Stata by Correia et al. (2019a and 2019 b).

### 3.2 DOES FDI IN AUSTRIA INDUCE POSITIVE SPILL-OVERS ON DOMESTIC COMPANIES?

As explored in the literature, it is not only FDI that may improve the performance of a firm owned by a foreign MNE, but FDI may also positively affect these variables in other firms in the sector or in the country in which the foreign-owned firm operates. This is usually referred to as positive spillovers. The literature is lacking empirical evidence of spillovers of FDI to innovation of novel technologies. Therefore, in this part of the research, we study how GF and BF projects and M&A deals completed by foreign MNEs in Austrian industries in each year influence innovation in each Austrian sector. The estimation equation is as follows:

$$P_{srt+1} = \exp[\beta_0 + \beta_{1,ne} \text{arc} P_{g,srt}^{non-env} + \beta_{1,e} \text{arc} P_{g,srt}^{env} + \beta_{1,FDI} k_{rst}^{FDI} + \beta_{1,GF} \text{arc} n, v_{srt}^{GF} + \beta_{1,M\&A} \text{arc} n, v_{srt}^{M\&A} + \beta_2 prod_{srt} + \beta_3 kl_{srt} + \beta_4 wage_{srt} + \beta_5 HHI_{srt} + \beta_6 agg_{srt} + \beta_7 GDPpc_{rt} + \beta_8 edu_{rt}^{3-4} + \beta_9 edu_{rt}^{5-8} + \beta_{10} RD_{rt} + \beta_{10} RDp_{rt} + \omega_{sr} + \omega_{t+1}] \times \varepsilon_{srt+1} \quad (2)$$

where the dependent variable  $P_{srt}$  is a measurement of innovation activity, in the Austrian sector  $s$  in region  $r$  in year  $t$  that is calculated using the number of patents linked to all firms located in each regional industry.

Four measurements of innovation are used:

- 1) number of patents published in all technologies, which includes both granted and still non-granted patents;
- 2) number of granted patents in all technologies;
- 3) number of published patents in environmental technologies (including both granted and still non-granted patents);
- 4) number of granted patents in environmental technologies.

Based on the OECD classification (Haščič and Migotto, 2015) identifying environment-related technologies, patents and innovation related to environmental technologies are separated from non-environmental technologies.

$\text{arc} P_{g,srt}^{non-env}$  is the hyperbolic sine transformation of the number of non-environmental patents (granted or published depending on the dependent variable) owned by the GUO that is investing in sector  $s$  in region  $r$  in year  $t$ ;  $\text{arc} P_{g,srt}^{env}$  is the hyperbolic sine transformation of the number of environmental patents (granted

or published depending on the dependent variable) owned by the GUO that is investing in sector  $s$  in region  $r$  in year  $t$ .

$k_{rst}^{FDI}$  is the total assets of foreign-owned firms in the regional industry;  $\text{arc } n, v_{rst}^{GF}$  is the hyperbolic sine transformation of the number or value of GF and BF projects in Austria in sector  $s$  in region  $r$  in year  $t$ ;  $\text{arc } n, v_{rst}^{M\&A}$  is the hyperbolic sine transformation of the number or value of M&A deals in Austria in sector  $s$  in region  $r$  in year  $t$ .

$GDPpc_{rt}$  is real GDP per capita in the region;  $RDp_{rt}$  is the log of full-time equivalent R&D personnel in all sectors in that region;  $\omega_{sr}$  and  $\omega_t$  are respectively regional sector and year fixed effects;  $\varepsilon_{rst}$  is the error term; and the rest of the variables are defined as above.

To assess the impact of FDI on the performance of domestic firms in Austria, in the third set of estimations we exclude foreign-owned firms from the analysis. This estimation equation is as follows:

$$P_{f,srt+1} = \exp[\delta_0 + \delta_{1,fne} \text{arc } P_{fo,srt}^{non-env} + \delta_{1,fe} \text{arc } P_{fo,srt}^{env} + \delta_{1,gne} \text{arc } P_{g,srt}^{non-env} + \delta_{1,ge} \text{arc } P_{g,srt}^{env} + \delta_{1,FDI} k_{rst}^{FDI} + \delta_{1,GF} \text{arc } n, v_{st-1}^{GF} + \delta_{1,M\&A} \text{arc } n, v_{st}^{M\&A} + \delta_2 prod_{f,srt-1} + \delta_3 kl_{f,srt-1} + \delta_4 wage_{f,srt} + \delta_5 HHI_{rst} + \delta_6 agg_{rst} + \delta_7 GDP_{rt} + \delta_8 edu_{rt} + \beta_9 RD_{rt} + \omega_f + \omega_{sr} + \omega_{t+1}] \times \varepsilon_{f,srt+1} \quad (3)$$

where the dependent variable  $P_{f,srt}$  is one of the four measurements of innovation explained above, for domestically owned firm  $f$  in region  $r$  in sector  $s$  in year  $t$ , plus two additional indicators – the number of employees of the domestically-owned firm, and its productivity, measured as total operating revenues relative to the number of employees. These two variables were not estimated in the model of equation (2) at the regional industry-level because the aggregates at the regional industry include information on both domestic and foreign-owned firms, which causes an endogeneity bias in the estimation. In fact, a larger FDI in a regional industry leads to larger employment in the foreign-owned firms that increase the employment at the regional industry.

$\text{arc } P_{fo,srt}^{non-env}$  is the hyperbolic sine transformation of the number of non-environmental patents (granted or published depending on the dependent variable) owned by foreign-owned firms operating in sector  $s$  in region  $r$  in year  $t$ ;  $\text{arc } P_{fo,srt}^{env}$  is the hyperbolic sine transformation of the number of environmental patents (granted or published depending on the dependent variable) owned by foreign-owned firms that are investing in sector  $s$  in region  $r$  in year  $t$ ;  $\omega_f$ ,  $\omega_{rs}$  and  $\omega_t$  are respectively firm, regional sector, and time FEs; and  $\varepsilon_{f,srt}$  is the error term.

Like in equation (1), the dependent variables in equations (2) and (3) are dated one period after the explanatory variables, to reflect the time lag with which potential spillovers from FDI occur. Again, in the Appendix we show the results with contemporaneous values of dependent and explanatory variables.

Since the dependent variable is a count measurement including zero values when the number of registered patents in a sector in a year is considered, both equations (2) and (3) are estimated using PPML.



## 4. Data

This study is built upon an extensive compilation of data from several sources. A major part of the data is compiled from firm-level databases provided by the Bureau van Dijk (BvD), owned by Moody's Analytics. The Bureau van Dijk microdata have certain limitations such as the fact that they only include published information on transactions and firms' balance sheets. The results of the analysis are obtained considering these limitations in the data. Financial information of firms in Austria and of the GUOs of foreign-owned firms in Austria, such as number of employees, amount of total assets, or operating revenue have been obtained from Orbis data provided by the BvD.

Information on GF and BF projects and M&A deals are from the Orbis Crossborder Investment database, provided by BvD. The data currently available include the period 2008-2017. Using the information available for foreign MNEs and Austrian subsidiaries from these data and from Orbis separately, data on the sector of activity of the MNE and other financial data have also been collected.

It is important to note that the Orbis Crossborder Investment database provides detailed information on investment GF and BF projects and M&A deals. As all the information is available in the compiled data, the analysis takes the form of a firm-to-firm approach, because the data have a headquarter-subsidiary-sector-home-year dimension that yields a rich analysis. Using the BvD identifiers of foreign investors and the investing company, these data are merged with the Orbis data where it is possible to link data on both foreign GUOs and Austrian subsidiaries with all other financial information for both the Austrian subsidiaries and the foreign MNEs.

Data on patents that are linked with firm identifiers are obtained from Amadeus, also provided by BvD. There are about 213,000 patents owned by Austrian firms that are linked with their BvD identifiers. These patents have information on the patent classification that identifies the technology covered by the patent. These patents are also matched with the OECD environmental technology classification (Haščič and Migotto, 2015) to distinguish which innovations are important in achieving the SDGs and the Paris Agreement's climate-neutral economy targets. Haščič and Migotto (2015) define these environmental technologies in six major categories:

- 1- Environmental management
- 2- Water-related adaptation technologies
- 3- Climate change mitigation technologies related to energy generation
- 4- Capture, storage, sequestration or disposal of GHG
- 5- Climate change mitigation technologies related to transportation
- 6- Climate change mitigation technologies related to buildings

These technologies correspond to 1,405 technology classes of the Cooperative Patent Classification (CPC), which in total includes more than 240,000 classes of technologies. Patents owned by the firms in the sample of analysis (i.e. domestic, foreign-owned firms in Austria, and foreign MNEs owning firms in



Austria) are then linked to these environmental technology classes to construct the variables on environmental patents.

Sector-level variables are collected from several sources. Structural Business Statistics provided by Eurostat include information at the regional and sectoral level on wages and employment. Data on capital stocks, employment, gross output and value added at the sector level are also available from EU KLEMS<sup>4</sup> (Stehrer et al., 2019). Annual data on graduates at different levels, such as tertiary education at the country level, are also from Eurostat. Regional and sectoral-level data, such as GDP, tertiary education, employment, wages, R&D expenditure and personnel, also come from Eurostat. The data on import tariffs are collected from Trade Analysis Information System (TRAINS) and the WTO Integrated Database (IDB) provided by World Integrated Trade Solutions (WITS). Data on annual bilateral ad valorem equivalents (AVEs) of NTMs have been taken from Adarov and Ghodsi (2021).

It is important to note that the coverage of some variables is limited to a smaller period and therefore, the sample size differs across specifications. For instance, information on some variables such as capital to labour ratio  $kl_{st}$  is obtained from the EU KLEMS that is bound to year 2017 as an end year. Or the data on GF and BF projects obtained from the Orbis Crossborder Investment database starts from only 2013 onwards. However, the data on M&A deals from the same source is augmented with the M&A data provided by Amadeus that covers years from much earlier. Furthermore, patent data that is obtained from Amadeus is limited to the year 2018 as the end year.

It is important to note that in the Orbis Crossborder Investment database, some foreign MNEs' or GUOs' investments in the form of GF and BF projects is identified with the same BvD firm identifiers as the accounts of the GUO. For instance, in 2018 Apple Inc. announced a GF project and opened a retail store in Vienna. The BvD firm identifier of the investing company is the same as Apple Inc. in the US. Or Deutsche Bahn AG completed a GF project in 2013 to establish a regional headquarters. The established headquarters has the same BvD identifier as the main GUO Deutsche Bahn AG. Therefore, such foreign-owned firms whose total assets are the ones reported by the consolidated accounts of the GUO are excluded from the sample of estimation of total assets in equation (1). Moreover, they are also excluded from the calculation of variables at regional sectors on patents and total assets of foreign-owned firms for the estimation of equations (2) and (3). However, these FDI linkages are included in the models estimating the GF and BF projects in equation (1) and aggregated regional industrial variables on GF and BF projects, M&A deals, and patents of foreign GUOs.

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<sup>4</sup> EU KLEMS stands for EU level analysis of capital (K), labour (L), energy (E), materials (M) and service (S) inputs.

## 5. Descriptive statistics

This part provides a descriptive analysis of the measurements of FDI that we use in this analysis – total assets of foreign-owned companies, number and value of GF and BF projects, and number and value of M&A deals, as well as of the patent activity of foreign-owned and domestic-owned firms in Austria. The analysis is presented over years, by regions and by sectors of activity.

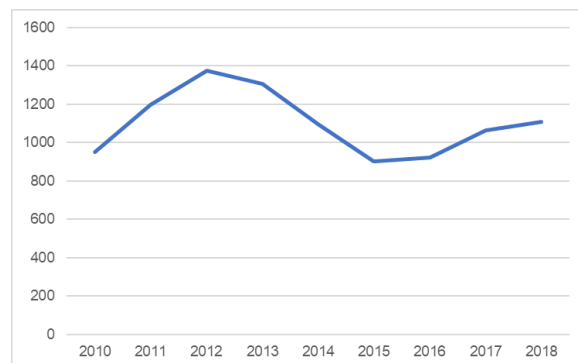
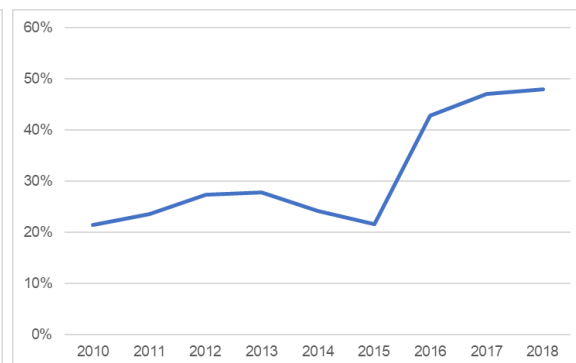
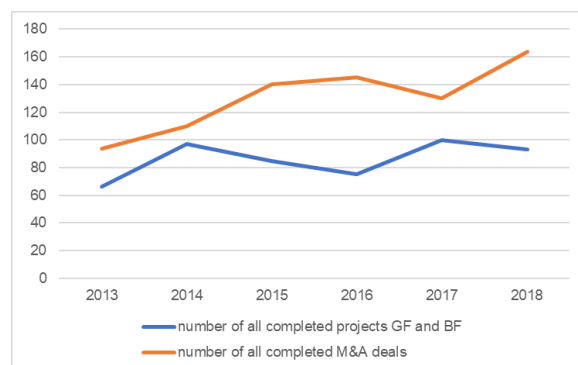
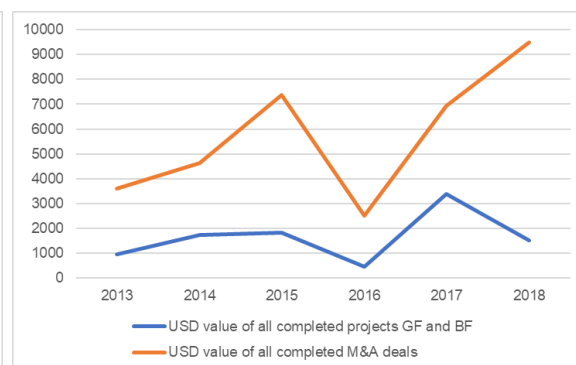
### 5.1 TRENDS OVER TIME

Figures 1-4 present some basic data on FDI in Austria using various measurements between 2010 and 2018, compiled from firm-level data from several data sources provided by the BvD. As can be seen in Figure 1, **total assets possessed by foreign-owned firms** in Austria fluctuate between USD 900 bn and USD 1,400 bn during this period. The peak was reached in 2012, then there was a decline for several years, and during the last years the total assets of foreign-owned firms have been rising once again.

The picture is slightly different when **foreign-owned firms are compared to the total firms in the country**, as can be seen in Figure 2. There is a clear upward trend here - foreign-owned firms possessed slightly less than one half of the total assets of all the firms in Austria in 2017-2018, which is more than double the level from 2010-2011. It is important to note that many mostly small firms with very few employees miss information on total assets in the data, which suggest that the coverage of data is better for larger firms that are also owned by foreign MNEs.

Figure 3 presents the **number of completed GF and BF projects** and the **number of M&A deals** in the country during 2013-2018. One can see that the number of M&A deals is greater than the number of BF and GF deals. In most recent years, there have been around 160 M&A deals, and 100 GF and BF projects. One reason for the greater number of M&A deals is that a single foreign MNE often invests more than once in a year in M&A deals with a single firm or more firms located in Austria. Both series exhibit an upward trend, but not to the extent of total assets.

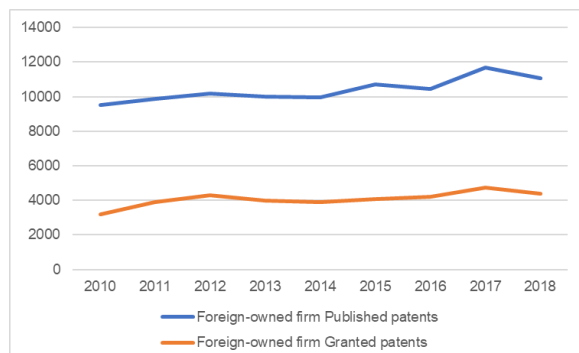
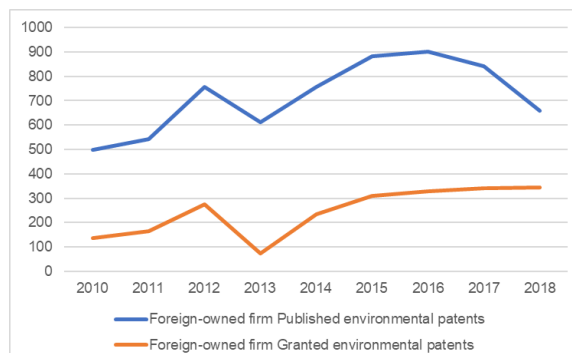
Figure 4 shows the **value of the GF and BF projects** and the **value of the M&A deals** in Austria, and again, one can see that the value of M&A deals is much higher than the value of the BF and GF deals – in 2018, the former exceeded USD 9 bn, while the latter was below USD 2bn. There are some pronounced fluctuations in both series, but they both have an increasing trend, which is especially steep for M&A deals. As the number of M&A deals did not increase that much during the same period, this implies that the average value of M&A deals has been growing over the time. It is however, important to note that the value of the invested capital is often missing for many M&A deals, which is less frequently the case for GF and BF projects.

**Figure 1 / Foreign-owned firms in Austria, total assets (USD bn)****Figure 2 / Foreign-owned firms in Austria, total assets (% of all firms)****Figure 3 / Number of all completed GF and BF projects and M&A deals in Austria****Figure 4 / Value of all completed GF and BF projects and M&A deals in Austria (USD m)**

Source: Orbis

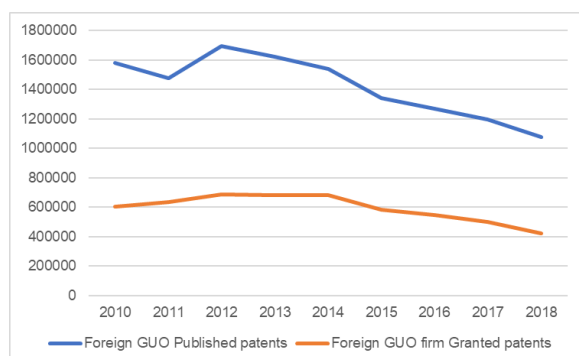
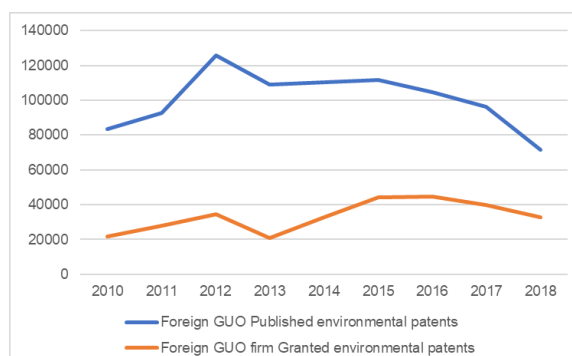
Figures 5 and 6 show some basic information on the patent activity of foreign-owned companies in Austria. The number of **total published patents of all types of technologies**, including patents which are not yet approved (Figure 5) has been in the range of 10,000-12,000 patents per year, with some increasing trend overall. These patents could have been published in any patent office across the world. The number of **granted/approved patents of all types of technologies** during the same period, shown in the same figure, is just around one-third of the total published patents. The trend here is very similar – the number of approved patents increased from around 3,200 in 2010 to 4,400 in 2018.

Figure 6 plots the number of **published patents in environmental technologies** (described above) of foreign-owned firms in Austria, as well as the number of **granted/approved environmental patents**. The numbers of **published environmental patents** fluctuate between 500-900 every year, which is just a small percentage of the total published patents owned by these companies. The trend is similar to total patents – the number of environmental patents is gradually increasing over time. The number of **granted/approved environmental patents** fluctuates between 80-350 per year, which is again a very small fraction of the same companies' total approved patents. The numbers have been growing over the years – from 150 in 2010-2011, to 350 in 2017-2018.

**Figure 5 / Number of published and granted patents of foreign-owned firms in Austria****Figure 6 / Number of published and granted environmental patents of foreign-owned firms in Austria**

Source: Orbis

Figures 7 and 8 show the patent statistics, but for the global ultimate owners (GUO) of foreign-owned companies in Austria. The first thing to note here is that the numbers of **published and granted patents of all types** of technologies (Figure 7) have a downward trend for these companies, implying that the patent activity of GUOs of Austrian foreign-owned companies has been slowing down. The number of **published environmental patents** is also declining (Figure 8), though not to the same extent, because its share in total patents is increasing. On the contrary, the number of approved environmental patents is increasing (Figure 8). All in all, one could say that GUOs of Austrian foreign-owned companies are showing a clear tendency of turning towards environmental patent activity, as opposed to other technologies.

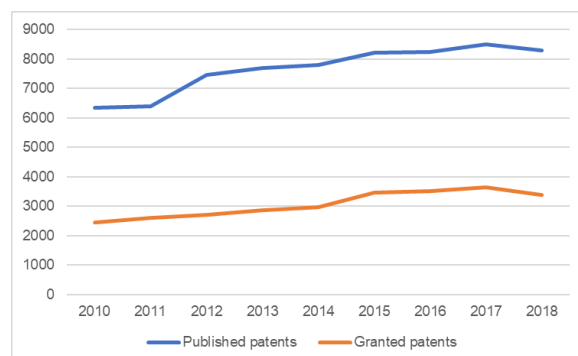
**Figure 7 / Number of published and granted patents by GUO of foreign-owned firms in Austria****Figure 8 / Number of published and granted environmental patents by GUO of foreign-owned firms in Austria**

Source: Orbis

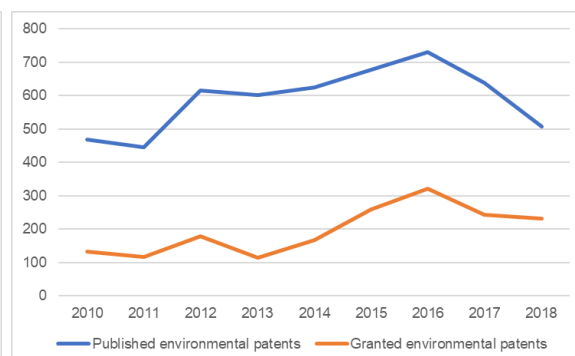
Figures 9 and 10 show patent statistics for domestically owned firms in Austria, and one can see that the picture here is very similar to foreign-owned firms. Numbers of **published and approved patents of all types** of technologies are increasing over time, though only moderately (Figure 9). **Published** patents in environmental technologies fluctuate between 450-700 every year, increasing gradually over time.

Granted patents in environmental technologies are increasing slightly more, from below 150 in 2010-2011 to around 250 in recent years (Figure 10).

**Figure 9 / Number of published and granted patents by domestic-owned firms in Austria**



**Figure 10 / Number of published and granted environmental patents by domestic-owned firms in Austria**



Source: Orbis

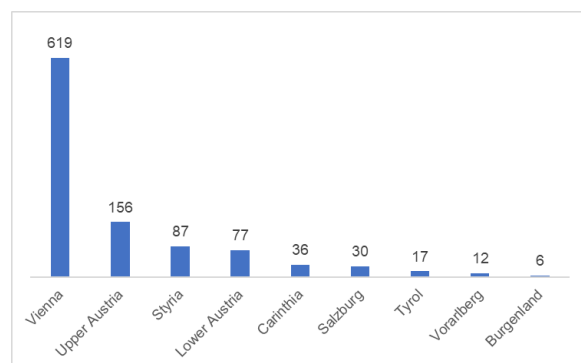
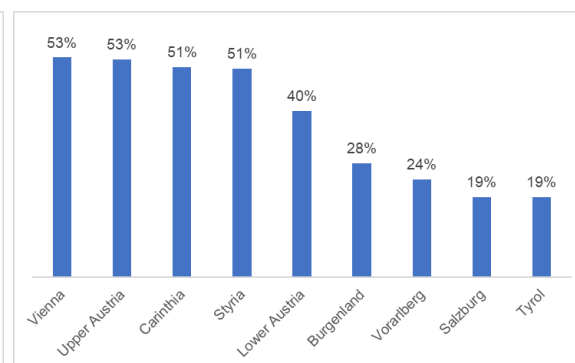
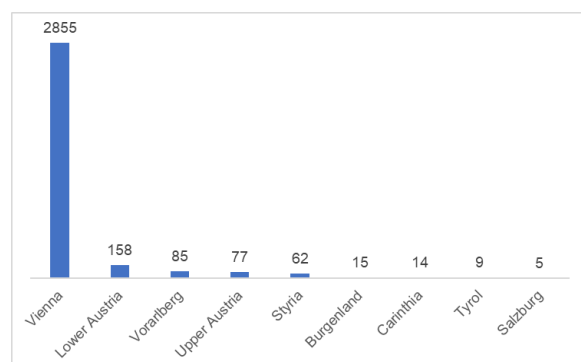
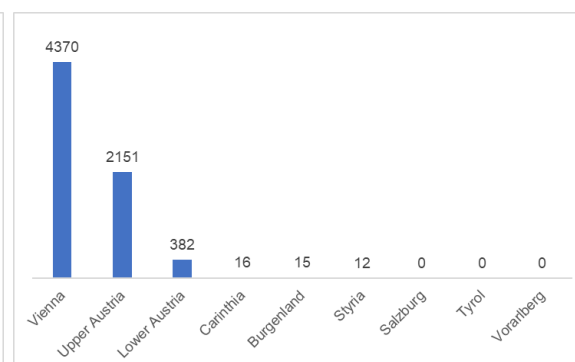
## 5.2 REGIONAL ANALYSIS

The next four figures present the regional distribution of the FDI data that we analyse, for the year 2017 across nine NUTS-2 regions in Austria. Figure 11 shows the distribution of the **total assets of foreign-owned firms** in Austria across these regions in 2017. It can be seen that a large majority of assets are in Vienna – USD 619 bn, or around 60% of total assets. Upper Austria follows with USD 156 bn, while Vorarlberg and Burgenland are last, with USD 12 bn and 6 bn, respectively.

