Cross-border M&As and innovative activity of acquiring and target firms

Joel Stiebale[1]

September 2015

Abstract:

This paper analyzes the effects of cross-border mergers and acquisitions (M&As) on the innovation of European firms. The results indicate a considerable increase in post-acquisition innovation in the merged entity. This is mainly driven by inventors based in the acquirer's country, while innovation in the target's country tends to decline. The asymmetry of effects between acquiring and target firms increases with pre-acquisition differences in knowledge stocks, indicating a relocation of innovative activities towards more efficient usage within multinational firms. Instrumental variable techniques as well as a propensity-score matching approach indicate that the effect of cross-border M&As on innovation is causal.

Keywords: Multinational Enterprises, Mergers and Acquisitions, Innovation

JEL Classification: F23, D22, G34, O31

---

[1]Duesseldorf Institute for Competition Economics (DICE), Heinrich-Heine University of Düsseldorf, Universitätsstr. 1, 40225 Düsseldorf, Germany, Email: stiebale@dice.hhu.de.

Financial support by the Fritz Thyssen Foundation is gratefully acknowledged. Comments by the co-editor, Stephen Yeaple, and two anonymous referees have greatly improved the paper. I would also like to thank Maria Garcia-Vega, Daniel Bernhofen, Thorsten Chmura, Markus Eberhardt, Sofronis Clerides, Sourafel Girma, Richard Kneller, Robert Owen, Michaela Trax, Zhihong Yu, and participants of the 4th ZEW Conference on Economics of Innovation and Patenting, the 38th conference of the EARIE, the 13th conference of the ETSG, the Annual Meeting of the German Economic Association, as well as seminar participants in Mannheim, Nottingham and Liverpool for helpful comments and suggestions.

1. Introduction

It is a well documented empirical fact that multinational companies outperform other firms and that they are responsible for much of the world's research and development (R&D) expenditures and innovative activities.[2] A large part of the foreign direct investment (FDI) of multinationals takes the form of cross-border mergers and acquisitions (M&As), especially among developed countries and in industries with a high R&D intensity (UNCTAD, 2005, 2007).

The effects of international M&As on R&D and innovation have important policy implications since innovative activity is regarded as a key factor for productivity and growth. There is a controversial policy debate regarding the effects of foreign acquisitions in many countries (see, for instance, Motta and Ruta, 2012; Bertrand et al., 2012). A particular concern is that cross-border M&As might lead to a reduction or relocation of innovation activities. For instance, speaking about foreign takeovers in the UK, Bob Bischof, vice-president of the German-British Chamber of Industry and Commerce, recently stated: "I think there's every reason to be worried. Very often the R&D goes abroad and the rest follows . . . It's a recipe for disaster and a slow hollowing out of our industrial base here."[3]

This paper analyzes the following research questions: (1) What is the impact of cross-border M&As on innovation in the merged entity? (2) Do cross-border M&As induce a relocation of innovative activity across countries and between acquirers and acquisition targets?

Economic theory yields contradictory predictions regarding the impact of cross-border M&As on innovation in the merged entity as a whole. On the one hand, international M&As might provide access to complementary firm-specific assets (e.g. Nocke and Yeaple, 2007, 2008) and to new markets which increases the returns to R&D investment (see, for instance, Guadalupe et al., 2012). On the other hand, there might be countervailing effects including a reduction of competition after M&As or debt financing of M&As raising the costs of external

[2] See, for instance, Benfratello and Sembenelli (2006), Criscuolo et al. (2010), Criscuolo and Martin (2009), Greenaway and Kneller (2007), Helpman et al. (2004) to name a few.
[3]See "Foreign takeovers revive talk of UK decline", *Financial Times*, September 8, 2013 (http://www.ft.com/cms/s/0/a0ea0bb8-08d7-11e3-8b32-00144feabdc0.html#axzz2vkXLXFsO, accessed March 19, 2014). Further policy debates include the impact of foreign takeovers in the US and the potential protectionist characteristic of China's "anti-monopoly law" (see, for instance, http://www.nytimes.com/2008/04/07/business/07sale.html?pagewanted=all and Anu Bradford, "Chinese antitrust law: The new face of protectionism?", *Huffington Post*, August 1, 2008).

funds for R&D (see section 2 for details). Hence, the net effect of cross-border M&As on innovation in the merged entity is ultimately an empirical question.