Figure 12 shows the **share of total assets in the region that are foreign owned**. Four regions have a share of foreign firms of around one-half – Vienna, Upper Austria, Carinthia and Styria. In Tyrol and Salzburg, on the other hand, only 19% of firm assets are owned by foreign firms.

Figure 13 presents the regional dispersion of the **value of all completed GF and BF projects** in Austria in 2017. As before, Vienna is first with USD 2.9 bn, or 87% of the GF and BF projects. Lower Austria is second, with USD 160 bn of GF and BF investment, while Tyrol and Salzburg are at the bottom, with less than USD 10 bn of GF and BF investment.

Figure 14 displays the regional dispersion of the **value of all completed M&A deals** in Austria in 2017. Again, Vienna is first with USD 4.4 bn of M&A deals, which is 63% of all the deals in the country. Upper Austria is second, with USD 2.2 bn, or 31% of all the M&A deals. Although Salzburg, Tyrol and Vorarlberg had few M&A deals in 2017 according to Figure 21, the value of investment is missing for these deals.

**Figure 11 / Foreign-owned firms in Austria, by regions, total assets (USD bn, 2017)****Figure 12 / Foreign-owned firms in Austria, by regions, total assets (% of all firms, 2017)****Figure 13 / Value of all completed GF and BF projects in Austria, by regions (USD m, 2017)****Figure 14 / Value of all completed M&A deals in Austria, by regions (USD m, 2017)**

Source: Orbis

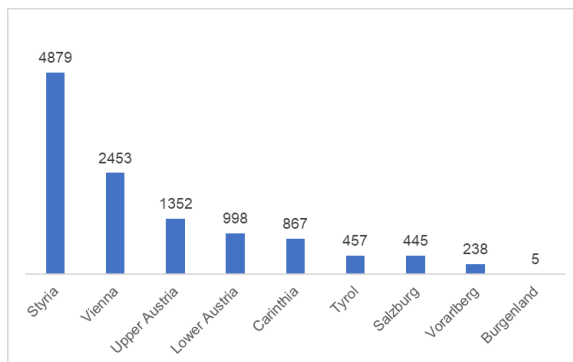
The next four figures present the regional distribution of patent measurements that we employ in the analysis, for 2017. Figure 15 shows the number of **all published patents by foreign-owned firms**, including non-granted patents. Perhaps surprisingly, Styria is first, with 4,900 patents, followed by Vienna, with 2,500. One potential explanation why Vienna is not first here, although it has more foreign-owned companies than the other regions, can be that the patents of these companies are not registered as patents of the Austrian subsidiary, but as patents of the GUO of the company. Burgenland is at the bottom of the list here with just 5 patents.

Figure 16 displays the number of **published environmental patents by foreign-owned firms**, including patents that await approval. Styria is again first, with 288 environmental patents, followed by Carinthia, Tyrol and Upper Austria, which have between 110-160 patents. Vienna had just 73 environmental patents in 2017, the same as Lower Austria. Burgenland and Vorarlberg had no published environmental patents.

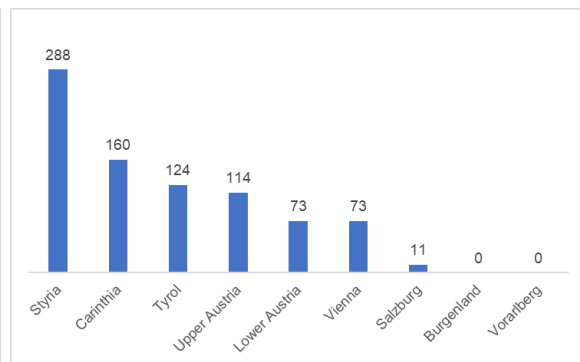
Figure 17 presents the number of **all published patents by domestically owned firms** in Austria, including non-granted patents. The picture here is notably different. Upper Austria is first with 2,000 total domestic patents, while Vorarlberg is second with 1,500 patents. Vienna, Styria and Lower Austria follow, with 1,000-1,300 patents, while Carinthia and Burgenland are at the bottom, with approximately 200 patents each.

Figure 18 shows the number of **published patents in environmental technologies by domestically owned firms**. The picture is again slightly different, as the number one region is Styria, with around 200 domestic environmental patents. Upper Austria and Vorarlberg follow, with approximately 100 patents each, while Vienna and Lower Austria come next, with roughly 70 patents each. Carinthia and Salzburg are the last, with less than 20 environmental patents each.

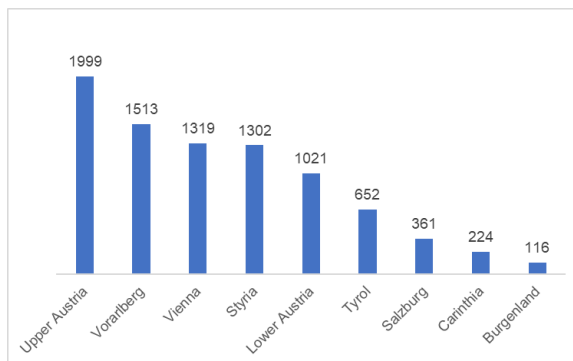
**Figure 15 / Number of published patents of foreign-owned firms in Austria, by region (in 2017)**



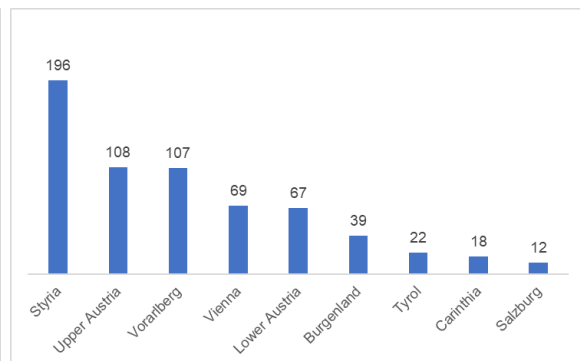
**Figure 16 / Number of published environmental patents of foreign-owned firms in Austria, by region (in 2017)**



**Figure 17 / Number of published patents of domestic-owned firms in Austria, by region (in 2017)**



**Figure 18 / Number of published environmental patents of domestic-owned firms in Austria, by region (in 2017)**



Source: Orbis

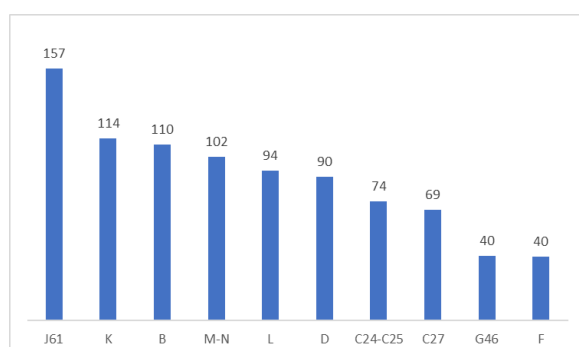
### 5.3 SECTORAL ANALYSIS

Finally, we present the sectoral distribution of the FDI and patent data that we have analysed. For clarity, we present just the top 10 sectors for each of the measurements, where each sector is denoted with its corresponding NACE code. Table A15 in the appendix shows the NACE codes and descriptions for each of the sectors. To make the firm-level data compatible with industry-level data the industry classification from EU KLEMS 2017 is used. Therefore, some sectors are on 1-digit NACE levels while others are on the 2-digit NACE level. All data refer to 2017.

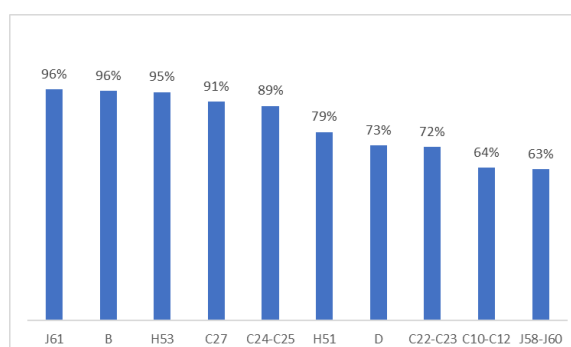
Figure 19 shows the sectoral distribution of the **total assets of foreign-owned firms** in Austria. Sector J61 (Telecommunications) has the largest stock of foreign-owned assets – USD 157 bn. Sector K (Financial and insurance activities) is second, with USD 114 bn in foreign assets. Sector B (Mining and quarrying) is third, with USD 110 bn of foreign-owned assets.

Figure 20 shows the top 10 sectors in terms of the **share of total assets in the sector that are foreign-owned**. Three sectors have foreign ownership of 95-96% of total assets in the sector - J61 (Telecommunications), B (Mining and quarrying) and H53 (Postal and courier activities)<sup>5</sup>. In fact, one can easily state that these important Austrian infrastructural sectors are majority-owned by foreign MNEs, and domestic firms have slightly smaller total assets.

**Figure 19 / Foreign-owned firms in Austria, top 10 sectors, total assets (USD bn, 2017)**



**Figure 20 / Foreign-owned firms in Austria, top 10 sectors, total assets (% of all firms, 2017)**



Source: Orbis

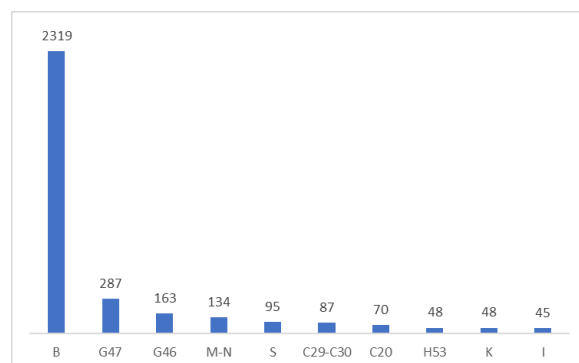
Figure 21 displays the sectoral dispersion of the **value of all completed GF and BF projects**. Sector B (Mining and quarrying) is dominant here, with USD 2.3 bn of greenfield and brownfield investment. G47 (Retail trade, except for motor vehicles and motorcycles) is second, with USD 287m, while G46 (Wholesale trade, except of motor vehicles and motorcycles) is third, with USD 163m. The large activity in the latter two sectors indicates that foreign MNEs invest a lot in these sectors to export and sell their products to the Austrian market, while the former sector indicates foreign MNEs' investment in the mining and quarrying sector to import refined resources from Austria.

<sup>5</sup> Postal and courier services are dominated by Deutsche Post, which is far bigger than Austrian Post.

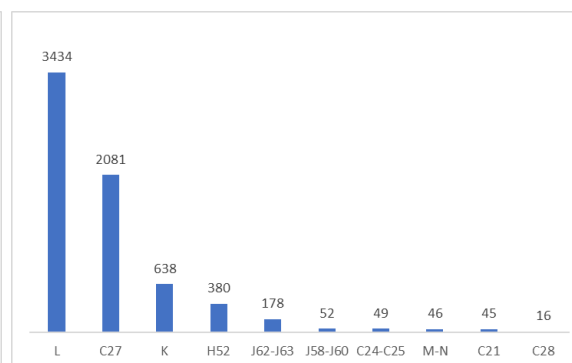


Figure 22 shows the top 10 sectors in terms of the **value of M&A deals**. Sector L (Real estate activities) is on top, with USD 3.4 bn of mergers and acquisitions. C27 (Manufacture of electrical equipment) is second, with M&A deals worth USD 2.1 bn, while K (Financial and insurance activities) is third, with USD 638 m.

**Figure 21/ Value of all completed GF and BF projects in Austria, top 10 sectors (USD m, 2017)**



**Figure 22 / Value of all completed M&A deals in Austria, top 10 sectors (USD m, 2017)**



Source: Orbis

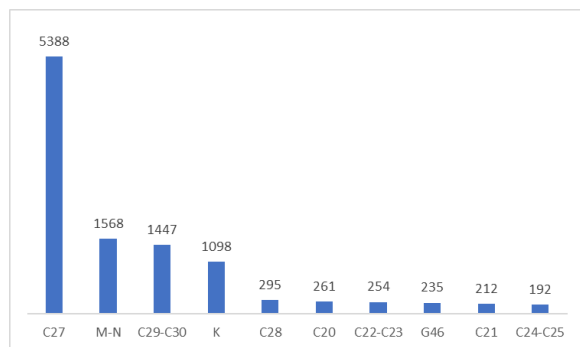
The last four figures present the sectoral distribution of the patent data. The top 10 sectors in terms of the **number of published patents by foreign-owned firms** are shown in Figure 23, and one can see that C27 (Manufacture of electrical equipment) has the highest number of patents at around 5,400. Sectors M and N (Professional, scientific, technical, administrative and support service activities) are second, with 1,600 patents, while C29-C30 (Manufacture of motor vehicles, trailers and semi-trailers, and Manufacture of other transport equipment) is third, with 1,400 patents.

The top 10 sectors according to the number of **published environmental patents by foreign-owned firms** are displayed in Figure 24. Sector C27 (Manufacture of electrical equipment) is first with 399 environmental patents, followed by C28 (Manufacture of machinery and equipment, not classified elsewhere) with 127 patents, and C29-C30 (Manufacture of motor vehicles, trailers and semi-trailers, and Manufacture of other transport equipment) with 103 patents.

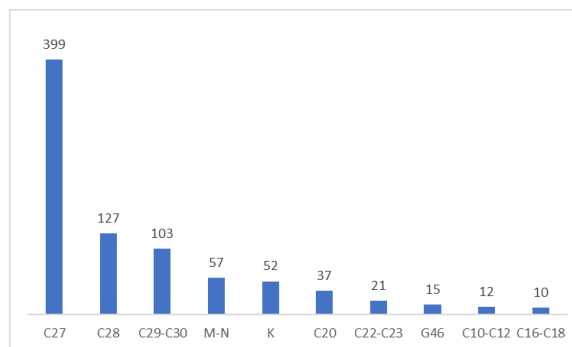
In Figure 25 one can see the top 10 sectors in terms of the **number of total published patents by domestically owned firms**. Sectors M and N (Professional, scientific and technical activities, and Administrative and support service activities) are first with 1,800 total domestic patents, while C27 (Manufacture of electrical equipment) and C29-C30 (Manufacture of motor vehicles, trailers and semi-trailers, and Manufacture of other transport equipment) follow with around 1,300 patents.

Lastly, Figure 26 shows the number of **published environmental patents by domestically-owned firms**. The same sectors as in the case of total patents emerge on top, with a slightly reversed order. C27 (Manufacture of electrical equipment) is first with 127 environmental patents, M and N (Professional, scientific and technical activities, and Administrative and support service activities) are second with 106 environmental patents, while C29-C30 (Manufacture of motor vehicles, trailers and semi-trailers, and Manufacture of other transport equipment) are third with 104 patents.

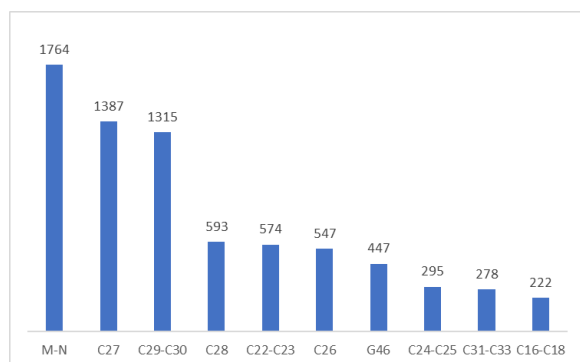
**Figure 23 / Number of published patents of foreign-owned firms in Austria, top 10 sectors (in 2017)**



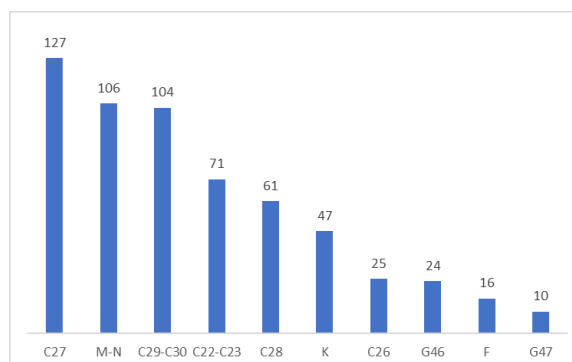
**Figure 24 / Number of published environmental patents of foreign-owned firms in Austria, top 10 sectors (in 2017)**



**Figure 25 / Number of published patents of domestic-owned firms in Austria, top 10 sectors (in 2017)**



**Figure 26 / Number of published environmental patents of domestic-owned firms in Austria, top 10 sectors (in 2017)**



Source: Orbis

## 6. Econometric results

### 6.1 RESULTS FOR THE DETERMINANTS OF FDI IN AUSTRIA

In this part we present the main findings from the econometric analysis of the determinants of FDI in Austria, as outlined by equation (1). As noted in section 3.1, we use five measurements of FDI: 1) total assets of foreign-owned firms located in Austria as a measurement of FDI stocks; 2) the number of GF and BF projects; 3) GF and BF invested capital, 4) the number of M&A deals; and 5) M&A capital of acquired firms. Each of these are presented respectively in Tables 1 through to 5.

Table 1 shows the results for the **total assets of foreign-owned firms in Austria**. There are around 15,000 observations included in the analysis for 1,907 foreign-owned firms in Austria. Column 1 shows the results with all firms' financial indicators, while column 2 shows the results when these indicators are excluded. Columns 3-7 then show the results when only one firm-level indicator is included at a time, to avoid potential collinearity issues. We discuss briefly the factors that turn out to be important.

The effects of tariffs imposed by Austria on the home country in the respective sector and of AVEs of TBTs imposed by the home country on exports from Austria turn out to be insignificant in all columns. However, the impact of tariffs imposed by the home country on Austrian exports is negative and statistically significant at the 10% level. In other words, when tariffs imposed by the home country on imports in a sector from Austria increase by 1%, the stock of FDI in the foreign-owned firm in Austria is reduced by 0.2%. This suggests that the type of FDI with these foreign-owned firms is vertical, because when trade costs from Austria to the home country increase, the foreign MNE is less likely to increase its investment in its Austrian subsidiary. Moreover, the effect of AVEs of TBTs imposed by Austria on imports from the home country is also negative in a statistically significant manner. In fact, a 1% increase in the trade restrictiveness of TBTs imposed by Austria measured in tariff-equivalent leads to a reduction in the total assets of foreign owned firms by 0.23%. This again points to the vertical integration of foreign MNEs in the Austrian economy. In other words, subsidiaries of GUOs in Austria are affected by trade policy imposed at the EU level and also at the Austrian level. It is important to note that single EU members can also impose their own NTMs independently from other EU members or the EU as a single entity. However, because of mutual recognition and harmonisation of regulations and standards, NTMs by single members cannot affect intra-EU trade while they can affect extra-EU trade. Therefore, the results indicate that foreign-owned subsidiaries are invested more when TBTs reduce trade costs as a non-tariff measure (NTM) rather than causing larger trade costs as a non-tariff barrier (NTB). One can argue that these foreign-owned subsidiaries are dependent on imports, and they are heavily participating in global value chains (GVCs) so that barriers to exports to Austria and from Austria can affect their invested capital.

The industry capital to labour ratio is significant and positive in all the columns, meaning that more capital-intensive industries attract more FDI. In other words, when the capital to labour ratio increases by 1% in an Austrian industry, the total assets of foreign owned firms increase by about 2.27% given the results of the first column. This suggests that when there is an overall increase in investment that makes

the capital more intensive in an Austrian sector, the same pattern applies for foreign-owned firms and they also increase their total assets, while their size measured in terms of turnover is controlled for.

The effect of value-added productivity of the industry is found to be negative and significant, in all the columns, implying that industries with lower productivity attract more FDI. When labour productivity in an Austrian sector increases by 1%, the total assets of foreign-owned firms in that sector are reduced by around 1%. One possible explanation for this is that FDI has been directed at industries with lower productivity, thus enabling the foreign-owned firm to compete better with Austrian industry, which also leads to a higher growth potential. Therefore, when productivity in the sector increases, the foreign-owned firm loses its competitive capacity and reduces its invested capital.

The impact of firms' operating revenue appears positive and significant in all the specifications, meaning that the revenues of the firm are an important driver of FDI. One could also interpret this variable as the size of the foreign-owned firm, which suggests that an increase in the size of a firm leads to a larger investment in the next period. The impact of cash flow on total assets is negative and statistically significant at 1%. The result suggests that when cashflow relative to assets of a foreign-owned subsidiary increases by 1%, its total assets in the next year are reduced by 0.35% controlling for profit/loss and liabilities of the firm. The impact of both current and non-current liabilities is statistically insignificant. Finally, profit or loss after tax is found to be positive and significant, implying that if the profit of the foreign-owned firm increases, its total assets should increase in the next period. This means that a company's profitability is an important driver of FDI. However, the impact of other variables on total assets of foreign-owned firms, such as cash flow, are shown to be statistically insignificant.

Controlling for firms' profit-loss, industrial wages increase the total assets of a foreign-owned subsidiary in a statistically significant manner. In other words, FDI is invested more in industries with higher wages while keeping the profit of the company constant. This is mainly because as an advanced economy, Austria attracts investment from other advanced economies for reasons other than efficiency seeking, like high quality of labour. The positive relationship between high wages and FDI stocks in an advanced economy could be better explained by efficiency wage models (Akerlof, 1984; Akerlof and Yellen, 1986). Furthermore, coefficients of HHI are positive and statistically significant in many models, indicating that the total assets of foreign owned firms increase when the concentration of regional industry also increases.

Regional industrial labour agglomeration is also positively related to the stock of FDI in foreign-owned firms, which is statistically significant at 1% in all models. This also indicates that foreign investors are attracted to the regions that are specialised in certain industries. In fact, when the specialisation in a regional sector increases, the stock of FDI in that regional industry also increases due to positive externalities that arise from such an agglomeration. In fact, according to the theories of Marshall-Arrow-Romer (MAR) (Marshall, 1890; Arrow, 1971 and Romer, 1986) or Porter (1990), knowledge spillovers between employees who are working in close proximity benefit industries by attracting more investment and developing faster. Finally, the coefficient of percentage (PC) of the regional population with upper secondary and post-secondary non-tertiary education is positive in a statistically significant manner in many models. This suggests that foreign MNEs are attracted to regions with this level of education rather than a lower level of education (i.e., less than primary and lower secondary education).

**Table 1 / Results of the econometric analysis for the determinants of FDI, for total assets of foreign-owned firms in Austria**

	1	2	3	4	5	6	7
Log of tariffs imposed by host on home in sector s	0.12 (0.13)	0.12 (0.13)	0.12 (0.13)	0.12 (0.13)	0.12 (0.13)	0.12 (0.13)	0.11 (0.13)
Log of tariffs imposed by home on host in sector s	-0.20* (0.12)	-0.21* (0.12)	-0.22* (0.12)	-0.21* (0.12)	-0.22* (0.12)	-0.22* (0.12)	-0.22* (0.12)
Log of AVE of TBTs imposed by host on home in sector s	-0.23*** (0.035)	-0.26*** (0.037)	-0.23*** (0.035)	-0.23*** (0.035)	-0.23*** (0.035)	-0.23*** (0.034)	-0.24*** (0.037)
Log of AVE of TBTs imposed by home on host in sector s	-0.040 (0.032)	-0.053 (0.033)	-0.041 (0.032)	-0.041 (0.032)	-0.041 (0.032)	-0.041 (0.032)	-0.042 (0.033)
Log of Industrial capital to labour ratio nominal m	2.27*** (0.24)	2.24*** (0.25)	2.32*** (0.24)	2.31*** (0.24)	2.32*** (0.24)	2.32*** (0.24)	2.29*** (0.24)
Log of Industrial value-added productivity nominal m	-0.95*** (0.18)	-0.84*** (0.16)	-1.06*** (0.18)	-1.00*** (0.18)	-1.06*** (0.18)	-1.06*** (0.18)	-1.06*** (0.17)
Log of regional industrial wage in EUR	0.36** (0.14)	0.18 (0.16)	0.23 (0.14)	0.21 (0.14)	0.23 (0.15)	0.23 (0.15)	0.33** (0.15)
Regional industrial HHI sum of squared market share of firms	0.31* (0.16)	0.25 (0.21)	0.32* (0.17)	0.33** (0.17)	0.32* (0.17)	0.32* (0.17)	0.29* (0.17)
Labour agglomeration of industry in the region	13.9*** (4.47)	15.4*** (4.23)	14.2*** (4.25)	13.9*** (4.24)	14.2*** (4.27)	14.1*** (4.38)	14.6*** (4.35)
Log of regional GDP in EUR million	0.038 (0.19)	0.026 (0.19)	0.045 (0.18)	0.044 (0.18)	0.045 (0.18)	0.051 (0.18)	0.035 (0.18)
PC of Less than primary and lower secondary education (levels 0-2)	-0.0020 (0.017)	-0.00086 (0.016)	-0.0072 (0.017)	-0.0071 (0.017)	-0.0072 (0.017)	-0.0073 (0.017)	-0.0034 (0.017)
PC of Upper secondary and post-secondary non-tertiary education (levels 3-4)	0.018* (0.0096)	0.027*** (0.0097)	0.017* (0.0094)	0.016* (0.0094)	0.017* (0.0093)	0.017* (0.0093)	0.018* (0.0096)
Log of GERD all sectors in EUR million	0.13 (0.12)	0.18 (0.12)	0.13 (0.11)	0.12 (0.11)	0.13 (0.11)	0.13 (0.12)	0.14 (0.12)
Log of operating revenue of firms in Austria	0.052*** (0.0067)		0.053*** (0.0075)	0.055*** (0.0076)	0.053*** (0.0071)	0.052*** (0.0076)	0.053*** (0.0075)
Log of cash flow relative to total assets of firms in Austria	-0.35*** (0.072)			-0.25*** (0.063)			
Log of current liabilities relative to total assets of firms in Austria	0.065 (0.10)				0.0011 (0.094)		
Log of non-current liabilities relative to total assets of firms in Austria	0.099 (0.085)					0.028 (0.074)	
Log profit-loss after tax	0.0031*** (0.00069)						0.0019*** (0.00063)
Constant	3.18 (2.79)	5.12* (2.95)	5.07* (2.84)	5.12* (2.79)	5.07* (2.81)	5.02* (2.83)	3.89 (2.86)
Observations	14913	14913	14913	14913	14913	14913	14913
Pseudo R-squared	0.975	0.974	0.975	0.975	0.975	0.975	0.975
AIC	5.50162e+11	5.77845e+11	5.55913e+11	5.53694e+11	5.55913e+11	5.55865e+11	5.54345e+11

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

Table 2 shows the results for **greenfield and brownfield projects in Austria**. Since a GF investment project is a form of FDI in a new project, firm-level variables such as turnover, liabilities, profits, and cash flow are not observable at the time the GF project is initiated, but only afterwards. Therefore, including these firm-level variables will exclude all GF initiation projects from the estimation sample. Thus, firm-level variables are excluded from the estimation of the number and value of investment in GF and BF projects. These two estimations are shown in two columns of Table 2. The number of observations is considerably lower now – just 2,292 for the number of projects and 2,274 for the value of projects. This is because the number of greenfield and brownfield projects in Austria was rather low during the analysed period of 2013-2018. As mentioned above, the Orbis cross-border investment data only reports these projects from 2013 onwards.

Trade policy measures do not have any statistically significant impact on GF and BF projects. The industry's capital to labour ratio is positive and significant only in terms of the number of projects, suggesting that FDI in Austria in the form of GF and BF projects is concentrated in more capital-

intensive industries. Larger labour productivity in value added of a sector is associated with a smaller amount of investment value in GF and BF projects, which is similar to what was observed for total assets of foreign-owned firms in Austria. Therefore, foreign MNEs invest more in sectors with lower productivity to be able to compete with local firms less fiercely. More projects take place in regional sectors with a larger agglomeration of labour, while projects with larger investment values are undertaken in regions with a larger GDP. In other words, when the GDP of a region increases by 1%, the amount of investment in GF and BF projects increases by 1.36%. However, the coefficients of other explanatory variables remain statistically insignificant.

**Table 2 / Results of the econometric analysis for the determinants of FDI, for GF and BF investment projects in Austria, number of projects and investment value**

	Number of GF and BF projects	Investment value of GF and BF projects
Log of tariffs imposed by host on home in sector s	1.18 (0.96)	0.42 (1.40)
Log of tariffs imposed by home on host in sector s	-1.83 (1.21)	-2.46 (4.05)
Log of AVE of TBTs imposed by host on home in sector s	0.34 (0.42)	0.33 (0.53)
Log of AVE of TBTs imposed by home on host in sector s	0.15 (0.43)	0.050 (0.68)
Log of Industrial capital to labour ratio nominal m	4.23** (1.95)	-1.22 (3.22)
Log of Industrial value-added productivity nominal m	0.11 (1.51)	-7.65*** (2.72)
Log of regional industrial wage in EUR	0.26 (0.61)	0.13 (2.73)
Regional industrial HHI sum of squared market share of firms	0.21 (0.55)	-0.77 (1.17)
Labour agglomeration of industry in the region	13.4* (7.39)	11.9 (17.2)
Log of regional GDP in EUR million	0.25 (0.42)	1.36* (0.77)
PC of Less than primary and lower secondary education (levels 0-2)	-0.0077 (0.055)	0.037 (0.20)
PC of Upper secondary and post-secondary non-tertiary education (levels 3-4)	-0.024 (0.022)	-0.0026 (0.056)
Log of GERD all sectors in EUR million	0.26 (0.25)	0.16 (0.41)
Constant	-32.1** (15.9)	48.0 (31.1)
Observations	2292	2274
Pseudo R-squared	0.095	0.680
AIC	2275.0	2.15829e+10

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2013-2017.

Table 3 shows the results for the **number of mergers and acquisitions deals**. The number of observations is now even lower than in the greenfield and brownfield investment case – 1,400. These results are slightly different from the previous ones. The only statistically significant coefficients now are the trade policy variables. The coefficients of both tariffs and TBT imposed by the host country on the home country in the respective sector turn out to be statistically significant and negative now, meaning that greater barriers to trade from the home towards Austria lead to a lower number of M&A deals. Since a larger cost of importing to Austria is significantly related to a lower number of M&A deals in Austria, one can argue that these deals are done predominantly with Austrian firms participating in global value chains and in sectors that have smaller import costs. Furthermore, a statistically significant and positive relationship between the cost of trade from Austria to the home of the foreign MNE and a larger number of M&A deals in Austria is evident for both tariffs and TBTs. This indicates that such M&A deals take

place in subsidiaries which benefit from access to the market of MNEs through the investment relationship, as the costs of trade from the host to home increase.

**Table 3 / Results of the econometric analysis for the determinants of FDI, for the number of M&A deals in Austria**

	1	2	3	4	5	6	7
Log of tariffs imposed by host on home in sector s	-1.96*** (0.74)	-2.07*** (0.77)	-2.07*** (0.77)	-2.07*** (0.77)	-2.04*** (0.75)	-2.05*** (0.76)	-2.00*** (0.76)
Log of tariffs imposed by home on host in sector s	2.31*** (0.76)	2.45*** (0.76)	2.44*** (0.77)	2.45*** (0.76)	2.40*** (0.75)	2.43*** (0.76)	2.37*** (0.75)
Log of AVE of TBTs imposed by host on home in sector s	-2.49*** (0.76)	-2.43*** (0.70)	-2.47*** (0.70)	-2.46*** (0.70)	-2.58*** (0.76)	-2.44*** (0.70)	-2.40*** (0.71)
Log of AVE of TBTs imposed by home on host in sector s	1.10*** (0.38)	1.14*** (0.38)	1.15*** (0.38)	1.15*** (0.38)	1.15*** (0.38)	1.15*** (0.37)	1.09*** (0.37)
Log of Industrial capital to labour ratio nominal m	2.42 (1.90)	3.01 (1.88)	2.84 (1.88)	2.85 (1.88)	2.65 (1.89)	2.73 (1.87)	2.68 (1.89)
Log of Industrial value-added productivity nominal m	-3.14 (2.15)	-2.71 (2.19)	-2.81 (2.16)	-2.79 (2.16)	-3.09 (2.14)	-2.81 (2.16)	-2.84 (2.17)
Log of regional industrial wage in EUR	1.63 (1.43)	1.62 (1.49)	1.63 (1.46)	1.63 (1.46)	1.66 (1.46)	1.67 (1.46)	1.57 (1.43)
Regional industrial HHI sum of squared market share of firms	0.99 (0.97)	0.66 (0.90)	0.82 (0.95)	0.82 (0.95)	0.97 (0.97)	0.82 (0.94)	0.85 (0.96)
Labour agglomeration of industry in the region	83.6 (61.0)	88.2 (58.8)	90.5 (59.7)	90.2 (59.7)	89.7 (60.0)	83.2 (60.2)	88.6 (59.5)
Log of regional GDP in EUR million	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
PC of Less than primary and lower secondary education (levels 0-2)	-0.0091 (0.14)	-0.0013 (0.14)	-0.0010 (0.14)	-0.00056 (0.14)	0.0045 (0.14)	0.0049 (0.14)	-0.016 (0.14)
PC of Upper secondary and post-secondary non-tertiary education (levels 3-4)	0.072 (0.10)	0.054 (0.10)	0.070 (0.10)	0.071 (0.10)	0.073 (0.10)	0.075 (0.10)	0.069 (0.10)
Log of GERD all sectors in EUR million	-0.20 (1.75)	-0.26 (1.73)	-0.31 (1.73)	-0.34 (1.75)	-0.24 (1.72)	-0.41 (1.73)	-0.26 (1.72)
Log of operating revenue of firms in Austria	-0.054 (0.044)		-0.071 (0.045)	-0.069 (0.049)	-0.055 (0.039)	-0.065 (0.051)	-0.067 (0.044)
Log of cash flow relative to total assets of firms in Austria	0.14 (0.31)			-0.059 (0.25)			
Log of current liabilities relative to total assets of firms in Austria	-0.90 (0.61)				-1.01* (0.61)		
Log of non-current liabilities relative to total assets of firms in Austria	0.21 (0.30)					0.30 (0.25)	
Log profit-loss after tax	-0.0050 (0.0064)						-0.0049 (0.0059)
Constant	-21.4 (24.4)	-26.9 (25.0)	-24.7 (24.6)	-24.7 (24.6)	-23.5 (24.6)	-24.2 (24.7)	-23.1 (24.5)
Observations	1397	1397	1397	1397	1397	1397	1397
Pseudo R-squared	0.113	0.109	0.111	0.111	0.113	0.111	0.111
AIC	1363.4	1359.6	1359.3	1361.3	1358.4	1360.4	1360.6

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

Table 4 shows the results for the investment **value of mergers and acquisitions deals**. In general, there are many M&A deals with missing information on the value of investment, which leads to a much smaller number of observations in this sample. The impact of trade policy variables remains similar to that of the specification with the number of M&A projects, yielding support to the finding that M&A projects in Austria are mainly done with importing firms that are participating in global value chains. However, the effects are now evident in a less significant manner. There are some other interesting new findings. The impact of wages in the regional sector appears to be positive and statistically significant now. This indicates that larger capital is merged or acquired via M&A deals in Austria in regional industries with higher wages. Efficiency wage models (Akerlof, 1984; Akerlof and Yellen, 1986) explain better how MNEs target firms within industries with higher wages. Similarly, the impact of the regional share of workers with less than primary and lower secondary education on the investment value of M&A



deals is negative and significant now, implying that regions with workers with a lower level of education are less attractive for M&A deals. However, the impact of government R&D expenditure on the value of investment in M&A deals turns out to be statistically significant and negative, suggesting a potential crowding-out effect of public expenditure on R&D and value of investment in M&A deals in Austria. Put differently, if the government spends more on R&D, less Austrian firms will be acquired or merged with foreign MNEs.

**Table 4 / Results of the econometric analysis for the determinants of FDI, for the investment value of M&A deals in Austria**

	1	2	3	4	5	6	7
Log of tariffs imposed by host on home in sector s	-5.27 (8.46)	-14.8* (8.89)	-18.6* (9.96)	-17.4* (9.78)	-14.7 (.)	-11.0 (8.58)	-16.3* (8.89)
Log of tariffs imposed by home on host in sector s	1.29 (4.39)	4.19 (3.87)	4.26 (4.42)	4.21 (4.10)	3.84 (.)	2.66 (4.15)	3.66 (4.52)
Log of AVE of TBTs imposed by host on home in sector s	-5.66** (2.45)	-2.19 (1.52)	-2.28 (1.58)	-2.46 (1.55)	-5.42 (.)	-4.28** (1.77)	-2.14 (1.61)
Log of AVE of TBTs imposed by home on host in sector s	1.55 (1.89)	2.05 (1.78)	2.26 (2.06)	2.31 (1.87)	2.72 (.)	1.93 (1.83)	1.91 (2.13)
Log of Industrial capital to labour ratio nominal m	-2.86 (5.10)	-5.93 (7.44)	-7.39 (6.89)	-6.76 (6.78)	-7.78 (.)	-3.43 (5.29)	-6.82 (6.20)
Log of Industrial value-added productivity nominal m	4.58 (5.11)	0.31 (5.54)	4.40 (5.80)	5.13 (5.22)	6.41 (.)	3.58 (5.21)	3.90 (5.63)
Log of regional industrial wage in EUR	15.8*** (5.30)	13.7*** (5.41)	14.6** (6.37)	14.5** (5.79)	13.6 (.)	16.5*** (5.37)	16.7** (7.54)
Regional industrial HHI sum of squared market share of firms	-6.32 (4.59)	-6.81* (3.96)	-8.71* (4.45)	-8.83* (4.60)	-6.71 (.)	-6.91 (4.30)	-8.73** (4.38)
Labour agglomeration of industry in the region	53.0 (280.7)	-6.91 (250.7)	75.8 (248.9)	165.5 (253.3)	173.3 (.)	-111.4 (240.1)	93.4 (251.8)
Log of regional GDP in EUR million	31.1 (38.5)	0.78 (25.6)	8.01 (28.0)	-0.21 (31.2)	37.4 (.)	20.4 (28.8)	9.46 (29.4)
PC of Less than primary and lower secondary education (levels 0-2)	-1.93*** (0.51)	-1.59*** (0.42)	-1.80*** (0.46)	-1.92*** (0.47)	-1.96 (.)	-1.87*** (0.45)	-1.79*** (0.45)
PC of Upper secondary and post-secondary non-tertiary education (levels 3-4)	-0.095 (0.34)	-0.16 (0.30)	-0.052 (0.31)	-0.034 (0.28)	0.035 (.)	-0.19 (0.30)	-0.026 (0.31)
Log of GERD all sectors in EUR million	-11.9* (6.92)	-9.53* (5.25)	-9.69* (5.80)	-9.83* (5.63)	-10.4 (.)	-11.3** (5.61)	-10.8 (6.68)
Log of operating revenue of firms in Austria	-0.23 (0.14)		-0.30** (0.15)	-0.30** (0.15)	-0.22 (.)	-0.26** (0.13)	-0.32** (0.16)
Log of cash flow relative to total assets of firms in Austria	-5.00 (3.25)			-6.25* (3.61)			
Log of current liabilities relative to total assets of firms in Austria	-4.05 (3.07)				-6.62 (.)		
Log of non-current liabilities relative to total assets of firms in Austria	3.46 (2.29)					4.87** (2.03)	
Log profit-loss after tax	0.011 (0.018)						0.015 (0.021)
Constant	-393.1 (447.8)	18.1 (306.9)	-87.7 (340.1)	2.95 (365.6)	-434.5 (.)	-259.1 (339.5)	-122.6 (363.2)
Observations	554	554	554	554	554	554	554
Pseudo R-squared	0.692	0.636	0.658	0.672	0.675	0.677	0.660
AIC	4.638e+10	5.476e+10	5.147e+10	4.940e+10	4.889e+10	4.868e+10	5.123e+10

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

To **summarise** the findings for the determinants of FDI in Austria:

- › Trade cost is a major driver of FDI in Austria, in line with the existing literature (Blonigen and Piger, 2014; Ghodsi, 2020). The decisions of foreign investors to pursue M&A deals and invest assets in Austria are driven by trade policy measures imposed at the EU level or independently by Austria on Austrian imports and by other trading partners on Austrian exports. Tariffs are less important for the total assets of foreign-owned subsidiaries. However, trade costs related to the TBTs imposed by the EU or by Austria reduce the total assets of foreign-owned subsidiaries, and the value and number of



M&A deals. Tariffs imposed at the EU level also reduce the value and number of M&A deals in Austria. This could suggest that these subsidiaries and such deals are mostly with importing Austrian firms that are participating heavily in global value chains, whose imports are operating better with lower trade costs to Austria. However, the opposite is the case for the cost of trade from Austria to the home of the MNE for both trade policy measures for M&A deals. This could additionally suggest that such M&A deals are done with Austrian firms that are participating in global value chains, whose exports are hampered by larger barriers to the home of the MNEs. However, BF and GF projects are not affected by either tariffs or technical barriers to trade imposed by Austria or faced by Austrian exports.

- › The impact of the capital to labour ratio is positive, meaning that FDI in Austria occurs primarily in more capital-intensive industries.
- › The impact of firm revenues and profitability on FDI are important and positive, meaning that the accumulation of stock of foreign investment in Austria in the form of total assets of foreign-owned firms is driven by their higher revenues and profits.
- › Government R&D expenditure crowds out M&A deals in Austria. In other words, if the government spends more on R&D, fewer Austrian firms will be acquired or merged with foreign MNEs.
- › Sectors with lower labour productivity are found to have larger investment values in GF and BF projects and larger total assets of foreign-owned firms. This suggests that FDI in Austria has occurred mainly in sectors and regions which have lower productivity, which could be translated in enabling foreign MNEs to compete more easily with Austrian firms.
- › Regional GDP has a positive impact on FDI in some cases, which indicates demand-driven FDI in Austria. This is in accordance with the existing literature, which usually finds GDP to be a significant determinant of FDI (Bevan and Estrin, 2004, Janicki and Wunnava, 2004, Blonigen and Piger 2014).
- › Higher wages in regional industries are associated with larger values of investment in M&A deals and larger total assets in foreign-owned firms, which is in line with the theories of efficiency wage models (Akerlof, 1984; Akerlof and Yellen, 1986).
- › Regions with a higher share of population with upper secondary and post-secondary non-tertiary education have large total assets.
- › The stock of FDI in foreign-owned firms increases with externalities associated with agglomeration and specialisation of regional industries (Hubert and Pain, 2002).

## 6.2 RESULTS FOR FDI TECHNOLOGICAL SPILLOVERS AT THE REGIONAL INDUSTRY

We next present the results of the econometric analysis of technological spillovers from FDI, at the level of regional sectors. These are basically the results of the estimation of equation (2) from section 3.2. Tables 5-8 present these results, where each of the tables corresponds to a different type of patent – i.e. total granted patents, total published patents (including non-granted), granted environmental patents, and total published environmental patents (including non-granted). For each type of patent, 8 different specifications are shown, based on different definitions and combinations of the FDI variables. In the interpretation of the results, we focus primarily on the patent and FDI variables, since our main interest lies in establishing whether the presence and patents of foreign companies and their subsidiaries in Austria lead to spillovers to local companies. The aggregated variables at the regional industry level

include both domestic and foreign-owned firms. Therefore, the number of patents owned by foreign-owned firms is not included as an explanatory variable.

Table 5 shows the results for **total granted patents at the regional industrial level**. One can see that there are positive spillovers from FDI – the coefficient of the number of granted environmental patents by foreign MNEs or GUOs that have invested in the respective regional sector is positive and significant. Similarly, the impact of total assets of foreign-owned firms in Austria is also positive and significant, as well as that of the value of brownfield and greenfield investment projects. On the other hand, the impact of the number of M&A deals is found to be negative for patent activity in a regional sector, which implies that mergers and acquisitions do not stimulate innovation in local firms. This suggests that technological spillovers from abroad to Austrian regional industries that lead to novel innovation, and which in the end receive allowances from patent offices, can be transmitted through GF and BF projects, accumulation of total assets in foreign-owned firms and granted patents in environmental technologies.

**Table 5 / Results of the econometric analysis for the FDI spill-overs, for regional sectors, for granted patents of all type**

	1	2	3	4	5	6	7	8
Log Number of granted non-environmental patents by GUOs investing in RS	-0.041 (0.046)	-0.045 (0.045)	-0.033 (0.046)	-0.038 (0.045)	-0.045 (0.046)	-0.045 (0.045)	-0.034 (0.045)	-0.040 (0.046)
Log Number of granted environmental patents by GUOs investing in RS	0.10* (0.060)	0.12* (0.060)	0.088 (0.058)	0.10* (0.058)	0.11* (0.060)	0.12* (0.060)	0.100* (0.059)	0.100* (0.058)
Log VA productivity in number of employees in thousands	-0.16 (0.61)	-0.16 (0.63)	-0.14 (0.61)	-0.11 (0.63)	-0.11 (0.62)	-0.16 (0.63)	-0.11 (0.62)	-0.094 (0.62)
Log Real capital to labour ratio	1.40*** (0.36)	0.95** (0.40)	1.33*** (0.38)	0.92** (0.43)	0.97** (0.40)	0.95** (0.40)	0.92** (0.43)	0.91** (0.43)
Log of wage in RS	0.46 (0.53)	0.45 (0.55)	0.34 (0.52)	0.32 (0.54)	0.42 (0.54)	0.45 (0.55)	0.32 (0.54)	0.31 (0.53)
Log of GDP per capita in region in EUR	5.13** (2.14)	5.51** (2.30)	5.16** (2.17)	5.74** (2.35)	5.47** (2.32)	5.51** (2.30)	5.64** (2.35)	5.63** (2.34)
Log of total regional fund	0.037 (0.064)	0.019 (0.064)	0.040 (0.064)	0.024 (0.066)	0.025 (0.067)	0.019 (0.064)	0.030 (0.066)	0.022 (0.067)
PC of 25-64 Tertiary education (levels 5-8)	0.060 (0.044)	0.055 (0.046)	0.061 (0.044)	0.054 (0.046)	0.050 (0.045)	0.055 (0.046)	0.051 (0.046)	0.052 (0.045)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.066* (0.038)	0.061 (0.040)	0.064* (0.038)	0.060 (0.040)	0.063 (0.040)	0.061 (0.040)	0.055 (0.040)	0.065* (0.039)
Log of Full-time equivalent R&D personnel in all sectors	-2.97*** (1.13)	-3.54*** (1.20)	-2.94** (1.14)	-3.49*** (1.19)	-3.48*** (1.19)	-3.54*** (1.20)	-3.59*** (1.20)	-3.37*** (1.19)
Log of GERD all sectors in EUR million	0.80 (0.92)	1.00 (0.96)	0.66 (0.93)	0.88 (0.96)	0.99 (0.95)	1.00 (0.96)	0.95 (0.97)	0.81 (0.94)
Agglomeration of labour in regional industry relative to region	46.9*** (17.5)	40.3** (18.2)	46.0*** (17.5)	41.1** (18.4)	37.7** (18.4)	40.3** (18.2)	36.5** (18.2)	40.9** (18.5)
HHI of firm's sales in the regional industry	-0.27* (0.14)	-0.26* (0.14)	-0.22 (0.14)	-0.22 (0.14)	-0.28* (0.15)	-0.26* (0.14)	-0.22 (0.14)	-0.24* (0.14)
Log of foreign-owned total assets in RS as FDI stock	0.014* (0.0080)	0.014* (0.0082)			0.014* (0.0081)	0.014* (0.0082)		
Number of M&A deals in RS	-0.17*** (0.047)		-0.17*** (0.048)					
Log Number of GF or BF projects in RS	0.067 (0.062)			0.061 (0.061)				
Log of USD value of all completed projects GF and BF in RS					0.0100** (0.0047)			0.0095** (0.0047)
Log value of M&A deals in RS					-0.0061 (0.0055)		-0.0067 (0.0054)	
Constant	-60.5*** (22.7)	-54.2** (23.7)	-57.7** (22.7)	-55.0** (24.0)	-54.9** (23.8)	-54.2** (23.7)	-52.9** (23.9)	-54.4** (24.0)
Observations	1634	1634	1634	1634	1634	1634	1634	1634
Pseudo R-squared	0.773	0.771	0.773	0.771	0.772	0.771	0.771	0.771
AIC	7402.7	7464.9	7415.7	7476.6	7449.5	7464.9	7472.3	7467.0

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

Table 6 shows the results for **all published patents, including non-granted patents at the regional industrial level**. There is an interesting difference here – the spillovers from the number of non-environmental patents published by foreign GUOs investing in the respective region and sector are found to be negative now. This implies that spillovers of FDI to non-granted patents are negative, differently from spillovers to granted patents. Furthermore, other variables of FDI do not have any statistically significant coefficient, which implies that FDI has only positive spillovers to novel technologies that receive allowances on granting from patent offices.