Cross-border acquisitions are also likely to affect the location of innovation across countries. Theoretical contributions based on the knowledge capital model (Markusen, 1997, 2002) argue that knowledge generated from R&D can be transferred to foreign subsidiaries at relatively low costs and can be used in different production facilities simultaneously. This implies a geographic concentration of innovation activity within multinational firms – particularly in the presence of varying returns to R&D investments across locations or economies of scale and scope in R&D. Cross-border M&As can thus lead to a relocation of innovative activity between acquirers and targets.

While much of the empirical literature on cross-border M&As has focused on the effects of foreign ownership on productivity (see, for instance, Chen, 2011; Arnold and Javorcik, 2009), a recent strand of the literature emphasizes innovation as a key determinant of multinationals' productivity advantage (e.g. Guadalupe et al., 2012; Criscuolo et al., 2010). Yet, existing empirical evidence on the effects of cross-border M&As is mostly limited to target firms, while much less is known about the corresponding effects on acquirers and the merged entity as a whole.[4] Evidence on the effects of cross-border M&As on investing firms and the combined entity is, however, essential to get a complete picture of the global effects of cross-border M&As on innovation and other outcomes. Furthermore, the effects of international M&As on target (and acquiring) firms are likely to depend on pre-acquisition characteristics of both parties if there is a relocation of innovative activity towards the entity with the higher productivity of R&D.

The main reason for the lack of empirical evidence on acquirers and the merged entity is that most studies use firm-level data from a single country in which information about foreign ownership but no information about pre- and post-acquisition characteristics of foreign acquirers is available. To overcome this limitation, a cross-country firm-level data set is constructed that combines balance-sheet data on European firms from the Amadeus database with information from the M&A database Zephyr and innovation indicators. Measurement of innovation mainly relies on patent-based indicators constructed from the database Patstat but alternative outcome variables, such as R&D expenditures, are analyzed as well. Following the previous literature, data on inventors and their addresses are used as a proxy for the location

[4] Recent exceptions that look at the effects on the acquiring companies' performance are Bertrand and Betschinger (2012) and Stiebale and Trax (2011).

of innovation which is sometimes different from the geographic location of patent ownership.[5]

This paper is, to the best of my knowledge, the first empirical study to analyze at the firm level the effects of international M&As on the innovation of acquirer and acquisition target simultaneously. By focusing on both acquiring and target firms, rather than on one side of the acquisition only, this paper contributes to our understanding of the overall impact of cross-border M&As. This approach also enables an analysis of how different pre-acquisition characteristics of acquiring and target firms and their interaction affect post-acquisition outcomes.

A major empirical challenge arises because foreign acquirers and acquisitions targets might differ in both observable and unobservable characteristics from other firms. Thus, the empirical framework accounts for unobserved firm heterogeneity and the possible endogeneity of cross-border acquisitions. In this paper, several alternative empirical strategies are used to identify causal effects. First, a propensity-score matching approach is used to construct an adequate control group and is combined with a difference-in-differences (DiD) estimator. Further, dynamic count data models are estimated, using pseudo maximum-likelihood and generalized methods-of-moments (GMM) techniques. Additionally, linear and non-linear instrumental variable (IV) models are employed. In these models, identification is achieved by exploiting changes in international accounting standards which are aimed at reducing information asymmetries in international transactions.