**Table 6 / Results of the econometric analysis for the FDI spillovers, for regional sectors, for all published patents (including non-granted)**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.056** (0.025)	-0.057** (0.025)	-0.058** (0.025)	-0.056** (0.025)	-0.059** (0.025)	-0.057** (0.025)	-0.058** (0.025)	-0.058** (0.025)
Log Number of environmental patents published by foreign GUO investing in RS	0.023 (0.019)	0.021 (0.019)	0.022 (0.019)	0.022 (0.019)	0.020 (0.019)	0.021 (0.019)	0.021 (0.019)	0.020 (0.019)
Log VA productivity in number of employees in thousands	-0.49* (0.25)	-0.49* (0.25)	-0.48* (0.25)	-0.50** (0.25)	-0.49* (0.25)	-0.49* (0.25)	-0.49* (0.25)	-0.49* (0.25)
Log Real capital to labour ratio	0.60*** (0.20)	0.65*** (0.18)	0.60*** (0.20)	0.64*** (0.18)	0.64*** (0.18)	0.65*** (0.18)	0.64*** (0.18)	0.65*** (0.18)
Log of wage in RS	-0.19 (0.19)	-0.19 (0.19)	-0.19 (0.19)	-0.19 (0.19)	-0.18 (0.19)	-0.19 (0.19)	-0.18 (0.19)	-0.19 (0.19)
Log of GDP per capita in region in EUR	0.064 (1.10)	0.11 (1.10)	0.15 (1.10)	0.025 (1.10)	0.11 (1.09)	0.11 (1.10)	0.099 (1.10)	0.14 (1.09)
Log of total regional fund	-0.040 (0.034)	-0.038 (0.035)	-0.040 (0.034)	-0.038 (0.034)	-0.038 (0.035)	-0.038 (0.035)	-0.039 (0.034)	-0.037 (0.035)
PC of 25-64 Tertiary education (levels 5-8)	0.024 (0.022)	0.024 (0.021)	0.023 (0.021)	0.025 (0.022)	0.025 (0.022)	0.024 (0.021)	0.025 (0.022)	0.024 (0.021)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.0041 (0.020)	0.0048 (0.020)	0.0043 (0.020)	0.0046 (0.020)	0.0068 (0.020)	0.0048 (0.020)	0.0060 (0.020)	0.0054 (0.020)
Log of Full-time equivalent R&D personnel in all sectors	0.099 (0.63)	0.14 (0.63)	0.093 (0.63)	0.15 (0.63)	0.20 (0.63)	0.14 (0.63)	0.18 (0.64)	0.16 (0.63)
Log of GERD all sectors in EUR million	0.13 (0.49)	0.14 (0.50)	0.15 (0.50)	0.12 (0.50)	0.099 (0.50)	0.14 (0.50)	0.11 (0.50)	0.13 (0.50)
Agglomeration of labour in regional industry relative to region	49.5*** (8.95)	51.1*** (9.20)	50.3*** (9.25)	50.3*** (8.76)	52.1*** (9.28)	51.1*** (9.20)	51.9*** (9.17)	51.3*** (9.16)
HHI of firm's sales in the regional industry	0.028 (0.068)	0.025 (0.068)	0.024 (0.065)	0.029 (0.065)	0.025 (0.068)	0.025 (0.068)	0.028 (0.065)	0.024 (0.065)
Log of foreign-owned total assets in RS as FDI stock	-0.00022 (0.0038)	0.00017 (0.0038)			0.00032 (0.0038)	0.00017 (0.0038)		
Number of M&A deals in RS	0.032 (0.028)		0.033 (0.027)					
Log Number of GF or BF projects in RS	-0.038 (0.039)			-0.040 (0.039)				
Log of USD value of all completed projects GF and BF in RS					0.0019 (0.0031)			0.0018 (0.0031)
Log value of M&A deals in RS					0.0027 (0.0026)		0.0027 (0.0026)	
Constant	1.79 (10.5)	-0.038 (10.6)	0.63 (10.6)	1.20 (10.5)	-0.37 (10.5)	-0.038 (10.6)	-0.0010 (10.6)	-0.43 (10.5)
Observations	3234	3234	3234	3234	3234	3234	3234	3234
Pseudo R-squared	0.927	0.927	0.927	0.927	0.927	0.927	0.927	0.927
AIC	26271.4	26315.6	26285.1	26295.8	26294.8	26315.6	26297.3	26309.7

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

Table 7 shows the results for **granted environmental patents at the regional industrial level**. There seem to be mixed spillovers from FDI to granted environmental patents in Austrian regional industries. The number of granted **non-environmental patents** by GUOs investing in the respective sector and region is found to be negative, while the number of granted **environmental patents** by GUOs is found to be positive. This is an interesting finding, as it implies that there is complementarity between

environmental patents by foreign and local companies, but substitution between foreign non-environmental patents and local environmental patents. It was observed in Table 5 that successful granted patents owned by foreign MNEs in environmental technologies also had a positive impact on successful granted patents in regional industries in all technological classes. However, this impact is much more robust and significant for granted patents in environmental technology classes in Austrian regional industries. This is the first empirical evidence that FDI in Austria successfully transmits technology to Austrian regional industries from abroad in the environmental technologies classes. In fact, a 1% increase in the number of novel environmental technologies (i.e. those that are granted) owned by foreign MNEs that invest in Austria leads to a 0.3% increase in the number of novel environmental technologies in Austrian regional industries.

**Table 7 / Results of the econometric analysis for FDI spillovers, for regional sectors, for granted environmental patents**

	1	2	3	4	5	6	7	8
Log Number of granted non-environmental patents by GUOs investing in RS	-0.12* (0.072)	-0.13* (0.072)	-0.13* (0.072)	-0.13* (0.072)	-0.13* (0.072)	-0.13* (0.072)	-0.13* (0.072)	-0.13* (0.072)
Log Number of granted environmental patents by GUOs investing in RS	0.30*** (0.074)	0.31*** (0.074)	0.30*** (0.073)	0.31*** (0.073)	0.31*** (0.073)	0.31*** (0.074)	0.31*** (0.073)	0.31*** (0.074)
Log VA productivity in number of employees in thousands	0.75 (0.90)	0.77 (0.91)	0.75 (0.90)	0.77 (0.91)	0.76 (0.92)	0.77 (0.91)	0.76 (0.92)	0.76 (0.91)
Log Real capital to labour ratio	0.70 (0.50)	0.47 (0.48)	0.70 (0.49)	0.47 (0.48)	0.46 (0.48)	0.47 (0.48)	0.47 (0.48)	0.47 (0.48)
Log of wage in RS	0.67 (0.66)	0.67 (0.66)	0.68 (0.66)	0.68 (0.67)	0.68 (0.66)	0.67 (0.66)	0.68 (0.67)	0.69 (0.67)
Log of GDP per capita in region in EUR	4.19 (3.38)	4.44 (3.45)	4.19 (3.36)	4.43 (3.46)	4.42 (3.44)	4.44 (3.45)	4.42 (3.45)	4.43 (3.44)
Log of total regional fund	0.074 (0.085)	0.066 (0.084)	0.074 (0.084)	0.066 (0.084)	0.063 (0.085)	0.066 (0.084)	0.062 (0.085)	0.066 (0.084)
PC of 25-64 Tertiary education (levels 5-8)	0.041 (0.054)	0.038 (0.055)	0.041 (0.054)	0.038 (0.055)	0.039 (0.055)	0.038 (0.055)	0.039 (0.055)	0.038 (0.055)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.064 (0.047)	0.062 (0.048)	0.064 (0.047)	0.062 (0.048)	0.063 (0.048)	0.062 (0.048)	0.064 (0.048)	0.061 (0.048)
Log of Full-time equivalent R&D personnel in all sectors	-1.69 (1.45)	-2.02 (1.50)	-1.70 (1.45)	-2.02 (1.49)	-2.00 (1.50)	-2.02 (1.50)	-1.99 (1.49)	-2.04 (1.50)
Log of GERD all sectors in EUR million	0.10 (1.06)	0.24 (1.08)	0.12 (1.06)	0.24 (1.08)	0.22 (1.08)	0.24 (1.08)	0.23 (1.08)	0.25 (1.08)
Agglomeration of labour in regional industry relative to region	43.3* (26.2)	39.1 (26.2)	43.3* (26.2)	39.1 (26.1)	40.5 (26.3)	39.1 (26.2)	40.8 (26.4)	38.9 (26.1)
HHI of firm's sales in the regional industry	0.12 (0.21)	0.12 (0.21)	0.12 (0.21)	0.12 (0.21)	0.13 (0.21)	0.12 (0.21)	0.12 (0.21)	0.12 (0.21)
Log of foreign-owned total assets in RS as FDI stock	-0.0018 (0.011)	-0.0015 (0.011)			-0.0013 (0.011)	-0.0015 (0.011)		
Number of M&A deals in RS	-0.087 (0.054)		-0.087 (0.054)					
Log Number of GF or BF projects in RS	-0.0033 (0.099)			-0.0036 (0.10)				
Log of USD value of all completed projects GF and BF in RS					-0.0016 (0.0077)			-0.0016 (0.0077)
Log value of M&A deals in RS					0.0028 (0.0066)		0.0029 (0.0066)	
Constant	-62.7** (31.9)	-60.4* (32.2)	-63.0** (31.7)	-60.4* (32.5)	-60.3* (32.2)	-60.4* (32.2)	-60.6* (32.3)	-60.4* (32.2)
Observations	1435	1435	1435	1435	1435	1435	1435	1435
Pseudo R-squared	0.670	0.670	0.670	0.670	0.670	0.670	0.670	0.670
AIC	3975.7	3977.5	3971.8	3977.5	3980.9	3977.5	3977.1	3977.4

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

Table 8 presents the results for **total environmental patents**, including both granted and non-granted patents at the Austrian regional industrial level. The coefficient of the number of published

**environmental** patents by GUOs is found to be positive and in a statistically significant manner, which implies positive spillovers from patent activity of GUOs. However, this marginal effect is slightly smaller than the marginal effect on granted environmental patents. Nevertheless, it again suggests that the transmission of technology from foreign MNEs to innovation in Austrian regional industries exists in a statistically significant manner. As for the FDI variables, the coefficients of the total FDI assets and the value of brownfield and greenfield investment are found to be positive for patent activity, while the coefficient of the number of M&As is found to be negative. While the impacts of these variables were shown to be statistically insignificant for granted environmental patents in Table 7, the results from Table 8 suggest that technological spillovers are influenced by financial measurements of FDI in addition to technological measurements of FDI in the form of patents. However, the technological spillovers from financial measurements do not lead to novel technologies that are finally successfully granted by patent offices.

**Table 8 / Results of the econometric analysis for FDI spillovers, for regional sectors, for published environmental patents (including non-granted)**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.052 (0.046)	-0.056 (0.046)	-0.049 (0.047)	-0.056 (0.046)	-0.059 (0.046)	-0.056 (0.046)	-0.053 (0.046)	-0.059 (0.047)
Log Number of environmental patents published by foreign GUO investing in RS	0.18*** (0.059)	0.20*** (0.059)	0.18*** (0.059)	0.19*** (0.059)	0.19*** (0.059)	0.20*** (0.059)	0.20*** (0.059)	0.19*** (0.059)
Log VA productivity in number of employees in thousands	-0.17 (0.60)	-0.16 (0.63)	-0.16 (0.61)	-0.13 (0.63)	-0.12 (0.61)	-0.16 (0.63)	-0.12 (0.62)	-0.11 (0.62)
Log Real capital to labour ratio	1.38*** (0.36)	0.96** (0.39)	1.31*** (0.37)	0.92** (0.41)	0.98** (0.39)	0.96** (0.39)	0.92** (0.41)	0.91** (0.41)
Log of wage in RS	0.42 (0.53)	0.41 (0.54)	0.31 (0.52)	0.30 (0.53)	0.38 (0.54)	0.41 (0.54)	0.29 (0.53)	0.29 (0.53)
Log of GDP per capita in region in EUR	4.97** (2.16)	5.30** (2.30)	5.05** (2.19)	5.55** (2.34)	5.25** (2.31)	5.30** (2.30)	5.49** (2.34)	5.41** (2.34)
Log of total regional fund	0.028 (0.064)	0.0094 (0.065)	0.030 (0.064)	0.014 (0.066)	0.016 (0.067)	0.0094 (0.065)	0.021 (0.066)	0.013 (0.067)
PC of 25-64 Tertiary education (levels 5-8)	0.062 (0.045)	0.058 (0.046)	0.062 (0.045)	0.056 (0.046)	0.052 (0.046)	0.058 (0.046)	0.053 (0.046)	0.055 (0.046)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.062* (0.038)	0.057 (0.040)	0.059 (0.038)	0.056 (0.039)	0.058 (0.039)	0.057 (0.040)	0.049 (0.040)	0.061 (0.039)
Log of Full-time equivalent R&D personnel in all sectors	-2.94*** (1.14)	-3.49*** (1.21)	-2.91** (1.15)	-3.43*** (1.20)	-3.45*** (1.21)	-3.49*** (1.21)	-3.55*** (1.21)	-3.32*** (1.20)
Log of GERD all sectors in EUR million	0.95 (0.89)	1.16 (0.93)	0.81 (0.90)	1.04 (0.93)	1.17 (0.92)	1.16 (0.93)	1.12 (0.94)	0.97 (0.92)
Agglomeration of labour in regional industry relative to region	47.0*** (17.2)	40.8** (17.8)	46.1*** (17.2)	41.5** (18.0)	37.5** (17.9)	40.8** (17.8)	36.2** (17.8)	41.4** (18.1)
HHI of firm's sales in the regional industry	-0.28** (0.14)	-0.27* (0.14)	-0.24* (0.14)	-0.24* (0.14)	-0.30** (0.15)	-0.27* (0.14)	-0.24* (0.14)	-0.25* (0.14)
Log of foreign-owned total assets in RS as FDI stock	0.013* (0.0076)	0.012 (0.0078)			0.013 (0.0078)	0.012 (0.0078)		
Number of M&A deals in RS	-0.16*** (0.047)		-0.16*** (0.048)					
Log Number of GF or BF projects in RS	0.061 (0.061)			0.054 (0.060)				
Log of USD value of all completed projects GF and BF in RS					0.0091* (0.0047)			0.0087* (0.0047)
Log value of M&A deals in RS					-0.0072 (0.0053)		-0.0077 (0.0053)	
Constant	-59.4*** (22.7)	-53.3** (23.6)	-57.1** (22.8)	-54.0** (23.9)	-53.5** (23.6)	-53.3** (23.6)	-52.4** (23.7)	-53.2** (23.8)
Observations	1634	1634	1634	1634	1634	1634	1634	1634
Pseudo R-squared	0.774	0.772	0.774	0.772	0.773	0.772	0.772	0.772
AIC	7373.7	7430.8	7384.1	7440.5	7415.3	7430.8	7433.3	7432.5

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

To **summarise** this section:

- › One could argue that there are indeed technological spillovers from the presence of foreign companies in Austria and their patent activity, on domestic patent activity, which is in accordance with the theories of Marshall-Arrow-Romer (Marshall, 1890; Arrow, 1971 and Romer, 1986) or Porter (1990), and is a common finding in the FDI literature (Doan et al., 2015).
- › The relationship is found to be complex, though, depending on the type of patent activity and the type of FDI presence. Overall, one could say that the spillovers are more often positive than negative.
- › For total granted patents, the effect of the number of granted environmental patents by GUOs that have invested in the respective regional sector is positive, just as is the effect of the total assets of foreign-owned firms in Austria, and the effect of the value of brownfield and greenfield investment projects. On the contrary, the impact of the number of M&A deals is found to be negative. The latter could potentially indicate the transfer of patent rights through M&A deals to foreign MNEs that lead to a lower number of patents in domestic regional industries.
- › For all published patents, including non-granted patents, spillovers from the number of non-environmental patents of foreign GUOs are found to be negative.
- › For granted environmental patents, the number of granted non-environmental patents by GUOs is found to be negative, while the number of granted environmental patents by GUOs is found to be positive.
- › For total environmental patents, including non-granted, the number of published environmental patents by GUOs is found to be positive, as well as the total FDI assets and the value of brownfield and greenfield investment. In contrast, the number of M&As is found to be negative. These results may be due to the intrinsic nature of environmental technologies whose use and transmission are not purely local and do not depend either on local market demand or the institutional environment of the invention. Environmental technologies are in high demand almost everywhere. This makes them even more transmittable through regional spillovers to other agents of the economy in close proximity, in line with the existing literature (Pazienza, 2015).

### 6.3 RESULTS FOR FDI TECHNOLOGICAL SPILLOVERS TO DOMESTICALLY OWNED FIRMS

Finally, we present the results for spillovers to domestically-owned firms, which are the results of equation (3) from section 3.2. Tables 9-14 show these results. First we present the results for productivity and employment of domestic firms. As previously, each of the tables displays 8 different specifications based on different definitions and combinations of FDI variables. Then, we present the results for the four different types of patents, as in the previous section – total granted patents, total published patents (including non-granted), granted environmental patents, and published environmental patents (including non-granted), but just for domestically owned firms.

Table 9 presents the results for spillovers of FDI to the **labour productivity of domestic companies**. While a very large Pseudo R-square indicates the larger explanatory power of the model, the total assets of a domestic firm have no impact on its productivity in a statistically significant manner. The other important point to note is that of the financial FDI measurements, only the impact of the number of M&A deals is found to be statistically significant, while the coefficients of other financial FDI



measurements are statistically insignificant. The coefficient of the number of M&As is positive, implying that M&A deals are good for the labour productivity of domestic firms, while other types of FDI have no sizeable effect. Of the patent variables, the impact of non-environmental patents published by foreign-owned firms in a regional sector (RS) is positive and statistically significant. This suggests that when innovative activities by foreign-owned firms in a regional sector increase, domestic firms become more productive, which indicates positive spillovers from innovation induced by FDI.

**Table 9 / Results of the econometric analysis for FDI spillovers, for labour productivity of domestically owned firms**

	1	2	3	4	5	6	7	8
Log total assets of domestically-owned firms	-0.040 (0.039)	-0.042 (0.040)	-0.042 (0.040)	-0.041 (0.040)	-0.040 (0.040)	-0.042 (0.040)	-0.041 (0.041)	-0.041 (0.040)
Log Number of non-environmental patents published by foreign-owned firms in RS	0.057** (0.024)	0.058** (0.024)	0.056** (0.024)	0.061** (0.024)	0.060** (0.024)	0.058** (0.024)	0.060** (0.024)	0.060** (0.024)
Log Number of environmental patents published by foreign-owned firms in RS	0.0076 (0.032)	0.0013 (0.031)	-0.0040 (0.030)	0.010 (0.033)	-0.0032 (0.029)	0.0013 (0.031)	-0.0071 (0.029)	0.0037 (0.031)
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.035 (0.039)	-0.022 (0.038)	-0.024 (0.038)	-0.030 (0.040)	-0.031 (0.040)	-0.022 (0.038)	-0.026 (0.039)	-0.028 (0.040)
Log Number of environmental patents published by foreign GUO investing in RS	-0.055 (0.050)	-0.062 (0.049)	-0.056 (0.050)	-0.061 (0.049)	-0.065 (0.049)	-0.062 (0.049)	-0.065 (0.049)	-0.062 (0.049)
Log VA productivity in number of employees in thousands	1.25* (0.71)	1.20* (0.70)	1.19* (0.71)	1.25* (0.72)	1.18* (0.70)	1.20* (0.70)	1.16* (0.70)	1.21* (0.71)
Log Real capital to labour ratio	-2.10*** (0.78)	-1.83*** (0.74)	-1.87*** (0.74)	-2.07*** (0.78)	-1.99*** (0.76)	-1.83*** (0.74)	-1.87*** (0.73)	-1.99*** (0.77)
Log of wage in RS	-0.76 (0.70)	-0.78 (0.70)	-0.77 (0.70)	-0.77 (0.70)	-0.76 (0.70)	-0.78 (0.70)	-0.77 (0.70)	-0.77 (0.71)
Log of total regional fund	0.016 (0.037)	0.020 (0.038)	0.022 (0.038)	0.020 (0.038)	0.018 (0.038)	0.020 (0.038)	0.023 (0.038)	0.020 (0.038)
PC of 25-64 Tertiary education (levels 5-8)	-0.0047 (0.034)	-0.0024 (0.034)	-0.0043 (0.034)	-0.0056 (0.034)	-0.0047 (0.034)	-0.0024 (0.034)	-0.0079 (0.034)	-0.0025 (0.034)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	-0.042 (0.038)	-0.037 (0.037)	-0.042 (0.038)	-0.035 (0.038)	-0.036 (0.037)	-0.037 (0.037)	-0.038 (0.038)	-0.034 (0.037)
Log of Full-time equivalent R&D personnel in all sectors	-1.21 (0.97)	-1.38 (1.03)	-1.27 (1.01)	-1.35 (1.01)	-1.34 (1.00)	-1.38 (1.03)	-1.36 (1.03)	-1.37 (1.02)
Log of GERD all sectors in EUR million	2.99*** (0.91)	3.04*** (0.94)	2.96*** (0.94)	3.09*** (0.95)	3.06*** (0.93)	3.04*** (0.94)	3.04*** (0.95)	3.08*** (0.95)
Agglomeration of labour in regional industry relative to region	-6.56 (15.0)	-6.91 (15.0)	-8.49 (14.8)	-4.93 (15.3)	-8.32 (15.7)	-6.91 (15.0)	-8.42 (15.8)	-6.65 (15.0)
HHI of firm's sales in the regional industry	0.56 (0.37)	0.59 (0.37)	0.59 (0.37)	0.58 (0.37)	0.57 (0.37)	0.59 (0.37)	0.59 (0.37)	0.58 (0.37)
Log of foreign-owned total assets in RS as FDI stock	0.034 (0.027)	0.035 (0.027)			0.034 (0.027)	0.035 (0.027)		
Number of M&A deals in RS	0.071** (0.033)		0.066** (0.032)					
Log Number of GF or BF projects in RS	0.063 (0.039)			0.053 (0.037)				
Log of USD value of all completed projects GF and BF in RS					0.0032 (0.0030)			0.0032 (0.0031)
Log value of M&A deals in RS					-0.0034 (0.0043)		-0.0036 (0.0044)	
Constant	26.7** (13.3)	25.0* (13.6)	26.1* (13.3)	27.3** (13.3)	26.7** (13.3)	25.0* (13.6)	26.7** (13.2)	27.0** (13.3)
Observations	89523	89523	89523	89523	89523	89523	89523	89523
Pseudo R-squared	0.948	0.947	0.948	0.947	0.948	0.947	0.947	0.947
AIC	1.32221e+10	1.32913e+10	1.32675e+10	1.32897e+10	1.32696e+10	1.32913e+10	1.32972e+10	1.32992e+10

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017

Of the other variables, VA productivity in number of employees at the industry level is found to be positively correlated with labour productivity in terms of operating revenues at the firm-level, while the capital to labour ratio of the industry is found to have a negative relationship with a firm's productivity. Importantly, and very plausibly, the impact of government spending on R&D in a region is found to be positive for labour productivity at the firm level in a statistically significant manner.

Table 10 presents the results of the estimations on **employment of domestic firms**. One easily observes a much larger sample of estimation on employment of domestic firms, than the sample of estimation on productivity of domestic firms, mainly because the information on operating revenue is missing for many more firms. While the Pseudo R-squared again indicates a larger explanatory power of the model, total assets of the domestic firm has a positive coefficient that is now statistically significant. This mainly suggests that larger firms have more employees, but they are not necessarily more productive according to the results presented in Table 9.

**Table 10 / Results of the econometric analysis for FDI spillovers, for employment of domestically owned firms**

	1	2	3	4	5	6	7	8
Log total assets of domestically-owned firm	0.22*** (0.017)	0.22*** (0.017)	0.22*** (0.017)	0.22*** (0.017)	0.22*** (0.017)	0.22*** (0.017)	0.22*** (0.017)	0.22*** (0.017)
Log Number of non-environmental patents published by foreign-owned firms in RS	-0.014 (0.0091)	-0.015 (0.0095)	-0.014 (0.0091)	-0.015 (0.0095)	-0.015 (0.0095)	-0.015 (0.0095)	-0.014 (0.0095)	-0.015 (0.0095)
Log Number of environmental patents published by foreign-owned firms in RS	-0.0040 (0.011)	-0.0029 (0.011)	-0.0029 (0.011)	-0.0039 (0.011)	-0.0030 (0.011)	-0.0029 (0.011)	-0.0029 (0.011)	-0.0029 (0.011)
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.0067 (0.0051)	-0.0078 (0.0052)	-0.0081 (0.0051)	-0.0070 (0.0051)	-0.0068 (0.0051)	-0.0078 (0.0052)	-0.0080 (0.0051)	-0.0071 (0.0051)
Log Number of environmental patents published by foreign GUO investing in RS	0.0030 (0.0052)	0.0019 (0.0052)	0.0018 (0.0052)	0.0026 (0.0052)	0.0023 (0.0052)	0.0019 (0.0052)	0.0016 (0.0052)	0.0021 (0.0052)
Log VA productivity in number of employees in thousands	-0.35*** (0.081)	-0.32*** (0.077)	-0.33*** (0.077)	-0.35*** (0.078)	-0.34*** (0.078)	-0.32*** (0.077)	-0.33*** (0.076)	-0.35*** (0.078)
Log Real capital to labour ratio	0.10 (0.098)	0.042 (0.088)	0.048 (0.091)	0.098 (0.095)	0.10 (0.094)	0.042 (0.088)	0.043 (0.088)	0.10 (0.095)
Log of wage in RS	-0.24 (0.18)	-0.24 (0.18)	-0.23 (0.18)	-0.23 (0.18)	-0.25 (0.18)	-0.24 (0.18)	-0.23 (0.18)	-0.24 (0.18)
Log of GDP per capita in region in EUR	1.50*** (0.39)	1.56*** (0.39)	1.64*** (0.39)	1.58*** (0.39)	1.49*** (0.38)	1.56*** (0.39)	1.64*** (0.39)	1.57*** (0.39)
Log of total regional fund	0.013* (0.0069)	0.012* (0.0070)	0.013* (0.0070)	0.013* (0.0070)	0.014** (0.0068)	0.012* (0.0070)	0.013* (0.0069)	0.015** (0.0070)
PC of 25-64 Tertiary education (levels 5-8)	-0.0033 (0.0067)	-0.0033 (0.0066)	-0.0041 (0.0067)	-0.0048 (0.0066)	-0.0043 (0.0066)	-0.0033 (0.0066)	-0.0044 (0.0066)	-0.0054 (0.0066)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.0060 (0.0052)	0.0062 (0.0051)	0.0056 (0.0054)	0.0045 (0.0051)	0.0052 (0.0050)	0.0062 (0.0051)	0.0051 (0.0052)	0.0042 (0.0051)
Log of Full-time equivalent R&D personnel in all sectors	-0.52** (0.22)	-0.53** (0.22)	-0.56** (0.23)	-0.55** (0.23)	-0.52** (0.22)	-0.53** (0.22)	-0.56** (0.23)	-0.56** (0.22)
Log of GERD all sectors in EUR million	-0.056 (0.083)	-0.028 (0.083)	-0.046 (0.083)	-0.064 (0.083)	-0.045 (0.082)	-0.028 (0.083)	-0.041 (0.083)	-0.057 (0.082)
Agglomeration of labour in regional industry relative to region	4.52** (2.07)	4.38** (2.12)	4.50** (2.09)	4.15* (2.14)	4.65** (2.10)	4.38** (2.12)	4.29** (2.15)	4.53** (2.11)
HHI of firm's sales in the regional industry	-0.053 (0.087)	-0.055 (0.088)	-0.066 (0.089)	-0.062 (0.089)	-0.050 (0.088)	-0.055 (0.088)	-0.064 (0.089)	-0.059 (0.089)
Log of foreign-owned total assets in RS as FDI stock	0.010*** (0.0034)	0.011*** (0.0034)			0.010*** (0.0034)	0.011*** (0.0034)		
Number of M&A deals in RS	-0.010 (0.011)		-0.0099 (0.011)					
Log Number of GF or BF projects in RS	-0.025** (0.011)			-0.026** (0.011)				
Log of USD value of all completed projects GF and BF in RS					-0.0025** (0.0010)			-0.0026*** (0.00098)
Log value of M&A deals in RS					-0.00017 (0.0012)		-0.00037 (0.0011)	
Constant	-5.56 (3.46)	-5.93* (3.47)	-6.13* (3.48)	-5.72* (3.47)	-5.41 (3.37)	-5.93* (3.47)	-6.08* (3.43)	-5.61 (3.42)
Observations	274658	274658	274658	274658	274658	274658	274658	274658
Pseudo R-squared	0.937	0.937	0.937	0.937	0.937	0.937	0.937	0.937
AIC	1563719.0	1564304.2	1564774.5	1564357.5	1563576.7	1564304.2	1564862.6	1564117.7

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017



The impact of total FDI assets appears positive and statistically significant, implying that sectors which have a bigger stock of FDI also have higher employment. At the same time, the coefficients of the number and value of GF and BF projects turn out to be negative. This could be due to the job-creation effects of GF and BF projects that attract employees from domestic firms with better opportunities, while controlling for average wages in the regional sector. None of the patent variables has any statistically significant impact on employment of domestic firms.

Of the other variables, productivity is found to have a negative effect on employment, while GDP per capita is found to have a positive impact. The number of R&D personnel is found to have a negative impact on employment of domestic firms, which should be due to the crowding out of employment in the regional market. Agglomeration of labour in regional industry exhibits a positive influence on employment.

Table 11 presents the results for **total granted patents of all types of technologies owned by domestic Austrian firms**. The first thing to note is that the sample size decreases substantially from approximately 90,000 observations in the sample estimating domestic firms' productivity to only about 12,000 in these new samples for estimation. The main reason is that due to lack of variation in the dependent variables in these estimations, many observations are dropped that are either singletons or separated by a fixed effect. However, the number of employees and operating turnover that are used to calculate the productivity of domestic firms are available for many firms. This suggests that innovation and decisions on patenting are concentrated among far fewer firms.

Total assets of the domestic firm have a positive impact on the number of granted patents. In other words, a 1% increase in total assets of a domestic firm leads to a 0.41% increase in the number of patents in all technological classes in a statistically significant manner.

Moreover, a larger number of **non-environmental** granted patents of foreign-owned firms in a given regional sector (RS) is found to lead to a higher number of total granted patents owned by domestically owned firms, while the effects of other patent variables become statistically insignificant. As for the FDI variables, the total assets owned by foreign firms in the respective regional sector are found to reduce the number of granted patents owned by domestic Austrian firms. Therefore, one can argue that the major positive spillovers to novel innovation in all types of technologies are transmitted through novel non-environmental technologies that are granted to foreign-owned firms in a regional industry.

The percentage of the population aged between 25 and 64 with tertiary education in a region has a positive impact on the number of patents granted to domestic firms, which is statistically significant at 5%. Furthermore, regions with a larger number of full-time equivalent R&D personnel in all sectors also have a larger number of patents. Regional industries with a larger level of agglomeration of labour also have more patents granted by domestic firms. This is in line with the MAR and Porter theories of knowledge spillovers. Furthermore, a larger index of HHI is associated with a larger number of patents granted by domestic firms in that region. This suggests that when the concentration of an industry in a given region increases and the competition decreases, firms innovate more.

**Table 11 / Results of the econometric analysis for FDI spillovers, for domestic firms, for granted patents of all types**

	1	2	3	4	5	6	7	8
Log total assets of domestically-owned firm	0.41*** (0.067)	0.41*** (0.067)	0.42*** (0.071)	0.42*** (0.071)	0.41*** (0.067)	0.41*** (0.067)	0.42*** (0.071)	0.42*** (0.071)
Log Number of granted non-environmental patents by foreign-owned firms in RS	0.078*** (0.029)	0.084*** (0.029)	0.085*** (0.030)	0.088*** (0.029)	0.083*** (0.029)	0.084*** (0.029)	0.087*** (0.029)	0.089*** (0.029)
Log granted environmental patents published by foreign-owned firms in RS	-0.059 (0.037)	-0.057 (0.037)	-0.055 (0.037)	-0.057 (0.037)	-0.055 (0.038)	-0.057 (0.037)	-0.053 (0.038)	-0.055 (0.037)
Log Number of granted non-environmental patents by GUOs investing in RS	-0.070 (0.047)	-0.070 (0.047)	-0.072 (0.048)	-0.073 (0.048)	-0.070 (0.047)	-0.070 (0.047)	-0.072 (0.048)	-0.072 (0.048)
Log Number of granted environmental patents by GUOs investing in RS	0.047 (0.040)	0.048 (0.041)	0.050 (0.040)	0.053 (0.040)	0.048 (0.040)	0.048 (0.041)	0.052 (0.041)	0.052 (0.041)
Log VA productivity in number of employees in thousands	0.14 (0.47)	0.11 (0.47)	0.35 (0.46)	0.33 (0.46)	0.12 (0.47)	0.11 (0.47)	0.33 (0.47)	0.32 (0.46)
Log Real capital to labour ratio	0.24 (0.42)	0.31 (0.42)	0.29 (0.45)	0.32 (0.44)	0.31 (0.41)	0.31 (0.42)	0.34 (0.44)	0.34 (0.44)
Log of wage in RS	-0.36 (0.31)	-0.34 (0.31)	-0.36 (0.33)	-0.38 (0.33)	-0.34 (0.31)	-0.34 (0.31)	-0.36 (0.33)	-0.36 (0.33)
Log of GDP per capita in region in EUR	0.34 (1.66)	0.39 (1.65)	0.17 (1.65)	-0.0047 (1.64)	0.40 (1.65)	0.39 (1.65)	0.091 (1.65)	0.14 (1.64)
Log of total regional fund	-0.078 (0.053)	-0.078 (0.055)	-0.079 (0.054)	-0.075 (0.054)	-0.079 (0.055)	-0.078 (0.055)	-0.078 (0.055)	-0.077 (0.055)
PC of 25-64 Tertiary education (levels 5-8)	0.055 (0.034)	0.055 (0.033)	0.048 (0.034)	0.050 (0.034)	0.055 (0.034)	0.055 (0.033)	0.049 (0.034)	0.048 (0.034)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.0058 (0.031)	0.0064 (0.031)	0.00034 (0.032)	0.0012 (0.032)	0.0070 (0.031)	0.0064 (0.031)	0.0020 (0.032)	0.0011 (0.032)
Log of Full-time equivalent R&D personnel in all sectors	1.49* (0.88)	1.56* (0.87)	1.41 (0.89)	1.55* (0.89)	1.57* (0.87)	1.56* (0.87)	1.54* (0.89)	1.50* (0.88)
Log of GERD all sectors in EUR million	0.091 (0.76)	0.079 (0.75)	0.28 (0.76)	0.20 (0.76)	0.076 (0.75)	0.079 (0.75)	0.23 (0.76)	0.25 (0.76)
Agglomeration of labour in regional industry relative to region	18.5 (13.0)	19.6 (13.2)	19.0 (13.7)	18.9 (13.5)	20.0 (13.2)	19.6 (13.2)	20.0 (13.8)	19.6 (13.6)
HHI of firm's sales in the regional industry	0.26* (0.15)	0.24 (0.16)	0.40** (0.18)	0.41** (0.18)	0.24 (0.16)	0.24 (0.16)	0.40** (0.18)	0.40** (0.18)
Log of foreign-owned total assets in RS as FDI stock	-0.038** (0.016)	-0.038** (0.016)			-0.038** (0.016)	-0.038** (0.016)		
Number of M&A deals in RS	0.031 (0.038)		0.030 (0.038)					
Log Number of GF or BF projects in RS	-0.042 (0.050)			-0.043 (0.048)				
Log of USD value of all completed projects GF and BF in RS					0.00073 (0.0041)			0.00089 (0.0040)
Log value of M&A deals in RS					0.00099 (0.0032)		0.0015 (0.0032)	
Constant	-24.8 (17.9)	-26.6 (18.1)	-27.1 (18.2)	-26.0 (18.1)	-26.9 (18.1)	-26.6 (18.1)	-27.6 (18.3)	-27.8 (18.2)
Observations	11854	11854	11854	11854	11854	11854	11854	11854
Pseudo R-squared	0.772	0.772	0.771	0.771	0.772	0.772	0.771	0.771
AIC	27543.9	27549.5	27634.2	27633.7	27552.9	27549.5	27637.3	27637.9

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017

Table 12 shows the results for technological spillovers from FDI in regional sectors to **domestic firms**, for **published patents of all types of technologies**, including those that are still not granted. These results are very similar to the previous ones. A larger number of **non-environmental** patents of foreign-owned firms in a given RS is found to lead to a larger number of total granted patents owned by domestically owned firms, while other variables of patents induced by FDI remain statistically insignificant. Similarly, larger total assets owned by foreign companies in RS leads to fewer patents published in all technologies by domestic firms, which indicates potential competitive pressure in the allocation of resources to innovative activities in a regional sector.

**Table 12 / Results of the econometric analysis for FDI spill-overs, for domestic companies, for published patents of all types (including non-granted)**

	1	2	3	4	5	6	7	8
Log total assets of domestically-owned firm	0.30*** (0.041)	0.30*** (0.041)	0.30*** (0.041)	0.30*** (0.041)	0.30*** (0.041)	0.30*** (0.041)	0.30*** (0.041)	0.30*** (0.041)
Log Number of non-environmental patents published by foreign-owned firms in RS	0.076*** (0.024)	0.076*** (0.024)	0.080*** (0.024)	0.081*** (0.024)	0.076*** (0.023)	0.076*** (0.024)	0.080*** (0.024)	0.081*** (0.024)
Log Number of environmental patents published by foreign-owned firms in RS	-0.017 (0.026)	-0.018 (0.026)	-0.021 (0.026)	-0.020 (0.026)	-0.017 (0.026)	-0.018 (0.026)	-0.021 (0.026)	-0.021 (0.026)
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.027 (0.032)	-0.028 (0.032)	-0.030 (0.031)	-0.028 (0.031)	-0.028 (0.032)	-0.028 (0.032)	-0.030 (0.031)	-0.029 (0.031)
Log Number of environmental patents published by foreign GUO investing in RS	-0.030 (0.027)	-0.031 (0.027)	-0.033 (0.027)	-0.032 (0.027)	-0.031 (0.027)	-0.031 (0.027)	-0.033 (0.027)	-0.033 (0.027)
Log VA productivity in number of employees in thousands	0.35 (0.34)	0.34 (0.34)	0.46 (0.33)	0.47 (0.33)	0.34 (0.34)	0.34 (0.34)	0.46 (0.33)	0.47 (0.33)
Log Real capital to labour ratio	-0.097 (0.29)	-0.085 (0.29)	-0.088 (0.31)	-0.095 (0.30)	-0.087 (0.29)	-0.085 (0.29)	-0.085 (0.30)	-0.087 (0.30)
Log of wage in RS	-0.26 (0.26)	-0.25 (0.26)	-0.26 (0.25)	-0.27 (0.25)	-0.25 (0.26)	-0.25 (0.26)	-0.26 (0.25)	-0.26 (0.25)
Log of GDP per capita in region in EUR	-2.65* (1.36)	-2.57* (1.34)	-2.77** (1.38)	-2.85** (1.35)	-2.59* (1.34)	-2.57* (1.34)	-2.78** (1.35)	-2.79** (1.35)
Log of total regional fund	-0.077 (0.048)	-0.079 (0.049)	-0.079 (0.049)	-0.077 (0.048)	-0.079 (0.048)	-0.079 (0.049)	-0.079 (0.049)	-0.079 (0.048)
PC of 25-64 Tertiary education (levels 5-8)	0.023 (0.024)	0.022 (0.024)	0.019 (0.024)	0.020 (0.024)	0.023 (0.024)	0.022 (0.024)	0.019 (0.024)	0.019 (0.024)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.0018 (0.023)	0.0018 (0.023)	-0.0019 (0.023)	-0.0018 (0.023)	0.0016 (0.023)	0.0018 (0.023)	-0.0016 (0.023)	-0.0020 (0.023)
Log of Full-time equivalent R&D personnel in all sectors	1.72** (0.67)	1.69** (0.66)	1.64** (0.67)	1.68** (0.66)	1.70** (0.66)	1.69** (0.66)	1.66** (0.66)	1.65** (0.66)
Log of GERD all sectors in EUR million	0.21 (0.55)	0.25 (0.55)	0.37 (0.54)	0.33 (0.54)	0.24 (0.55)	0.25 (0.55)	0.36 (0.54)	0.36 (0.54)
Agglomeration of labour in regional industry relative to region	11.5 (10.3)	12.2 (10.5)	11.9 (10.6)	11.2 (10.4)	12.1 (10.5)	12.2 (10.5)	12.0 (10.7)	11.7 (10.6)
HHI of firm's sales in the regional industry	0.28** (0.13)	0.28** (0.13)	0.37*** (0.14)	0.37*** (0.14)	0.28** (0.13)	0.28** (0.13)	0.37*** (0.14)	0.37*** (0.14)
Log of foreign-owned total assets in RS as FDI stock	-0.025** (0.011)	-0.025** (0.011)			-0.025** (0.011)	-0.025** (0.011)		
Number of M&A deals in RS	0.00074 (0.031)		0.0015 (0.030)					
Log Number of GF or BF projects in RS	-0.039 (0.043)			-0.037 (0.042)				
Log of USD value of all completed projects GF and BF in RS					-0.00092 (0.0033)			-0.00076 (0.0033)
Log value of M&A deals in RS					0.000054 (0.0026)		0.00030 (0.0026)	
Constant	10.5 (14.6)	9.56 (14.6)	9.71 (14.6)	10.6 (14.5)	9.74 (14.6)	9.56 (14.6)	9.74 (14.6)	9.86 (14.6)
Observations	13907	13907	13907	13907	13907	13907	13907	13907
Pseudo R-squared	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838
AIC	46468.7	46473.4	46559.6	46551.9	46476.8	46473.4	46559.6	46559.2

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017

Similar to the results on granted patents in all technologies, the total assets of a domestic firm have a positive impact on the number of published patents by domestic firms. In other words, a 1% increase in total assets of a domestic firm leads to a 0.3% increase in the number of published patents in all technological classes in a statistically significant manner. Again regions with a larger number of full-time equivalent R&D personnel in all sectors also have a greater number of patents. Moreover, a larger index of HHI is associated with a greater number of patents published by domestic firms in that region.

Table 13 displays the results for technological spillovers from FDI in the regional sector to domestic firms, for granted environmental patents. Similar results for technological spillovers are observed here. The number of granted non-environmental patents by foreign-owned firms in the respective regional sector is found to have a positive impact on the environmental patent activity of domestic firms located in

that region. Moreover, in these results one can observe that environmental patents by foreign GUOs also have a significant positive impact on patents in environmental technologies that are granted to domestic firms. Therefore, spillovers to novel environmental technologies to domestic Austrian firms are transmitted not only through novel innovation in all types of technologies of foreign-owned firms in a regional sector, but also through novel innovation in environmental technologies owned by their foreign GUOs. The latter is an additional passage of positive spillover that was not found for all types of innovation by domestic firms in the results above. Similarly, from the FDI variables, the number and value of GF and BF projects is found to exhibit a positive influence on domestic patent activity.

**Table 13 / Results of the econometric analysis for FDI spillovers, for domestic companies, for granted environmental patents**

	1	2	3	4	5	6	7	8
Log total assets of domestically-owned firm	0.094 (0.082)	0.094 (0.077)	0.094 (0.079)	0.10 (0.084)	0.10 (0.084)	0.094 (0.077)	0.098 (0.079)	0.11 (0.086)
Log Number of granted non-environmental patents by foreign-owned firms in RS	0.14** (0.069)	0.14** (0.069)	0.13* (0.070)	0.14** (0.069)	0.15** (0.069)	0.14** (0.069)	0.13* (0.070)	0.14** (0.069)
Log granted environmental patents published by foreign-owned firms in RS	0.0093 (0.088)	-0.015 (0.089)	-0.017 (0.089)	0.0097 (0.087)	0.0046 (0.096)	-0.015 (0.089)	-0.018 (0.096)	0.0021 (0.088)
Log Number of granted non-environmental patents by GUOs investing in RS	0.034 (0.068)	0.031 (0.070)	0.029 (0.071)	0.047 (0.067)	0.034 (0.068)	0.031 (0.070)	0.036 (0.070)	0.038 (0.068)
Log Number of granted environmental patents by GUOs investing in RS	0.18* (0.098)	0.18* (0.099)	0.18* (0.100)	0.18* (0.098)	0.18* (0.098)	0.18* (0.099)	0.18* (0.099)	0.18* (0.099)
Log VA productivity in number of employees in thousands	-0.60 (1.15)	-0.40 (1.22)	-0.51 (1.23)	-0.60 (1.15)	-0.48 (1.17)	-0.40 (1.22)	-0.45 (1.22)	-0.54 (1.17)
Log Real capital to labour ratio	-2.47*** (0.82)	-2.32*** (0.78)	-2.45*** (0.81)	-2.16*** (0.76)	-2.21*** (0.79)	-2.32*** (0.78)	-2.28*** (0.76)	-2.17*** (0.77)
Log of wage in RS	-0.35 (0.77)	-0.44 (0.75)	-0.42 (0.75)	-0.37 (0.77)	-0.41 (0.76)	-0.44 (0.75)	-0.44 (0.75)	-0.41 (0.76)
Log of GDP per capita in region in EUR	3.49 (4.54)	2.44 (4.48)	3.11 (4.60)	3.11 (4.36)	2.61 (4.57)	2.44 (4.48)	2.69 (4.49)	2.84 (4.49)
Log of total regional fund	-0.19** (0.097)	-0.16 (0.10)	-0.17* (0.10)	-0.18* (0.099)	-0.20** (0.099)	-0.16 (0.10)	-0.16 (0.10)	-0.20** (0.099)
PC of 25-64 Tertiary education (levels 5-8)	0.084 (0.071)	0.11 (0.073)	0.10 (0.074)	0.093 (0.070)	0.098 (0.071)	0.11 (0.073)	0.11 (0.073)	0.100 (0.070)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.13* (0.074)	0.15** (0.072)	0.14* (0.075)	0.14* (0.072)	0.14** (0.073)	0.15** (0.072)	0.15** (0.072)	0.14** (0.073)
Log of Full-time equivalent R&D personnel in all sectors	2.00 (2.88)	2.78 (2.77)	2.32 (2.90)	2.40 (2.81)	2.67 (2.84)	2.78 (2.77)	2.66 (2.78)	2.55 (2.88)
Log of GERD all sectors in EUR million	-0.16 (1.72)	-0.95 (1.68)	-0.69 (1.75)	-0.51 (1.70)	-0.60 (1.70)	-0.95 (1.68)	-0.92 (1.70)	-0.59 (1.72)
Agglomeration of labour in regional industry relative to region	-81.0** (40.3)	-64.7 (40.5)	-61.9 (39.8)	-66.6* (38.0)	-70.9* (40.7)	-64.7 (40.5)	-58.5 (39.9)	-64.6* (38.1)
HHI of firm's sales in the regional industry	1.26*** (0.47)	1.25*** (0.47)	1.18** (0.46)	1.14** (0.46)	1.22*** (0.47)	1.25*** (0.47)	1.17** (0.46)	1.13** (0.46)
Log of foreign-owned total assets in RS as FDI stock	0.045 (0.041)	0.042 (0.043)			0.040 (0.042)	0.042 (0.043)		
Number of M&A deals in RS	0.089 (0.067)		0.060 (0.070)					
Log Number of GF or BF projects in RS	0.43*** (0.13)			0.41*** (0.13)				
Log of USD value of all completed projects GF and BF in RS					0.032*** (0.012)			0.032*** (0.012)
Log value of M&A deals in RS					0.00070 (0.0088)		-0.00092 (0.0087)	
Constant	-21.4 (38.9)	-16.9 (40.0)	-17.7 (40.0)	-22.9 (38.4)	-20.1 (39.9)	-16.9 (40.0)	-18.0 (40.2)	-21.0 (39.1)
Observations	1512	1512	1512	1512	1512	1512	1512	1512
Pseudo R-squared	0.661	0.658	0.658	0.660	0.660	0.658	0.658	0.660
AIC	2654.5	2674.0	2674.4	2654.7	2660.7	2674.0	2675.5	2658.2

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017

In contrast to the results presented above, the total assets of domestic firms do not have any impact on its innovation in environmental technologies in a statistically significant manner. The capital to labour

ratio in a sector has a negative impact on the number of granted environmental patents to domestic firms. This means that when 1% more people are employed in a sector relative to its invested capital, the number of granted patents by domestic firms will increase by 2.47% in a statistically significant manner. This may suggest that innovation in these technologies is very labour intensive. Moreover, the percentage of the population aged between 25 and 64 with upper secondary and post-secondary non-tertiary education in a region has a positive impact on the number of patents granted to domestic firms in environmental technologies, which is statistically significant at the 5-10% level. Additionally, the total assets of a domestic firm, full-time equivalent R&D personnel in all sectors, and regional agglomeration of a sector have no statistically significant impact on the number of granted patent in environmental technologies. However, a larger index of HHI is again associated with a greater number of patents granted by domestic firms in environmental technologies in that region.

**Table 14 / Results of the econometric analysis for FDI spillovers, for domestic companies, for published environmental patents (including not granted)**

	1	2	3	4	5	6	7	8
Log total assets of domestically-owned firm	0.22*** (0.083)	0.22*** (0.083)	0.22*** (0.083)	0.22*** (0.084)	0.22*** (0.084)	0.22*** (0.083)	0.22*** (0.084)	0.22*** (0.084)
Log Number of non-environmental patents published by foreign-owned firms in RS	0.11** (0.050)	0.11** (0.051)	0.11** (0.050)	0.11** (0.051)	0.12** (0.050)	0.11** (0.051)	0.12** (0.051)	0.11** (0.051)
Log Number of environmental patents published by foreign-owned firms in RS	-0.039 (0.055)	-0.028 (0.054)	-0.031 (0.054)	-0.033 (0.054)	-0.042 (0.054)	-0.028 (0.054)	-0.029 (0.053)	-0.037 (0.054)
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.079 (0.060)	-0.081 (0.059)	-0.074 (0.059)	-0.080 (0.060)	-0.081 (0.062)	-0.081 (0.059)	-0.072 (0.060)	-0.085 (0.060)
Log Number of environmental patents published by foreign GUO investing in RS	-0.011 (0.078)	0.00012 (0.078)	-0.0020 (0.078)	-0.0083 (0.078)	-0.0054 (0.077)	0.00012 (0.078)	0.0041 (0.078)	-0.0080 (0.077)
Log VA productivity in number of employees in thousands	0.10 (0.85)	0.091 (0.86)	0.11 (0.85)	0.050 (0.85)	0.087 (0.82)	0.091 (0.86)	0.11 (0.82)	0.033 (0.85)
Log Real capital to labour ratio	-1.29** (0.63)	-1.44** (0.61)	-1.32** (0.63)	-1.39** (0.60)	-1.44** (0.59)	-1.44** (0.61)	-1.50*** (0.58)	-1.38** (0.60)
Log of wage in RS	-0.36 (0.79)	-0.38 (0.81)	-0.38 (0.81)	-0.35 (0.82)	-0.34 (0.81)	-0.38 (0.81)	-0.36 (0.83)	-0.36 (0.82)
Log of GDP per capita in region in EUR	1.74 (3.50)	1.91 (3.53)	1.76 (3.52)	2.16 (3.45)	1.88 (3.44)	1.91 (3.53)	2.02 (3.46)	2.05 (3.46)
Log of total regional fund	-0.22*** (0.085)	-0.22*** (0.085)	-0.21** (0.085)	-0.23*** (0.085)	-0.22*** (0.084)	-0.22*** (0.085)	-0.20** (0.085)	-0.24*** (0.085)
PC of 25-64 Tertiary education (levels 5-8)	0.088* (0.051)	0.089* (0.051)	0.093* (0.051)	0.086* (0.051)	0.071 (0.052)	0.089* (0.051)	0.074 (0.052)	0.087* (0.051)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.10* (0.053)	0.099* (0.053)	0.10** (0.053)	0.098* (0.052)	0.081 (0.055)	0.099* (0.053)	0.081 (0.055)	0.099* (0.053)
Log of Full-time equivalent R&D personnel in all sectors	1.02 (1.96)	0.89 (1.95)	1.12 (1.96)	0.71 (1.93)	0.63 (1.94)	0.89 (1.95)	0.67 (1.94)	0.73 (1.93)
Log of GERD all sectors in EUR million	0.28 (1.40)	0.26 (1.38)	0.066 (1.40)	0.43 (1.38)	0.60 (1.40)	0.26 (1.38)	0.41 (1.40)	0.45 (1.38)
Agglomeration of labour in regional industry relative to region	-11.1 (31.8)	-12.4 (31.2)	-5.80 (30.8)	-10.4 (30.1)	-22.9 (31.8)	-12.4 (31.2)	-19.5 (31.1)	-10.3 (30.2)
HHI of firm's sales in the regional industry	0.27 (0.38)	0.28 (0.38)	0.23 (0.38)	0.23 (0.38)	0.24 (0.38)	0.28 (0.38)	0.23 (0.38)	0.22 (0.38)
Log of foreign-owned total assets in RS as FDI stock	0.018 (0.024)	0.017 (0.023)			0.013 (0.024)	0.017 (0.023)		
Number of M&A deals in RS	-0.040 (0.052)		-0.049 (0.053)					
Log Number of GF or BF projects in RS	0.17** (0.084)			0.17** (0.084)				
Log of USD value of all completed projects GF and BF in RS					0.018** (0.0076)			0.018** (0.0076)
Log value of M&A deals in RS					-0.0100 (0.0069)		-0.010 (0.0070)	
Constant	-17.9 (34.6)	-16.1 (35.3)	-17.1 (35.0)	-18.3 (34.7)	-14.4 (34.2)	-16.1 (35.3)	-14.5 (34.7)	-17.1 (34.7)
Observations	2013	2013	2013	2013	2013	2013	2013	2013
Pseudo R-squared	0.737	0.736	0.736	0.736	0.737	0.736	0.736	0.737
AIC	5711.4	5717.5	5716.4	5709.9	5702.4	5717.5	5711.2	5706.2

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017

Table 14 shows the results for technological spillovers of FDI in regional sectors to **domestic companies**, for **published environmental patents**, including patents which are not granted and those that are granted. The results are mostly the same as the previous ones - the number of granted **non-environmental** patents by foreign-owned firms in the respective sector and region is found to have a positive impact on the environmental patent activity of domestic firms, while other patent variables have statistically insignificant coefficients. The number and value of greenfield and brownfield projects also has a positive impact on the number of published environmental patents by domestic firms.

Again, a firm's total assets have a positive impact on its number of patents in environmental technologies, which was not the case for granted patents in these technology classes. Moreover, the capital to labour ratio of a sector has a negative impact on the number of published patents by domestic firms. Both types of education groups of the population in a region also have a positive impact on the number of published patents in these technologies.

To **summarise** the findings from this section:

- › Where the labour productivity of domestic firms is concerned, there are positive spillovers from the number of M&A deals, but no spillovers from other forms of measurement of FDI. The finding of the positive spillovers is in accordance with the existing literature (Pain and Hubert, 2002; Navaretti and Venables, 2006; Bayar and Ozturk, 2018). On the other hand, there are negative spillovers from the number of environmental patents published by foreign-owned firms.
- › Regarding employment of domestic firms, there are positive spillovers from the presence of foreign companies, but also negative spillovers from BF and GF projects. There are also negative spillovers from the number of environmental patents published by foreign-owned firms.
- › When domestic firms' patents of all types are concerned, we find that positive technological spillovers are transmitted mostly through non-environmental innovations by subsidiaries of foreign MNEs rather than through foreign MNEs themselves. However, we also find that novel innovation in domestic firms' environmental technologies that are granted by patent offices are also stimulated by novel environmental technologies of foreign MNEs, which is an additional channel only for these types of innovation.
- › However, there are negative spillovers to non-environmental innovation by domestic firms from the presence of foreign-owned companies in terms of the total assets of foreign-owned companies in a regional sector: this might indicate negative competitive pressure of FDI in a given regional sector. Such negative spillovers are not observed for the environmental technologies of domestic firms. In contrast, we find positive spillovers from the number and value of GF and BF projects to environmental patents of domestic firms. These results hold equally for published and granted domestic patents.

## 7. Summary and concluding remarks

This study investigates the determinants and the effects of FDI in Austria, using firm-level data, with a special focus on positive spillovers to innovation of novel environmental technologies. More precisely, it investigates which factors drive FDI in Austria at the firm level, and how FDI in Austria affects local firms and regional industries.

Five measurements of FDI are considered: 1) the total assets of foreign-owned firms in Austria as a measurement of FDI stock; 2) the number of GF and BF projects; 3) GF and BF invested capital, 4) the number of M&A deals; and 5) M&A capital for acquired firms.

Several important empirical findings for **FDI in Austria** have emerged. First, FDI in Austria heavily involves firms that participate in global value chains. This is mainly because FDI decisions in Austria are affected by trade policy measures imposed at the EU level or independently by Austria and its trading partners. This means that barriers to trade are important factors for FDI. A foreign investor's decision to increase their investment in their subsidiaries in Austria is clearly driven by the lower cost of trade induced by TBTs imposed at the EU level or independently by Austria, and by lower tariffs imposed by the home of the foreign MNE. M&A deals also take place in Austrian firms that are participating in global value chains. When the costs of trade to Austria increase due to higher tariffs or greater trade costs induced by the EU's or Austrian TBTs in a given sector, M&A activities in these Austrian sectors are reduced, which could suggest that the acquired firms under these deals are importers, participating extensively in global value chains. Moreover, the larger cost of exporting from Austria to the home of the M&A deals increases the number and invested value of M&A deals in those Austrian sectors. An Austrian firm is then chosen as a target of participation in global value chains. This suggests that tariffs and costs induced by TBTs imposed at the EU level or independently by Austria should decrease to augment the presence and total assets of foreign-owned firms in Austria.

Second, more FDI is received in industries that are more capital-intensive and have higher wages, and that are more agglomerated and concentrated in Austrian regions, and regions with a larger share of upper secondary and post-secondary non-tertiary education. Third, FDI in Austria accrues in regions and sectors which are more advanced, i.e. have higher GDP and wages. Fourth, some of the FDI in Austria has occurred in sectors and regions with lower productivity, which could be translated into enabling foreign MNEs to compete more easily with Austrian firms. Fifth, foreign investment in Austrian firms is driven by higher revenues and profits within these firms. Sixth, access to finance is an important driver of FDI, especially for longer-term finance. Seventh, lower government spending on R&D may lead to Austrian firms being acquired or merged with foreign companies.

Regarding spillovers from FDI to the Austrian economy, spillovers to aggregated outcomes in regional sectors are distinguished from spillovers to outcomes of domestic firms. Technological spillovers to all types of technology classes, and technological spillovers to environmental technologies, are the main points at both these levels. Published and granted patents are used to measure technological innovation in this study. Moreover, spillovers from FDI to employment and productivity of domestic firms are two



other aspects that are analysed at the firm-level, while at the regional industrial level they could be purely endogenous.

The main findings regarding aggregated **technological spillovers to regional sectors** are as follows. First, there are indeed spillovers from the presence of foreign companies in Austria and their patent activity, to the patent activity of regional sectors, although the relationship is found to be complex and dependent on the type of patent activity and type of FDI measurement. Overall, one could say that spillovers are more often positive than negative. Second, for the total number of granted patents of regional sectors, the effect of the number of granted environmental patents by foreign GUOs that have invested in the respective regional sector is positive, just as is the effect of the total assets of foreign-owned firms in Austria, and the effect of the value of brownfield and greenfield investment projects. On the contrary, the impact of the number of M&A deals is found to be negative. This could be due to the change in ownership of patent rights from domestic firms to foreign GUOs after M&A deals that lead to lower numbers of patenting in a regional industry. Third, for all published patents, including both non-granted and granted patents, spillovers from the number of non-environmental patents of foreign GUOs are found to be negative. Fourth, for granted environmental patents, the impact of the number of granted non-environmental patents by GUOs is found to be negative, while the impact of the number of granted environmental patents by GUOs is found to be positive. Fifth, for total environmental patents, including both granted and non-granted patents, the impact of the number of published environmental patents by GUOs is found to be positive. These results may be due to the intrinsic nature of environmental technologies whose use and transmission are not purely local, and do not depend either on demand in the local market or the institutional environment of the invention. This allows MNEs to diffuse these technologies in a regional sector where they invest. Moreover, total FDI assets and the value of brownfield and greenfield investment are also found to improve technological spillovers to regional industries while the number of M&As reduced the number of environmental patents at the regional industry level.

The main findings for **spillovers to domestic Austrian firms** are as follows. First, the number of non-environmental patents published by foreign-owned firms and the number of M&A deals in a regional industry stimulate domestic firms' productivity. Other measurements of FDI have no statistically significant impact on the productivity of domestic firms. However, gross expenditure on research and development at the regional level contributes positively to the productivity of domestic Austrian firms. Second, the total assets of foreign-owned firms in a regional industry contribute positively to employment in domestic Austrian firms. However, measurements of FDI using GF and BF projects contribute negatively to employment in domestic Austrian firms. Third, where domestic companies' patents of all types are concerned, we find that there are negative spillovers from the total assets of foreign-owned companies, but positive spillovers from their patent activity in non-environmental technologies. These results hold for both published and granted domestic patents. This might indicate the negative competitive pressure of FDI in a given regional sector. Such negative spillovers are not observed for the environmental technologies of domestic firms. Moreover, employment of R&D personnel in all sectors in a region contributes positively to the innovation of domestic firms in all types of technologies. Fourth, when domestic companies' environmental patents are in question, we find positive spillovers from the number and value of GF and BF projects, as well as from the granted non-environmental patents of foreign-owned firms. These results hold equally for published and granted domestic patents. Moreover, we find positive spillovers from a regional foreign MNEs' granted patents in environmental technologies to the granted patents of domestic firms in environmental technologies. This link was not observed in



other forms of innovative activities. Furthermore, we find that the percentage of the population in a region with a higher level of education also stimulates innovative activities in domestic firms in environmental technologies.

Overall, positive spillovers of FDI to domestic firms are observed across many specifications. These overall effects (i.e. here the summation of all elasticities) across all FDI measurements are strongest and most positive for innovative activities in environmental technologies. Six types of novel environmental technologies that mitigate climate change effects were the focus of this study. Not every innovative activity leads to novel innovation and technologies. Furthermore, this requires the allocation of huge resources to successfully grant patents for new innovations. This is the case mostly for large multinational enterprises (MNEs) that expand their network of activities across sectors and over numerous countries. Therefore, the successful granting of patents could be interpreted as a major breakthrough that can fundamentally support climate change mitigation, which is also studied in this paper. Therefore, to reach a climate-neutral economy and achieve the Sustainable Development Goals (SDGs) and targets of the Paris Agreement, Austria should stimulate novel innovation in environmental technologies. In so doing, domestic Austrian firms should become more innovative in major environmental technologies, which leads to the successful granting of patents by patent offices across the globe. Such an innovative effort could be best supported at the firm-level by supporting the total assets and investment of domestic firms, improving the share of the population with higher levels of education and employment of R&D personnel, and most importantly with the active presence of innovative foreign MNEs that enjoy large technological capacities, high-skilled labour, experienced management, and large-scale resources that lead to innovative activities. By facilitating the presence of high-tech MNEs in Austria to invest in subsidiaries that are heavily involved in their global production networks, Austrian domestic firms can enjoy positive spillovers not only from their presence but also from their innovative activities. As traditional theories of economic geography (Marshall, 1890; Arrow, 1971 and Romer, 1986; or Porter, 1990) predict, this leads to the transfer of knowledge from foreign-owned subsidiaries to domestic firms through labour forces that are employed in proximity to each other in a regional sector. This will stimulate innovation in novel environmental technologies that will eventually support SDGs to not only mitigate the negative effects of climate change but also bring new technologies that do not harm the environment through emissions. Furthermore, as the empirical evidence presented here indicates, domestic firms' productivity and employment will also be positively affected by FDI, assisting Austria to better achieve the SDGs of larger inclusive growth.

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## Appendix - Results for estimations with contemporaneous values of dependent and explanatory variables

In this section we present the results of the same specifications as in Tables 1-15, but with contemporaneous values of the dependent and explanatory variables. For brevity, we do not interpret the results fully, but just point out the main differences between these results and the previously shown results.

**Table A1 / Results of the econometric analysis for the determinants of FDI, for total assets of the foreign-owned firms in Austria, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7
Log of tariffs imposed by host against home in sector s	-0.0055 (0.037)	-0.0049 (0.042)	-0.0059 (0.040)	-0.00029 (0.038)	-0.0095 (0.041)	-0.0056 (0.041)	-0.0067 (0.040)
Log of tariffs imposed by home against host in sector s	-0.18* (0.100)	-0.20* (0.11)	-0.22** (0.11)	-0.20* (0.11)	-0.21** (0.10)	-0.23** (0.11)	-0.22** (0.11)
Log of AVE of TBTs imposed by host against home in sector s	-0.26*** (0.038)	-0.31*** (0.039)	-0.26*** (0.037)	-0.25*** (0.036)	-0.26*** (0.038)	-0.27*** (0.039)	-0.26*** (0.037)
Log of AVE of TBTs imposed by home against host in sector s	-0.038 (0.031)	-0.053* (0.031)	-0.027 (0.030)	-0.027 (0.030)	-0.039 (0.031)	-0.031 (0.031)	-0.027 (0.030)
Log of Industrial capital to labour ratio nominal m	1.26*** (0.18)	1.18*** (0.22)	1.33*** (0.17)	1.31*** (0.18)	1.32*** (0.17)	1.32*** (0.18)	1.32*** (0.18)
Log of Industrial value-added productivity nominal m	-0.51*** (0.15)	-0.13 (0.18)	-0.64*** (0.16)	-0.54*** (0.16)	-0.66*** (0.15)	-0.68*** (0.15)	-0.63*** (0.16)
Log of regional industrial wage in EUR	0.18* (0.092)	-0.027 (0.12)	0.033 (0.12)	-0.0014 (0.11)	0.087 (0.11)	0.053 (0.11)	0.090 (0.11)
Regional industrial HHI sum of squared market share of firms	0.70*** (0.11)	0.52*** (0.23)	0.68*** (0.13)	0.71*** (0.13)	0.68*** (0.11)	0.65*** (0.12)	0.66*** (0.13)
Labour agglomeration of industry in the region	2.61 (2.14)	4.14 (3.08)	2.54 (2.32)	2.02 (2.29)	3.43 (2.16)	3.30 (2.29)	2.69 (2.35)
Log of regional GDP in EUR million	0.012 (0.094)	0.079 (0.13)	0.10 (0.10)	0.100 (0.100)	0.0075 (0.093)	0.073 (0.10)	0.098 (0.10)
PC of Less than primary and lower secondary education (levels 0-2)	0.043*** (0.0099)	0.055*** (0.015)	0.041*** (0.010)	0.042*** (0.010)	0.039*** (0.010)	0.042*** (0.011)	0.043*** (0.010)
PC of Upper secondary and post-secondary non-tertiary education (levels 3 4)	0.019*** (0.0060)	0.045*** (0.0090)	0.024*** (0.0063)	0.022*** (0.0063)	0.020*** (0.0061)	0.023*** (0.0064)	0.025*** (0.0063)
Log of GERD all sectors in million EUR	0.034 (0.060)	0.070 (0.079)	-0.0091 (0.067)	-0.018 (0.066)	0.051 (0.059)	0.014 (0.065)	-0.0063 (0.069)
Log of operating revenue of firms in Austria	0.080*** (0.0095)		0.11*** (0.0087)	0.11*** (0.0090)	0.080*** (0.0085)	0.11*** (0.0090)	0.11*** (0.0087)
Log of cash flow relative to total assets of firms in Austria	-0.51*** (0.10)			-0.44*** (0.11)			
Log of current liabilities relative to total assets of firms in Austria	0.71*** (0.15)				0.61*** (0.14)		
Log of non-current liabilities relative to total assets of firms in Austria	0.15** (0.065)					-0.16** (0.066)	
Log profit-loss after tax	0.0022*** (0.00067)						0.00099 (0.00068)
Constant	9.67*** (1.83)	9.43*** (2.55)	10.1*** (2.00)	10.3*** (1.98)	11.1*** (1.98)	10.4*** (2.03)	9.45*** (1.94)
Observations	14913	14913	14913	14913	14913	14913	14913
Pseudo R-squared	0.986	0.981	0.985	0.985	0.986	0.985	0.985
AIC	3.12453e+11	4.32037e+11	3.34517e+11	3.27449e+11	3.21947e+11	3.32728e+11	3.34102e+11

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.



*The coefficient on Percentage of less than primary and lower secondary education (levels 0-2) is positive and significant now, while it was negative and insignificant in Table 1.*

*The coefficient on Current liabilities relative to total assets of firm in Austria is positive and significant now, while it was insignificant previously.*

*The other coefficients are largely the same as before.*

**Table A2 / Results of the econometric analysis for the determinants of FDI, for the number and value of GF and BF investment in Austria, for contemporaneous values of the dependent and explanatory variables**

	Number of GF and BF projects	Value of GF and BF projects
Log of tariffs imposed by host against home in sector s	-6.19** (3.16)	-12.7*** (4.17)
Log of tariffs imposed by home against host in sector s	6.26 (5.46)	-3.92 (7.06)
Log of AVE of TBTs imposed by host against home in sector s	-0.93 (0.86)	-3.19** (1.57)
Log of AVE of TBTs imposed by home against host in sector s	0.62 (0.58)	1.93 (1.28)
Log of Industrial capital to labour ratio nominal m	8.75** (3.96)	12.6** (6.06)
Log of Industrial value-added productivity nominal m	-5.26 (3.56)	0.43 (5.73)
Log of regional industrial wage in EUR	0.52 (0.80)	-5.39 (4.77)
Regional industrial HHI sum of squared market share of firms	0.95 (0.81)	-1.86 (1.79)
Labour agglomeration of industry in the region	-5.49 (13.8)	-52.3 (61.0)
Log of regional GDP in EUR million	-0.93 (0.70)	0.52 (1.42)
PC of Less than primary and lower secondary education (levels 0-2)	0.022 (0.087)	0.0091 (0.29)
PC of Upper secondary and post-secondary non-tertiary education (levels 3-4)	-0.070** (0.032)	-0.12 (0.082)
Log of GERD all sectors in EUR million	0.76* (0.41)	1.78 (1.26)
Constant	-20.8 (24.4)	-7.65 (67.0)
Observations	818	813
Pseudo R-squared	0.116	0.601
AIC	938.5	7.97335e+09

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2013-2017.

*The coefficient on Tariffs imposed by host against home are negative and significant now, in Table 2 it was insignificant.*

*The coefficient on the share of upper secondary and post-secondary non-tertiary education is negative and significant now, while it was insignificant in Table 2.*

*The coefficient on agglomeration of industry in the region is negative and insignificant now, while previously it was positive and sometimes significant.*

*Another new finding is that government expenditure on R&D is positive and significant, which implies that higher spending on R&D is positive for attracting more GF and BF projects.*

**Table A3 / Results of the econometric analysis for the determinants of FDI, for the number of M&A's in Austria, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7
Log of tariffs imposed by host against home in sector s	-0.62 (0.69)	-0.65 (0.66)	-0.65 (0.66)	-0.66 (0.67)	-0.65 (0.67)	-0.64 (0.66)	-0.68 (0.68)
Log of tariffs imposed by home against host in sector s	0.11 (0.58)	0.025 (0.54)	0.024 (0.54)	0.13 (0.60)	0.012 (0.51)	0.024 (0.54)	0.011 (0.54)
Log of AVE of TBTs imposed by host against home in sector s	-0.00026 (0.26)	0.043 (0.25)	0.040 (0.25)	0.019 (0.26)	0.022 (0.26)	0.039 (0.25)	0.041 (0.26)
Log of AVE of TBTs imposed by home against host in sector s	-0.14 (0.32)	-0.13 (0.32)	-0.13 (0.32)	-0.095 (0.32)	-0.15 (0.32)	-0.14 (0.32)	-0.11 (0.32)
Log of Industrial capital to labour ratio nominal m	3.64** (1.62)	3.54** (1.64)	3.52** (1.64)	3.38** (1.62)	3.44** (1.62)	3.57** (1.62)	3.35** (1.64)
Log of Industrial value-added productivity nominal m	2.05 (1.88)	2.24 (1.85)	2.18 (1.84)	2.27 (1.89)	1.96 (1.82)	2.18 (1.85)	2.15 (1.85)
Log of regional industrial wage in EUR	2.76 (1.80)	3.01 (1.83)	3.00 (1.83)	2.70 (1.83)	2.83 (1.83)	3.03* (1.84)	2.79 (1.82)
Regional industrial HHI sum of squared market share of firms	0.28 (1.16)	0.11 (1.12)	0.13 (1.13)	0.26 (1.14)	0.19 (1.14)	0.13 (1.13)	0.24 (1.14)
Labour agglomeration of industry in the region	121.3** (57.7)	112.8** (53.8)	113.4** (53.8)	110.3** (53.8)	111.1** (54.7)	116.0** (55.1)	109.9** (53.4)
Log of regional GDP in EUR million	-15.8* (8.91)	-14.8* (8.89)	-14.9* (8.88)	-15.8* (8.92)	-14.1 (8.90)	-15.0* (8.92)	-15.7* (8.93)
PC of Less than primary and lower secondary education (levels 0-2)	0.029 (0.14)	0.014 (0.14)	0.013 (0.14)	0.026 (0.14)	0.016 (0.14)	0.012 (0.14)	0.0023 (0.14)
PC of Upper secondary and post-secondary non-tertiary education (levels 3-4)	0.20 (0.12)	0.17 (0.12)	0.18 (0.12)	0.21* (0.12)	0.17 (0.12)	0.17 (0.12)	0.18 (0.12)
Log of GERD all sectors in EUR million	-0.14 (1.86)	0.12 (1.86)	0.17 (1.86)	-0.21 (1.87)	0.16 (1.86)	0.19 (1.86)	0.28 (1.85)
Log of operating revenue of firms in Austria	0.012 (0.059)		-0.018 (0.047)	-0.017 (0.047)	0.0024 (0.052)	-0.018 (0.047)	-0.013 (0.047)
Log of cash flow relative to total assets of firms in Austria	-1.14*** (0.34)			-1.01*** (0.28)			
Log of current liabilities relative to total assets of firms in Austria	-1.24 (0.83)				-1.02 (0.68)		
Log of non-current liabilities relative to total assets of firms in Austria	-0.58 (0.47)					-0.097 (0.37)	
Log profit-loss after tax	0.0017 (0.0071)						-0.0064 (0.0059)
Constant	102.2 (96.4)	87.9 (96.6)	89.1 (96.6)	104.8 (97.1)	84.2 (96.4)	90.0 (96.8)	100.7 (96.8)
Observations	1371	1371	1371	1371	1371	1371	1371
Pseudo R-squared	0.074	0.064	0.065	0.072	0.066	0.065	0.065
AIC	1315.1	1318.8	1320.7	1312.5	1320.3	1322.6	1321.6

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

*The coefficient on the trade variables are all insignificant now, though in general with same signs as in Table 3.*

*The coefficient on Industrial capital to labour ratio is significant now, but with the same positive sign as before.*

*The coefficient on Labour agglomeration of industry in the region is significant now, with the same positive sign as before.*

*The coefficient on Cash flows relative to total assets of firms in Austria are negative and significant now, while it was insignificant previously.*

**Table A4 / Results of the econometric analysis for the determinants of FDI, for the value of M&A's in Austria, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7
Log of tariffs imposed by host against home in sector s	-25.5 (19.4)	-11.2 (18.2)	-14.5 (18.1)	-15.4 (19.0)	-12.7 (16.1)	-11.0 (14.6)	-20.1 (17.4)
Log of tariffs imposed by home against host in sector s	6.15 (7.21)	3.10 (6.12)	3.50 (6.06)	3.31 (6.37)	2.50 (5.59)	2.38 (5.28)	6.25 (6.32)
Log of AVE of TBTs imposed by host against home in sector s	5.59 (3.55)	4.45* (2.54)	4.33* (2.35)	4.42* (2.38)	3.65 (2.81)	4.24* (2.57)	5.38* (2.91)
Log of AVE of TBTs imposed by home against host in sector s	-4.03 (2.78)	-3.01 (2.14)	-2.58 (1.99)	-2.44 (2.01)	-2.57 (2.09)	-3.17 (2.15)	-4.11* (2.39)
Log of Industrial capital to labour ratio nominal m	1.01 (6.37)	1.04 (6.97)	4.05 (7.37)	3.91 (7.61)	2.53 (7.31)	5.26 (7.06)	4.92 (6.07)
Log of Industrial value-added productivity nominal m	-13.1** (5.77)	-15.2** (6.81)	-20.1*** (7.27)	-19.6*** (7.20)	-18.1*** (6.99)	-19.3*** (7.19)	-17.2*** (5.81)
Log of regional industrial wage in EUR	1.92 (5.55)	10.3** (4.34)	9.07** (4.03)	8.91** (4.03)	8.08* (4.15)	9.29** (4.14)	5.69 (4.80)
Regional industrial HHI sum of squared market share of firms	7.98** (3.68)	5.45* (3.14)	6.24* (3.31)	5.79* (3.25)	6.04* (3.21)	6.67* (3.46)	8.81** (3.61)
Labour agglomeration of industry in the region	-295.1* (179.2)	-39.8 (131.4)	-69.0 (129.4)	-78.7 (140.0)	-83.1 (129.7)	-96.7 (138.7)	-191.0 (142.6)
Log of regional GDP in EUR million	40.4 (28.4)	0.97 (22.4)	6.43 (21.0)	9.49 (21.5)	25.1 (24.4)	13.5 (21.8)	9.74 (25.5)
PC of Less than primary and lower secondary education (levels 0-2)	-0.91** (0.45)	-0.54 (0.41)	-0.51 (0.36)	-0.51 (0.37)	-0.43 (0.35)	-0.55 (0.36)	-0.88** (0.43)
PC of Upper secondary and post-secondary non-tertiary education (levels 3-4)	-0.86*** (0.32)	-0.72** (0.28)	-0.83*** (0.31)	-0.85*** (0.31)	-0.77** (0.32)	-0.85*** (0.31)	-0.88*** (0.31)
Log of GERD all sectors in EUR million	-3.29 (4.92)	-2.62 (5.12)	-3.11 (4.79)	-3.00 (4.96)	-5.74 (5.67)	-4.44 (5.02)	-1.11 (3.88)
Log of operating revenue of firms in Austria	0.40** (0.17)		0.44*** (0.16)	0.42*** (0.16)	0.62*** (0.22)	0.42*** (0.15)	0.27** (0.13)
Log of cash flow relative to total assets of firms in Austria	3.57* (1.97)			1.58 (1.09)			
Log of current liabilities relative to total assets of firms in Austria	-5.25* (2.92)				-4.33 (2.70)		
Log of non-current liabilities relative to total assets of firms in Austria	-0.96 (1.89)					1.87 (1.71)	
Log profit-loss after tax	-0.091*** (0.024)						-0.076*** (0.021)
Constant	-326.9 (325.6)	33.7 (257.6)	-8.38 (232.6)	-43.3 (231.6)	-202.7 (261.7)	-95.0 (236.8)	-32.1 (302.4)
Observations	534	534	534	534	534	534	534
Pseudo R-squared	0.656	0.543	0.585	0.589	0.592	0.589	0.635
AIC	2.41383e+10	3.20413e+10	2.91511e+10	2.88584e+10	2.86535e+10	2.88676e+10	2.56289e+10

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, home country-industry, and year fixed effects. The period of estimation is 2010-2017.

*The coefficients on the trade variables are mostly insignificant now, differently from Table 4.*

*The coefficient on Industrial value-added productivity is negative and significant now, while it was positive, though insignificant before.*

*The coefficient on regional industrial HHI sum of squared market share of firms is positive and significant now, while in Table 5 it was negative and significant.*

*The coefficients on the firm-level variables are significant now, while previously they were mostly insignificant.*

**Table A5 / Results of the econometric analysis for FDI spill-overs, for regional sectors, for granted patents of all type, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of granted non-environmental patents by GUOs investing in RS	-0.070 (0.052)	-0.074 (0.052)	-0.054 (0.052)	-0.060 (0.052)	-0.085 (0.052)	-0.074 (0.052)	-0.066 (0.052)	-0.062 (0.052)
Log Number of granted environmental patents by GUOs investing in RS	0.16** (0.068)	0.17** (0.069)	0.14** (0.066)	0.15** (0.066)	0.18*** (0.065)	0.17** (0.069)	0.16** (0.064)	0.15** (0.066)
Log VA productivity in number of employees in thousands	-0.032 (0.61)	-0.058 (0.62)	-0.019 (0.62)	0.0060 (0.61)	-0.040 (0.60)	-0.058 (0.62)	-0.037 (0.61)	0.021 (0.61)
Log Real capital to labour ratio	1.20*** (0.40)	0.75* (0.43)	1.07** (0.44)	0.70 (0.49)	0.75* (0.42)	0.75* (0.43)	0.64 (0.49)	0.68 (0.49)
Log of wage in RS	0.39 (0.42)	0.37 (0.43)	0.16 (0.43)	0.15 (0.44)	0.38 (0.44)	0.37 (0.43)	0.16 (0.44)	0.14 (0.44)
Log of GDP per capita in region in euro	3.38 (2.41)	3.58 (2.49)	3.61 (2.45)	4.20* (2.54)	3.64 (2.53)	3.58 (2.49)	4.07 (2.54)	4.05 (2.56)
Log of total regional fund	0.018 (0.070)	0.00018 (0.070)	0.023 (0.070)	0.011 (0.072)	-0.015 (0.069)	0.00018 (0.070)	-0.0060 (0.070)	0.0092 (0.072)
PC of 25-64 Tertiary education (levels 5-8)	-0.0077 (0.046)	-0.0095 (0.047)	-0.0054 (0.046)	-0.011 (0.047)	-0.0047 (0.047)	-0.0095 (0.047)	-0.0038 (0.047)	-0.011 (0.047)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.014 (0.043)	0.0095 (0.044)	0.011 (0.043)	0.0091 (0.045)	0.025 (0.044)	0.0095 (0.044)	0.015 (0.044)	0.013 (0.045)
Log of Full-time equivalent R&D personnel in all sectors	-1.69 (1.29)	-2.25* (1.36)	-1.68 (1.28)	-2.26* (1.35)	-1.94 (1.38)	-2.25* (1.36)	-2.06 (1.34)	-2.17 (1.37)
Log of GERD all sectors in EUR million	0.78 (1.04)	0.97 (1.09)	0.49 (1.06)	0.76 (1.10)	0.77 (1.06)	0.97 (1.09)	0.59 (1.08)	0.69 (1.09)
Agglomeration of labour in regional industry relative to region	47.0** (18.6)	38.4** (19.6)	44.5** (18.8)	39.9** (19.8)	47.7** (19.8)	38.4** (19.6)	44.6** (19.6)	39.2** (20.0)
HHI of firm's sales in the regional industry	-0.23 (0.17)	-0.21 (0.18)	-0.14 (0.17)	-0.14 (0.17)	-0.22 (0.18)	-0.21 (0.18)	-0.12 (0.17)	-0.14 (0.17)
Log of foreign-owned total assets in RS as FDI stock	0.029*** (0.0098)	0.029*** (0.0099)			0.030*** (0.0098)	0.029*** (0.0099)		
Number of M&A deals in RS	-0.16*** (0.048)		-0.16*** (0.050)					
Log Number of GF or BF projects in RS	0.11* (0.063)			0.096 (0.065)				
Log of USD value of all completed projects GF and BF in RS					0.011** (0.0053)			0.010* (0.0053)
Log value of M&A deals in RS					0.013*** (0.0049)		0.012** (0.0050)	
Constant	-46.7** (23.5)	-38.0 (24.4)	-42.4* (23.6)	-40.4 (24.8)	-41.3* (24.7)	-38.0 (24.4)	-38.7 (24.9)	-39.2 (24.8)
Observations	1652	1652	1652	1652	1652	1652	1652	1652
Pseudo R-squared	0.769	0.767	0.767	0.766	0.769	0.767	0.766	0.766
AIC	7358.2	7415.2	7413.2	7460.0	7376.7	7415.2	7444.5	7453.8

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including regional industry and year fixed effects. The period of estimation is 2008-2017.

*Results here are similar to results in Table 5, with some differences in significance.*

**Table A6 / Results of the econometric analysis for FDI spillovers, for regional sectors, for all published patents (including non-granted), for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.052** (0.025)	-0.056** (0.025)	-0.056** (0.025)	-0.050** (0.025)	-0.057** (0.025)	-0.056** (0.025)	-0.058** (0.025)	-0.054** (0.025)
Log Number of environmental patents published by foreign GUO investing in RS	-0.0035 (0.022)	-0.0071 (0.022)	-0.0060 (0.022)	-0.0051 (0.022)	-0.0055 (0.022)	-0.0071 (0.022)	-0.0076 (0.022)	-0.0057 (0.022)
Log VA productivity in number of employees in thousands	-0.48* (0.27)	-0.46* (0.27)	-0.45* (0.26)	-0.48* (0.27)	-0.48* (0.26)	-0.46* (0.27)	-0.46* (0.26)	-0.47* (0.27)
Log Real capital to labour ratio	0.79*** (0.22)	0.87*** (0.21)	0.81*** (0.23)	0.84*** (0.22)	0.83*** (0.21)	0.87*** (0.21)	0.84*** (0.22)	0.87*** (0.22)
Log of wage in RS	-0.21 (0.17)	-0.19 (0.17)	-0.22 (0.18)	-0.22 (0.18)	-0.18 (0.17)	-0.19 (0.17)	-0.20 (0.18)	-0.22 (0.18)
Log of GDP per capita in region in EUR	0.19 (1.17)	0.40 (1.16)	0.50 (1.17)	0.19 (1.14)	0.33 (1.17)	0.40 (1.16)	0.43 (1.16)	0.41 (1.16)
Log of total regional fund	-0.048 (0.034)	-0.045 (0.036)	-0.047 (0.036)	-0.045 (0.034)	-0.048 (0.035)	-0.045 (0.036)	-0.047 (0.035)	-0.044 (0.035)
PC of 25-64 Tertiary education (levels 5-8)	0.026 (0.022)	0.024 (0.022)	0.022 (0.022)	0.027 (0.022)	0.027 (0.022)	0.024 (0.022)	0.026 (0.022)	0.024 (0.022)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	-0.0013 (0.020)	-0.00023 (0.020)	-0.0019 (0.020)	-0.0018 (0.020)	0.0017 (0.021)	-0.00023 (0.020)	0.0020 (0.020)	-0.0029 (0.020)
Log of Full-time equivalent R&D personnel in all sectors	-0.17 (0.70)	-0.13 (0.70)	-0.17 (0.71)	-0.10 (0.70)	-0.050 (0.69)	-0.13 (0.70)	-0.0058 (0.70)	-0.14 (0.70)
Log of GERD all sectors in EUR million	0.43 (0.53)	0.46 (0.53)	0.45 (0.53)	0.40 (0.54)	0.40 (0.53)	0.46 (0.53)	0.36 (0.53)	0.45 (0.54)
Agglomeration of labour in regional industry relative to region	53.2*** (10.5)	57.5*** (11.4)	55.9*** (11.6)	53.5*** (10.3)	58.7*** (11.2)	57.5*** (11.4)	58.8*** (11.5)	56.3*** (11.1)
HHI of firm's sales in the regional industry	-0.087 (0.072)	-0.098 (0.073)	-0.086 (0.071)	-0.073 (0.070)	-0.087 (0.073)	-0.098 (0.073)	-0.077 (0.071)	-0.079 (0.071)
Log of foreign-owned total assets in RS as FDI stock	0.0036 (0.0037)	0.0046 (0.0038)			0.0045 (0.0038)	0.0046 (0.0038)		
Number of M&A deals in RS	0.036 (0.028)		0.040 (0.028)					
Log Number of GF or BF projects in RS	-0.11*** (0.040)			-0.12*** (0.040)				
Log of USD value of all completed projects GF and BF in RS					-0.0037 (0.0031)			-0.0041 (0.0031)
Log value of M&A deals in RS					0.0068*** (0.0026)		0.0069*** (0.0026)	
Constant	-1.47 (11.2)	-6.03 (11.3)	-5.50 (11.2)	-2.35 (11.1)	-5.18 (11.3)	-6.03 (11.3)	-6.33 (11.3)	-5.39 (11.3)
Observations	3253	3253	3253	3253	3253	3253	3253	3253
Pseudo R-squared	0.924	0.924	0.924	0.924	0.924	0.924	0.924	0.924
AIC	26366.0	26560.3	26541.7	26413.0	26423.3	26560.3	26470.3	26555.6

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including regional industry and year fixed effects. The period of estimation is 2008-2017.

*Results here are similar to results in Table 6, with some differences in significance.*

**Table A7 / Results of the econometric analysis for FDI spillovers, for regional sectors, for granted environmental patents, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of granted non-environmental patents by GUOs investing in RS	-0.17** (0.073)	-0.17** (0.073)	-0.16** (0.072)	-0.17** (0.072)	-0.18** (0.073)	-0.17** (0.073)	-0.17** (0.072)	-0.16** (0.072)
Log Number of granted environmental patents by GUOs investing in RS	0.34*** (0.074)	0.35*** (0.074)	0.33*** (0.072)	0.34*** (0.071)	0.36*** (0.072)	0.35*** (0.074)	0.34*** (0.070)	0.34*** (0.071)
Log VA productivity in number of employees in thousands	-0.30 (0.83)	-0.27 (0.84)	-0.27 (0.84)	-0.28 (0.84)	-0.35 (0.83)	-0.27 (0.84)	-0.29 (0.84)	-0.29 (0.83)
Log Real capital to labour ratio	1.02** (0.49)	0.74 (0.49)	1.07** (0.50)	0.65 (0.51)	0.68 (0.49)	0.74 (0.49)	0.71 (0.51)	0.67 (0.51)
Log of wage in RS	-0.48 (0.62)	-0.51 (0.64)	-0.57 (0.63)	-0.53 (0.63)	-0.47 (0.63)	-0.51 (0.64)	-0.58 (0.64)	-0.52 (0.63)
Log of GDP per capita in region in EUR	1.98 (3.00)	2.58 (3.05)	2.42 (3.00)	2.44 (3.03)	2.41 (3.02)	2.58 (3.05)	2.72 (3.05)	2.64 (3.00)
Log of total regional fund	0.062 (0.095)	0.054 (0.096)	0.070 (0.097)	0.052 (0.094)	0.038 (0.093)	0.054 (0.096)	0.042 (0.095)	0.056 (0.095)
PC of 25-64 Tertiary education (levels 5-8)	0.017 (0.057)	0.015 (0.059)	0.017 (0.057)	0.014 (0.058)	0.017 (0.059)	0.015 (0.059)	0.020 (0.059)	0.013 (0.058)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.028 (0.057)	0.033 (0.059)	0.032 (0.057)	0.026 (0.058)	0.029 (0.058)	0.033 (0.059)	0.038 (0.058)	0.022 (0.058)
Log of Full-time equivalent R&D personnel in all sectors	0.15 (1.68)	-0.37 (1.78)	0.12 (1.71)	-0.40 (1.74)	-0.31 (1.72)	-0.37 (1.78)	-0.27 (1.76)	-0.48 (1.73)
Log of GERD all sectors in EUR million	0.0088 (1.32)	0.27 (1.36)	-0.014 (1.33)	0.16 (1.35)	0.28 (1.34)	0.27 (1.36)	0.16 (1.35)	0.25 (1.36)
Agglomeration of labour in regional industry relative to region	46.7* (24.8)	45.2* (25.1)	50.8** (25.4)	39.9 (24.8)	48.8** (24.0)	45.2* (25.1)	50.8** (25.1)	41.5* (24.5)
HHI of firm's sales in the regional industry	0.15 (0.24)	0.14 (0.24)	0.15 (0.23)	0.18 (0.24)	0.17 (0.24)	0.14 (0.24)	0.17 (0.23)	0.19 (0.24)
Log of foreign-owned total assets in RS as FDI stock	0.0083 (0.013)	0.010 (0.013)			0.010 (0.013)	0.010 (0.013)		
Number of M&A deals in RS	-0.13** (0.061)		-0.13** (0.061)					
Log Number of GF or BF projects in RS	-0.17 (0.12)			-0.18 (0.12)				
Log of USD value of all completed projects GF and BF in RS					-0.014 (0.010)			-0.015 (0.010)
Log value of M&A deals in RS					0.013** (0.0064)		0.013** (0.0064)	
Constant	-30.4 (30.6)	-30.8 (30.6)	-35.2 (30.3)	-25.9 (30.8)	-28.0 (30.6)	-30.8 (30.6)	-31.1 (30.8)	-28.1 (30.4)
Observations	1426	1426	1426	1426	1426	1426	1426	1426
Pseudo R-squared	0.659	0.657	0.658	0.658	0.659	0.657	0.658	0.658
AIC	3845.7	3858.8	3849.5	3853.9	3848.0	3858.8	3853.6	3852.9

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including regional industry and year fixed effects. The period of estimation is 2008-2017.

*Results here are similar to results in Table 7, with some differences in significance.*

**Table A8 / Results of the econometric analysis for FDI spillovers, for regional sectors, for published environmental patents (including non-granted), for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.092* (0.052)	-0.095* (0.052)	-0.086* (0.052)	-0.094* (0.052)	-0.10** (0.052)	-0.095* (0.052)	-0.095* (0.052)	-0.096* (0.052)
Log Number of environmental patents published by foreign GUO investing in RS	0.27*** (0.078)	0.29*** (0.080)	0.27*** (0.078)	0.29*** (0.080)	0.29*** (0.079)	0.29*** (0.080)	0.28*** (0.079)	0.28*** (0.080)
Log VA productivity in number of employees in thousands	-0.034 (0.59)	-0.055 (0.59)	-0.038 (0.59)	-0.014 (0.59)	-0.032 (0.58)	-0.055 (0.59)	-0.050 (0.59)	0.0011 (0.59)
Log Real capital to labour ratio	1.21*** (0.39)	0.79* (0.41)	1.06** (0.41)	0.71 (0.46)	0.80** (0.41)	0.79* (0.41)	0.67 (0.46)	0.70 (0.46)
Log of wage in RS	0.35 (0.43)	0.33 (0.44)	0.13 (0.43)	0.12 (0.44)	0.34 (0.44)	0.33 (0.44)	0.13 (0.45)	0.12 (0.44)
Log of GDP per capita in region in EUR	2.97 (2.41)	3.13 (2.48)	3.30 (2.43)	3.77 (2.50)	3.08 (2.52)	3.13 (2.48)	3.63 (2.51)	3.61 (2.53)
Log of total regional fund	0.0023 (0.067)	-0.016 (0.067)	0.0068 (0.067)	-0.0046 (0.069)	-0.028 (0.067)	-0.016 (0.067)	-0.020 (0.067)	-0.0065 (0.069)
PC of 25-64 Tertiary education (levels 5-8)	-0.0046 (0.046)	-0.0051 (0.047)	-0.0028 (0.045)	-0.0072 (0.046)	-0.00080 (0.046)	-0.0051 (0.047)	-0.00034 (0.046)	-0.0071 (0.046)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.0060 (0.043)	0.0022 (0.044)	0.0014 (0.043)	0.00064 (0.045)	0.017 (0.044)	0.0022 (0.044)	0.0065 (0.044)	0.0045 (0.045)
Log of Full-time equivalent R&D personnel in all sectors	-1.59 (1.26)	-2.11 (1.33)	-1.58 (1.24)	-2.11 (1.31)	-1.83 (1.36)	-2.11 (1.33)	-1.95 (1.31)	-2.02 (1.33)
Log of GERD all sectors in EUR million	0.96 (1.02)	1.16 (1.06)	0.69 (1.02)	0.95 (1.06)	0.98 (1.04)	1.16 (1.06)	0.80 (1.05)	0.89 (1.06)
Agglomeration of labour in regional industry relative to region	48.5*** (18.3)	40.6** (19.1)	46.0** (18.4)	41.9** (19.3)	49.0** (19.4)	40.6** (19.1)	46.1** (19.2)	41.3** (19.4)
HHI of firm's sales in the regional industry	-0.25 (0.17)	-0.23 (0.17)	-0.16 (0.16)	-0.16 (0.17)	-0.24 (0.17)	-0.23 (0.17)	-0.15 (0.17)	-0.17 (0.17)
Log of foreign-owned total assets in RS as FDI stock	0.027*** (0.0092)	0.026*** (0.0093)			0.028*** (0.0092)	0.026*** (0.0093)		
Number of M&A deals in RS	-0.15*** (0.048)		-0.15*** (0.049)					
Log Number of GF or BF projects in RS	0.10 (0.063)			0.089 (0.064)				
Log of USD value of all completed projects GF and BF in RS					0.010* (0.0055)			0.0090* (0.0054)
Log value of M&A deals in RS					0.011** (0.0047)		0.010** (0.0048)	
Constant	-43.8* (23.8)	-35.7 (24.5)	-40.4* (23.9)	-38.0 (24.8)	-37.8 (24.8)	-35.7 (24.5)	-36.3 (24.9)	-36.6 (24.8)
Observations	1652	1652	1652	1652	1652	1652	1652	1652
Pseudo R-squared	0.771	0.770	0.770	0.768	0.771	0.770	0.769	0.768
AIC	7294.6	7344.5	7342.5	7383.2	7315.2	7344.5	7372.2	7378.5
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.092* (0.052)	-0.095* (0.052)	-0.086* (0.052)	-0.094* (0.052)	-0.10** (0.052)	-0.095* (0.052)	-0.095* (0.052)	-0.096* (0.052)

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including regional industry and year fixed effects. The period of estimation is 2008-2017.

*Results here are very similar to results in Table 8, with some differences in significance.*

**Table A9 / Results of the econometric analysis for FDI spillovers, for labour productivity of domestically owned firms, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign-owned firms in RS	0.019 (0.023)	0.019 (0.023)	0.019 (0.023)	0.019 (0.023)	0.018 (0.023)	0.019 (0.023)	0.019 (0.023)	0.019 (0.023)
Log Number of environmental patents published by foreign-owned firms in RS	-0.0063 (0.026)	-0.011 (0.026)	-0.011 (0.025)	-0.0070 (0.027)	-0.014 (0.027)	-0.011 (0.026)	-0.018 (0.027)	-0.0080 (0.026)
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.026 (0.038)	-0.024 (0.037)	-0.024 (0.037)	-0.026 (0.038)	-0.031 (0.039)	-0.024 (0.037)	-0.027 (0.038)	-0.028 (0.039)
Log Number of environmental patents published by foreign GUO investing in RS	0.072 (0.049)	0.072 (0.048)	0.071 (0.049)	0.072 (0.048)	0.071 (0.048)	0.072 (0.048)	0.070 (0.048)	0.073 (0.048)
Log VA productivity in number of employees in thousands	0.075 (0.49)	0.057 (0.50)	0.053 (0.50)	0.070 (0.49)	0.058 (0.50)	0.057 (0.50)	0.034 (0.50)	0.071 (0.49)
Log Real capital to labour ratio	-1.63** (0.65)	-1.56** (0.64)	-1.57** (0.64)	-1.64** (0.65)	-1.65** (0.66)	-1.56** (0.64)	-1.58** (0.64)	-1.65** (0.66)
Log of wage in RS	0.94 (0.77)	0.94 (0.77)	0.94 (0.77)	0.94 (0.77)	0.96 (0.77)	0.94 (0.77)	0.96 (0.77)	0.94 (0.77)
Log of total regional fund	0.0062 (0.044)	0.0079 (0.045)	0.0085 (0.045)	0.0069 (0.044)	0.0062 (0.045)	0.0079 (0.045)	0.0099 (0.045)	0.0058 (0.045)
PC of 25-64 Tertiary education (levels 5-8)	0.11*** (0.041)	0.11*** (0.040)	0.11*** (0.041)	0.11*** (0.040)	0.11*** (0.041)	0.11*** (0.040)	0.10** (0.040)	0.11*** (0.041)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.076** (0.036)	0.075** (0.035)	0.075** (0.036)	0.076** (0.036)	0.076** (0.036)	0.075** (0.035)	0.074** (0.035)	0.077** (0.036)
Log of Full-time equivalent R&D personnel in all sectors	-0.48 (0.84)	-0.51 (0.86)	-0.50 (0.86)	-0.48 (0.84)	-0.44 (0.84)	-0.51 (0.86)	-0.46 (0.86)	-0.48 (0.84)
Log of GERD all sectors in EUR million	1.26* (0.66)	1.27* (0.66)	1.27* (0.66)	1.27* (0.66)	1.24* (0.65)	1.27* (0.66)	1.25* (0.66)	1.26* (0.65)
Agglomeration of labour in regional industry relative to region	-32.6** (15.8)	-32.8** (15.7)	-32.7** (15.8)	-32.7** (15.8)	-34.6** (15.8)	-32.8** (15.7)	-34.3** (15.9)	-33.1** (15.7)
HHI of firm's sales in the regional industry	-0.36 (0.45)	-0.36 (0.45)	-0.36 (0.45)	-0.36 (0.45)	-0.37 (0.45)	-0.36 (0.45)	-0.37 (0.45)	-0.37 (0.45)
Log of foreign-owned total assets in RS as FDI stock	0.0097 (0.015)	0.0093 (0.015)			0.0092 (0.015)	0.0093 (0.015)		
Number of M&A deals in RS	-0.0055 (0.030)		-0.0059 (0.029)					
Log Number of GF or BF projects in RS	0.017 (0.033)			0.017 (0.033)				
Log of USD value of all completed projects GF and BF in RS					0.0020 (0.0025)			0.0018 (0.0025)
Log total assets of domestically-owned firms	0.34*** (0.082)	0.34*** (0.083)	0.34*** (0.082)	0.34*** (0.082)	0.34*** (0.083)	0.34*** (0.083)	0.34*** (0.083)	0.34*** (0.082)
Log value of M&A deals in RS					-0.0032 (0.0027)		-0.0031 (0.0027)	
Constant	7.97 (10.1)	7.64 (10.3)	7.89 (10.2)	8.38 (10.2)	8.30 (10.3)	7.64 (10.3)	8.03 (10.2)	8.52 (10.3)
Observations	80173	80173	80173	80173	80173	80173	80173	80173
Pseudo R-squared	0.944	0.944	0.944	0.944	0.944	0.944	0.944	0.944
AIC	1.23078e+10	1.23098e+10	1.23105e+10	1.23091e+10	1.22998e+10	1.23098e+10	1.23043e+10	1.23077e+10

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017

*The coefficient on total assets of domestically-owned firms is positive and significant now, while it was negative and insignificant before.*

*The coefficient on number of M&A deals in RS is negative and insignificant now, while it was positive and significant before.*



**Table A10 / Results of the econometric analysis for FDI spillovers, for employment of domestically owned firms, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign-owned firms in RS	-0.0036 (0.0096)	-0.0042 (0.010)	-0.0032 (0.0097)	-0.0045 (0.010)	-0.0050 (0.010)	-0.0042 (0.010)	-0.0043 (0.010)	-0.0047 (0.010)
Log Number of environmental patents published by foreign-owned firms in RS	0.021 (0.035)	0.021 (0.035)	0.021 (0.035)	0.021 (0.035)	0.021 (0.035)	0.021 (0.035)	0.021 (0.035)	0.021 (0.035)
Log Number of non-environmental patents published by foreign GUO investing in RS	0.018*** (0.0051)	0.017*** (0.0052)	0.017*** (0.0052)	0.018*** (0.0051)	0.018*** (0.0052)	0.017*** (0.0052)	0.017*** (0.0053)	0.018*** (0.0052)
Log Number of environmental patents published by foreign GUO investing in RS	-0.019 (0.013)	-0.020 (0.013)	-0.020 (0.013)	-0.020 (0.013)	-0.019 (0.013)	-0.020 (0.013)	-0.020 (0.013)	-0.020 (0.013)
Log VA productivity in number of employees in thousands	-0.52*** (0.16)	-0.51*** (0.16)	-0.51*** (0.16)	-0.51*** (0.16)	-0.51*** (0.16)	-0.51*** (0.16)	-0.50*** (0.16)	-0.51*** (0.16)
Log Real capital to labour ratio	0.22 (0.16)	0.20 (0.15)	0.19 (0.15)	0.20 (0.15)	0.23 (0.16)	0.20 (0.15)	0.18 (0.15)	0.22 (0.15)
Log of wage in RS	-0.39** (0.17)	-0.39** (0.17)	-0.39** (0.17)	-0.39** (0.17)	-0.39** (0.17)	-0.39** (0.17)	-0.39** (0.17)	-0.40** (0.17)
Log of GDP per capita in region in EUR	1.40*** (0.44)	1.41*** (0.43)	1.47*** (0.43)	1.45*** (0.44)	1.38*** (0.43)	1.41*** (0.43)	1.47*** (0.43)	1.43*** (0.43)
Log of total regional fund	0.028*** (0.0086)	0.027*** (0.0087)	0.028*** (0.0087)	0.028*** (0.0086)	0.028*** (0.0083)	0.027*** (0.0087)	0.027*** (0.0085)	0.029*** (0.0085)
PC of 25-64 Tertiary education (levels 5-8)	-0.012 (0.0080)	-0.012 (0.0081)	-0.012 (0.0081)	-0.012 (0.0080)	-0.013 (0.0080)	-0.012 (0.0081)	-0.012 (0.0080)	-0.013 (0.0080)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.0020 (0.012)	0.0021 (0.012)	0.0017 (0.012)	0.00098 (0.011)	0.0012 (0.011)	0.0021 (0.012)	0.0015 (0.011)	0.00042 (0.011)
Log of Full-time equivalent R&D personnel in all sectors	-0.59** (0.25)	-0.59** (0.25)	-0.62** (0.25)	-0.61** (0.25)	-0.59** (0.25)	-0.59** (0.25)	-0.62** (0.25)	-0.62** (0.25)
Log of GERD all sectors in EUR million	-0.24 (0.15)	-0.23 (0.15)	-0.25* (0.15)	-0.26* (0.15)	-0.24 (0.15)	-0.23 (0.15)	-0.25* (0.15)	-0.26* (0.15)
Agglomeration of labour in regional industry relative to region	10.7*** (2.67)	10.4*** (2.71)	10.3*** (2.70)	10.2*** (2.73)	10.6*** (2.76)	10.4*** (2.71)	10.0*** (2.78)	10.5*** (2.74)
HHI of firm's sales in the regional industry	0.083 (0.077)	0.084 (0.079)	0.060 (0.079)	0.063 (0.081)	0.086 (0.079)	0.084 (0.079)	0.062 (0.081)	0.065 (0.080)
Log of foreign-owned total assets in RS as FDI stock	0.0073* (0.0044)	0.0074* (0.0044)			0.0072* (0.0044)	0.0074* (0.0044)		
Number of M&A deals in RS	-0.0085 (0.014)		-0.0084 (0.014)					
Log Number of GF or BF projects in RS	-0.0097 (0.012)			-0.011 (0.012)				
Log of USD value of all completed projects GF and BF in RS					-0.0019* (0.0010)			-0.0019* (0.0010)
Log total assets of domestically-owned firms	0.37*** (0.016)	0.37*** (0.016)	0.37*** (0.016)	0.37*** (0.016)	0.37*** (0.016)	0.37*** (0.016)	0.37*** (0.016)	0.37*** (0.016)
Log value of M&A deals in RS					0.00068 (0.0012)		0.00056 (0.0012)	
Constant	-2.88 (4.96)	-2.80 (5.01)	-2.82 (4.96)	-2.52 (4.98)	-2.52 (4.99)	-2.80 (5.01)	-2.63 (5.00)	-2.38 (4.96)
Observations	276973	276973	276973	276973	276973	276973	276973	276973
Pseudo R-squared	0.933	0.933	0.933	0.933	0.933	0.933	0.933	0.933
AIC	1574082.1	1574204.1	1574433.6	1574426.0	1573834.5	1574204.1	1574469.8	1574151.7

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017

*The results here are in general similar to the results from Table 10, with some differences in the magnitudes and significance of the coefficients.*

**Table A11 / Results of the econometric analysis for FDI spillovers, for domestic firms, for granted patents of all type, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of granted non-environmental patents by foreign-owned firms in RS	0.11*** (0.033)	0.12*** (0.033)	0.12*** (0.034)	0.12*** (0.033)	0.11*** (0.032)	0.12*** (0.033)	0.11*** (0.033)	0.12*** (0.033)
Log granted environmental patents published by foreign-owned firms in RS	-0.040 (0.041)	-0.036 (0.042)	-0.034 (0.042)	-0.038 (0.041)	-0.017 (0.043)	-0.036 (0.042)	-0.014 (0.044)	-0.036 (0.042)
Log Number of granted non-environmental patents by GUOs investing in RS	-0.061 (0.046)	-0.060 (0.047)	-0.060 (0.047)	-0.061 (0.047)	-0.060 (0.047)	-0.060 (0.047)	-0.060 (0.047)	-0.060 (0.047)
Log Number of granted environmental patents by GUOs investing in RS	-0.017 (0.046)	-0.019 (0.046)	-0.019 (0.047)	-0.016 (0.046)	-0.020 (0.047)	-0.019 (0.046)	-0.020 (0.047)	-0.017 (0.046)
Log VA productivity in number of employees in thousands	-0.10 (0.61)	-0.10 (0.60)	-0.0067 (0.61)	-0.022 (0.61)	-0.021 (0.59)	-0.10 (0.60)	0.065 (0.60)	-0.018 (0.61)
Log Real capital to labour ratio	0.78* (0.40)	0.83** (0.40)	0.78* (0.40)	0.76* (0.40)	0.84** (0.38)	0.83** (0.40)	0.82** (0.38)	0.79** (0.40)
Log of wage in RS	-0.21 (0.36)	-0.18 (0.36)	-0.18 (0.37)	-0.20 (0.37)	-0.19 (0.36)	-0.18 (0.36)	-0.18 (0.36)	-0.18 (0.37)
Log of GDP per capita in region in EUR	-0.13 (2.01)	0.092 (2.00)	0.023 (2.00)	-0.22 (1.99)	-0.14 (1.98)	0.092 (2.00)	-0.15 (1.98)	-0.074 (1.99)
Log of total regional fund	-0.057 (0.055)	-0.061 (0.055)	-0.061 (0.056)	-0.056 (0.054)	-0.074 (0.054)	-0.061 (0.055)	-0.075 (0.054)	-0.059 (0.055)
PC of 25-64 Tertiary education (levels 5-8)	0.019 (0.041)	0.017 (0.041)	0.014 (0.041)	0.016 (0.041)	0.021 (0.041)	0.017 (0.041)	0.018 (0.041)	0.014 (0.041)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	-0.039 (0.039)	-0.039 (0.039)	-0.041 (0.040)	-0.041 (0.040)	-0.033 (0.039)	-0.039 (0.039)	-0.034 (0.040)	-0.041 (0.040)
Log of Full-time equivalent R&D personnel in all sectors	0.89 (1.04)	0.85 (1.02)	0.79 (1.04)	0.89 (1.04)	1.10 (1.03)	0.85 (1.02)	1.06 (1.03)	0.86 (1.04)
Log of GERD all sectors in EUR million	0.72 (0.91)	0.78 (0.91)	0.85 (0.92)	0.77 (0.93)	0.66 (0.91)	0.78 (0.91)	0.73 (0.91)	0.81 (0.92)
Agglomeration of labour in regional industry relative to region	34.9** (15.0)	36.8** (15.2)	35.9** (15.3)	34.3** (15.1)	39.7*** (15.4)	36.8** (15.2)	39.6** (15.5)	35.6** (15.2)
HHI of firm's sales in the regional industry	-0.36** (0.16)	-0.37** (0.16)	-0.32* (0.17)	-0.30* (0.17)	-0.36** (0.16)	-0.37** (0.16)	-0.31* (0.17)	-0.31* (0.17)
Log of foreign-owned total assets in RS as FDI stock	-0.017 (0.017)	-0.016 (0.017)			-0.016 (0.017)	-0.016 (0.017)		
Number of M&A deals in RS	0.0057 (0.036)		0.011 (0.036)					
Log Number of GF or BF projects in RS	-0.086* (0.046)			-0.085* (0.046)				
Log of USD value of all completed projects GF and BF in RS					-0.0026 (0.0036)			-0.0028 (0.0036)
Log total assets of domestically-owned firms	0.40*** (0.10)	0.40*** (0.10)	0.40*** (0.10)	0.40*** (0.10)	0.39*** (0.10)	0.40*** (0.10)	0.39*** (0.10)	0.40*** (0.10)
Log value of M&A deals in RS					0.011*** (0.0033)		0.011*** (0.0034)	
Constant	-21.5 (20.8)	-24.8 (21.1)	-24.8 (21.0)	-21.8 (21.0)	-25.0 (21.1)	-24.8 (21.1)	-26.2 (21.3)	-24.0 (21.1)
Observations	11672	11672	11672	11672	11672	11672	11672	11672
Pseudo R-squared	0.763	0.763	0.763	0.763	0.763	0.763	0.763	0.763
AIC	27391.8	27405.5	27417.2	27400.8	27361.0	27405.5	27369.8	27415.3

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017.

*The coefficient on the HHI of firm's sales in the regional industry is positive and significant now, while it was negative and significant in Table 11.*

*Other results are similar to the previous ones, with some differences in significance.*

**Table A12 / Results of the econometric analysis for FDI spill-overs, for domestic companies, for published patents of all type (including non-granted), for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign-owned firms in RS	0.080*** (0.024)	0.085*** (0.025)	0.079*** (0.024)	0.085*** (0.025)	0.077*** (0.024)	0.085*** (0.025)	0.077*** (0.024)	0.085*** (0.025)
Log Number of environmental patents published by foreign-owned firms in RS	0.012 (0.024)	0.0098 (0.024)	0.011 (0.024)	0.011 (0.024)	0.012 (0.024)	0.0098 (0.024)	0.0087 (0.024)	0.012 (0.024)
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.055* (0.033)	-0.058* (0.034)	-0.059* (0.034)	-0.054 (0.033)	-0.058* (0.033)	-0.058* (0.034)	-0.061* (0.033)	-0.055* (0.033)
Log Number of environmental patents published by foreign GUO investing in RS	-0.059* (0.033)	-0.060* (0.033)	-0.060* (0.033)	-0.059* (0.033)	-0.060* (0.034)	-0.060* (0.033)	-0.061* (0.033)	-0.059* (0.033)
Log VA productivity in number of employees in thousands	0.38 (0.40)	0.34 (0.40)	0.38 (0.40)	0.37 (0.40)	0.37 (0.39)	0.34 (0.40)	0.36 (0.39)	0.36 (0.40)
Log Real capital to labour ratio	-0.013 (0.29)	0.068 (0.29)	0.00099 (0.29)	0.039 (0.29)	0.060 (0.28)	0.068 (0.29)	0.075 (0.28)	0.049 (0.29)
Log of wage in RS	-0.076 (0.23)	-0.049 (0.23)	-0.051 (0.23)	-0.074 (0.23)	-0.059 (0.23)	-0.049 (0.23)	-0.046 (0.23)	-0.062 (0.23)
Log of GDP per capita in region in EUR	-2.84** (1.40)	-2.78** (1.38)	-2.66* (1.39)	-2.98** (1.38)	-3.13** (1.37)	-2.78** (1.38)	-3.05** (1.36)	-2.89** (1.38)
Log of total regional fund	-0.098** (0.048)	-0.10** (0.049)	-0.10** (0.049)	-0.097** (0.048)	-0.11** (0.047)	-0.10** (0.049)	-0.11** (0.048)	-0.098** (0.048)
PC of 25-64 Tertiary education (levels 5-8)	0.025 (0.026)	0.024 (0.026)	0.023 (0.026)	0.026 (0.026)	0.030 (0.026)	0.024 (0.026)	0.029 (0.026)	0.025 (0.026)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	-0.012 (0.024)	-0.011 (0.024)	-0.012 (0.024)	-0.012 (0.024)	-0.0047 (0.024)	-0.011 (0.024)	-0.0038 (0.024)	-0.013 (0.024)
Log of Full-time equivalent R&D personnel in all sectors	2.03*** (0.74)	2.07*** (0.71)	1.94*** (0.73)	2.15*** (0.72)	2.39*** (0.71)	2.07*** (0.71)	2.34*** (0.71)	2.12*** (0.72)
Log of GERD all sectors in EUR million	0.013 (0.65)	0.052 (0.64)	0.11 (0.64)	-0.021 (0.64)	-0.14 (0.64)	0.052 (0.64)	-0.076 (0.63)	0.0052 (0.64)
Agglomeration of labour in regional industry relative to region	13.4 (10.5)	16.2 (11.0)	15.4 (10.9)	13.9 (10.6)	18.9* (11.1)	16.2 (11.0)	20.2* (11.3)	14.8 (10.8)
HHI of firm's sales in the regional industry	0.017 (0.13)	0.00081 (0.13)	0.010 (0.13)	0.022 (0.13)	0.016 (0.13)	0.00081 (0.13)	0.0092 (0.13)	0.018 (0.13)
Log of foreign-owned total assets in RS as FDI stock	-0.0025 (0.0072)	-0.0020 (0.0071)			-0.0015 (0.0071)	-0.0020 (0.0071)		
Number of M&A deals in RS	0.030 (0.030)		0.036 (0.030)					
Log Number of GF or BF projects in RS	-0.086** (0.040)			-0.089** (0.040)				
Log of USD value of all completed projects GF and BF in RS					-0.0057* (0.0032)			-0.0058* (0.0031)
Log total assets of domestically-owned firm	0.30*** (0.067)	0.30*** (0.068)	0.30*** (0.068)	0.31*** (0.067)	0.30*** (0.067)	0.30*** (0.068)	0.30*** (0.067)	0.31*** (0.068)
Log value of M&A deals in RS					0.0088*** (0.0027)		0.0088*** (0.0027)	
Constant	8.27 (15.3)	6.10 (15.4)	6.11 (15.4)	8.36 (15.3)	7.84 (15.3)	6.10 (15.4)	6.73 (15.3)	7.27 (15.3)
Observations	13857	13857	13857	13857	13857	13857	13857	13857
Pseudo R-squared	0.832	0.832	0.832	0.832	0.832	0.832	0.832	0.832
AIC	46800.7	46851.4	46838.0	46807.0	46743.8	46851.4	46764.1	46826.4

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017.

*The results here are in general similar to the results from Table 12, with some differences in the magnitudes and significance of the coefficients.*

**Table A13 / Results of the econometric analysis for FDI spillovers, for domestic companies, for granted environmental patents, for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of granted non-environmental patents by foreign-owned firms in RS	0.17** (0.071)	0.17** (0.071)	0.17** (0.070)	0.17** (0.070)	0.15** (0.070)	0.17** (0.071)	0.15** (0.070)	0.17** (0.070)
Log granted environmental patents published by foreign-owned firms in RS	0.038 (0.086)	0.037 (0.086)	0.038 (0.086)	0.037 (0.087)	0.083 (0.087)	0.037 (0.086)	0.085 (0.087)	0.036 (0.087)
Log Number of granted non-environmental patents by GUOs investing in RS	-0.15* (0.083)	-0.15* (0.082)	-0.15* (0.083)	-0.15* (0.083)	-0.16** (0.082)	-0.15* (0.082)	-0.16** (0.083)	-0.15* (0.082)
Log Number of granted environmental patents by GUOs investing in RS	0.24* (0.12)	0.24* (0.12)	0.23* (0.12)	0.23* (0.12)	0.23* (0.12)	0.24* (0.12)	0.23* (0.12)	0.23* (0.12)
Log VA productivity in number of employees in thousands	-0.57 (1.36)	-0.57 (1.36)	-0.54 (1.36)	-0.55 (1.35)	-0.50 (1.36)	-0.57 (1.36)	-0.49 (1.35)	-0.54 (1.36)
Log Real capital to labour ratio	-2.03** (0.90)	-2.08** (0.88)	-2.05** (0.90)	-2.09** (0.88)	-1.95** (0.89)	-2.08** (0.88)	-1.93** (0.91)	-2.12** (0.87)
Log of wage in RS	-0.44 (0.84)	-0.44 (0.84)	-0.44 (0.84)	-0.43 (0.84)	-0.48 (0.85)	-0.44 (0.84)	-0.47 (0.85)	-0.44 (0.84)
Log of GDP per capita in region in EUR	-3.51 (4.29)	-3.46 (4.26)	-3.66 (4.24)	-3.58 (4.25)	-3.22 (4.25)	-3.46 (4.26)	-3.24 (4.22)	-3.62 (4.23)
Log of total regional fund	-0.12 (0.12)	-0.12 (0.12)	-0.12 (0.12)	-0.12 (0.12)	-0.15 (0.12)	-0.12 (0.12)	-0.15 (0.12)	-0.12 (0.12)
PC of 25-64 Tertiary education (levels 5-8)	0.041 (0.077)	0.041 (0.077)	0.040 (0.076)	0.039 (0.077)	0.057 (0.079)	0.041 (0.077)	0.056 (0.078)	0.039 (0.077)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	0.074 (0.077)	0.073 (0.077)	0.073 (0.077)	0.071 (0.077)	0.090 (0.079)	0.073 (0.077)	0.090 (0.079)	0.071 (0.077)
Log of Full-time equivalent R&D personnel in all sectors	4.42 (2.81)	4.35 (2.75)	4.47 (2.80)	4.38 (2.75)	4.61* (2.73)	4.35 (2.75)	4.58* (2.73)	4.43 (2.74)
Log of GERD all sectors in EUR million	0.19 (2.01)	0.23 (1.94)	0.19 (1.99)	0.26 (1.94)	0.041 (1.89)	0.23 (1.94)	0.10 (1.89)	0.19 (1.92)
Agglomeration of labour in regional industry relative to region	-41.8 (43.4)	-42.9 (41.7)	-44.1 (42.4)	-45.4 (40.7)	-33.8 (42.2)	-42.9 (41.7)	-35.3 (41.2)	-44.7 (40.6)
HHI of firm's sales in the regional industry	0.60 (0.54)	0.60 (0.55)	0.64 (0.53)	0.64 (0.54)	0.63 (0.54)	0.60 (0.55)	0.64 (0.53)	0.65 (0.53)
Log of foreign-owned total assets in RS as FDI stock	-0.014 (0.031)	-0.014 (0.030)			-0.0062 (0.031)	-0.014 (0.030)		
Number of M&A deals in RS	-0.014 (0.079)		-0.014 (0.081)					
Log Number of GF or BF projects in RS	0.014 (0.19)			0.015 (0.19)				
Log of USD value of all completed projects GF and BF in RS					-0.0054 (0.020)			-0.0057 (0.020)
Log total assets of domestically-owned firms	0.39*** (0.13)	0.38*** (0.13)	0.38*** (0.12)	0.38*** (0.13)	0.38*** (0.12)	0.38*** (0.13)	0.39*** (0.13)	0.38*** (0.12)
Log value of M&A deals in RS					0.019** (0.0095)		0.019** (0.0095)	
Constant	24.8 (40.4)	25.4 (40.0)	25.9 (40.1)	25.9 (40.3)	18.4 (40.5)	25.4 (40.0)	17.9 (40.5)	27.0 (40.1)
Observations	1481	1481	1481	1481	1481	1481	1481	1481
Pseudo R-squared	0.660	0.660	0.660	0.660	0.661	0.660	0.660	0.660
AIC	2536.9	2533.0	2533.1	2533.2	2530.0	2533.0	2526.4	2532.8

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017.

*The results here are in general similar to the results from Table 13, with some differences in the magnitudes and significance of the coefficients.*

**Table A14 / Results of the econometric analysis for FDI spillovers, for domestic companies, for published environmental patents (including not granted), for contemporaneous values of the dependent and explanatory variables**

	1	2	3	4	5	6	7	8
Log Number of non-environmental patents published by foreign-owned firms in RS	0.096* (0.052)	0.094* (0.052)	0.096* (0.053)	0.091* (0.052)	0.088* (0.053)	0.094* (0.052)	0.085 (0.053)	0.092* (0.052)
Log Number of environmental patents published by foreign-owned firms in RS	0.040 (0.071)	0.053 (0.071)	0.050 (0.070)	0.044 (0.071)	0.044 (0.072)	0.053 (0.071)	0.056 (0.071)	0.044 (0.072)
Log Number of non-environmental patents published by foreign GUO investing in RS	-0.11* (0.063)	-0.11* (0.060)	-0.10* (0.062)	-0.11* (0.062)	-0.12** (0.061)	-0.11* (0.060)	-0.11* (0.061)	-0.12* (0.061)
Log Number of environmental patents published by foreign GUO investing in RS	0.088 (0.096)	0.10 (0.098)	0.10 (0.099)	0.092 (0.095)	0.093 (0.096)	0.10 (0.098)	0.10 (0.098)	0.096 (0.096)
Log VA productivity in number of employees in thousands	0.88 (0.85)	0.93 (0.86)	0.94 (0.86)	0.84 (0.85)	0.87 (0.85)	0.93 (0.86)	0.90 (0.86)	0.86 (0.85)
Log Real capital to labour ratio	-1.64*** (0.57)	-1.81*** (0.55)	-1.68*** (0.57)	-1.71*** (0.55)	-1.67*** (0.55)	-1.81*** (0.55)	-1.74*** (0.55)	-1.73*** (0.55)
Log of wage in RS	0.35 (0.56)	0.31 (0.57)	0.29 (0.56)	0.35 (0.56)	0.32 (0.57)	0.31 (0.57)	0.28 (0.57)	0.33 (0.56)
Log of GDP per capita in region in EUR	-2.78 (2.96)	-2.76 (3.00)	-2.87 (2.99)	-2.42 (2.94)	-2.76 (2.97)	-2.76 (3.00)	-2.58 (3.01)	-2.62 (2.94)
Log of total regional fund	-0.060 (0.095)	-0.056 (0.096)	-0.051 (0.098)	-0.063 (0.093)	-0.080 (0.094)	-0.056 (0.096)	-0.066 (0.096)	-0.069 (0.094)
PC of 25-64 Tertiary education (levels 5-8)	0.033 (0.053)	0.037 (0.054)	0.041 (0.054)	0.031 (0.053)	0.043 (0.053)	0.037 (0.054)	0.047 (0.054)	0.034 (0.053)
PC of 25-64 Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	-0.0036 (0.052)	-0.0045 (0.052)	0.00089 (0.053)	-0.0060 (0.052)	0.0071 (0.052)	-0.0045 (0.052)	0.0078 (0.052)	-0.0039 (0.052)
Log of Full-time equivalent R&D personnel in all sectors	3.48* (1.81)	3.54** (1.76)	3.77** (1.80)	3.21* (1.77)	3.49** (1.77)	3.54** (1.76)	3.60** (1.76)	3.32* (1.76)
Log of GERD all sectors in EUR million	0.23 (1.32)	0.069 (1.26)	-0.13 (1.30)	0.36 (1.27)	0.19 (1.26)	0.069 (1.26)	-0.054 (1.25)	0.28 (1.26)
Agglomeration of labour in regional industry relative to region	-18.6 (28.8)	-19.7 (28.9)	-13.1 (28.1)	-19.3 (27.8)	-15.3 (29.8)	-19.7 (28.9)	-11.4 (29.2)	-18.6 (28.0)
HHI of firm's sales in the regional industry	1.26*** (0.37)	1.27*** (0.37)	1.24*** (0.37)	1.22*** (0.36)	1.26*** (0.37)	1.27*** (0.37)	1.24*** (0.36)	1.21*** (0.36)
Log of foreign-owned total assets in RS as FDI stock	0.014 (0.025)	0.013 (0.025)			0.015 (0.024)	0.013 (0.025)		
Number of M&A deals in RS	-0.036 (0.050)		-0.048 (0.052)					
Log Number of GF or BF projects in RS	0.26*** (0.093)			0.26*** (0.094)				
Log of USD value of all completed projects GF and BF in RS					0.018* (0.0097)			0.018* (0.0097)
Log total assets of domestically-owned firms	0.28** (0.12)	0.28** (0.11)	0.28** (0.11)	0.28** (0.12)	0.28** (0.12)	0.28** (0.11)	0.28** (0.11)	0.28** (0.12)
Log value of M&A deals in RS					0.0066 (0.0057)		0.0064 (0.0057)	
Constant	-0.65 (30.5)	1.77 (30.9)	0.30 (30.8)	-1.02 (30.8)	-0.39 (30.9)	1.77 (30.9)	-0.91 (31.2)	0.78 (30.8)
Observations	2018	2018	2018	2018	2018	2018	2018	2018
Pseudo R-squared	0.741	0.740	0.740	0.741	0.740	0.740	0.740	0.740
AIC	5609.6	5627.1	5625.7	5607.5	5614.6	5627.1	5624.8	5614.4

Standard errors in parentheses. \*\*\* indicates significance at 1%, \*\* at 5%, \* at 10%. All regressions are estimated using PPML, including firm, regional industry, and year fixed effects. The period of estimation is 2008-2017.

*Results here are similar to results in Table 14, with some differences in magnitudes and significance of coefficients.*

**Table A15 / List of sectors used in the analysis and their corresponding codes**

Code	Description
A	Agriculture, forestry and fishing
B	Mining and quarrying
C10-C12	...Food products, beverages and tobacco
C13-C15	...Textiles, wearing apparel, leather and related products
C16-C18	...Wood and paper products; printing and reproduction of recorded media
C19	...Coke and refined petroleum products
C20	...Chemicals and chemical products
C21	...Basic pharmaceutical products and pharmaceutical preparations
C22-C23	...Rubber and plastics products, and other non-metallic mineral products
C24-C25	...Basic metals and fabricated metal products, except machinery and equipment
C26	...Computer, electronic and optical products
C27	...Electrical equipment
C28	...Machinery and equipment n.e.c.
C29-C30	...Transport equipment
C31-C33	...Other manufacturing; repair and installation of machinery and equipment
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage; waste management and remediation activities
F	Construction
G45	...Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	...Wholesale trade, except of motor vehicles and motorcycles
G47	...Retail trade, except of motor vehicles and motorcycles
H49	...Land transport and transport via pipelines
H50	...Water transport
H51	...Air transport
H52	...Warehousing and support activities for transportation
H53	...Postal and courier activities
I	Accommodation and food service activities
J58-J60	...Publishing, audio-visual and broadcasting activities
J61	...Telecommunications
J62-J63	...IT and other information services
K	Financial and insurance activities
L	Real estate activities
M-N	Professional, scientific, technical, administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Health and social work
R	Arts, entertainment and recreation
S	Other service activities



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