To preview the results, all of the various estimation techniques suggest that international M&As lead to a substantial increase in innovation output in the merged entity (more than 20% within the first three years in most specifications). The results show that much of the increase in innovation can be attributed to inventors based in the country of the acquiring firms' headquarters, while innovation conducted in the country of target firms' headquarters tends to decrease. The main reason for this reallocation seems to lie in the higher level of pre-acquisition innovation in acquiring firms. The asymmetry of effects between acquirers and targets increases with pre-acquisition differences in patent stocks, indicating a relocation of innovative activities towards more efficient usage within multinational firms across countries. As discussed in more detail in the next section, this result is in line with the knowledge capital model and related theories of multinational firms which predict that multinationals

[5] As discussed in detail in section 4, using patent-based measures of innovation has both advantages and disadvantages over alternative outcome measures. The location of inventors is a common proxy for the location of innovation (see e.g. Guellec and van Pottelsberghe, 2001). Separating the location of inventors from the residence of applicants is crucial as firms might file patents via corporate headquarters even if innovation was conducted in a foreign subsidiary or vice versa.

concentrate innovation activities at a single location and exploit cross-country differences in R&D costs.

The overall impact on the merged entity is found to vary with pre-acquisition firm heterogeneity as well. The estimated effects on the combined entity are most pronounced if both acquirer and target firm have a large pre-acquisition innovation stock. This suggests that access to complementary knowledge plays an important role in the effects of cross-border M&As on innovation. While the asymmetric effects between acquirer and target country are not in line with complementarities in *post*-acquisition innovation, it is possible that target firm's *pre*-acquisition knowledge stock is valuable to the acquirer's research program, and that the acquired knowledge is mainly exploited for further innovation in the acquirer's country. This is line with anecdotal evidence on large technology-based firms like Google and Microsoft that acquire smaller innovative companies whose technologies are integrated into the acquirer's research programs afterwards. A prominent example is the acquisition of the Australian company Where2, whose mapping software became the basis for Google Maps.[6]

The fact that similar effects are found for citation-weighted patents and R&D expenditures indicates that the estimates reflect an overall increase in innovation output rather than solely a change in intellectual property (IP) strategy. It is also found that the increase in innovation is accompanied by increased growth of sales and productivity from the perspective of the target firm and the merged entity as a whole. This indicates that target firms are not downsized on average but specialize in production and benefit from a technology transfer of acquirers.

The rest of this paper is organized as follows. Section 2 discusses the related theoretical and empirical literature, section 3 describes the empirical strategy, and section 4 provides a description of the data. Results of the empirical analysis are presented in section 5 and section 6 concludes.

2. Related literature

There are various channels by which international M&As can affect innovation and patenting which are linked to the heterogeneous motives behind the deals. First of all, M&As are a means of reallocating the control of resources towards more efficient usage (e.g. Braguinsky et al., 2015; Maksimovic et al., 2011; Jovanovic and Rousseau, 2002; Breinlich,

[6] See, for instance, "The new GE: Google, everywhere", *Economist*, January 18, 2014 (http://www.economist.com/news/business/21594259-string-deals-internet-giant-has-positioned-itself-become-big-inventor-and) and David (2013) for further examples.

2008). This reallocation can affect the scale and location of innovative activity after cross-border M&As. According to the knowledge capital model (Markusen, 1997; 2002) and recent related theories of multinational firms (e.g. Arkolakis et al., 2013; Ekholm and Hakala, 2007), innovation can be geographically separated from production and the (relative) costs of R&D vary across countries. The knowledge generated from innovation can be transferred to foreign affiliates at relatively low costs compared to the duplication of R&D activities and can be used simultaneously for production in multiple locations. These characteristics imply that multinationals concentrate innovation at a single location, which is chosen based on differences in the costs of R&D across countries or subsidiaries, and transfer the knowledge generated from R&D to their affiliates.[7]

Although the knowledge capital model analyzes FDI in the form of greenfield investments and not cross-border M&As, a hypothesis consistent with this theory is that post-acquisition, innovation activities will be shifted towards the location with the highest returns to R&D investment. It is likely that in the majority of cases, this implies a relocation of innovation from target's towards acquirer's country since theory and evidence suggest that due to higher costs and barriers of operating in foreign countries, firms investing abroad must have superior R&D assets (Markusen, 2002) or productivity (e.g. Helpman et al., 2004).[8] If the displacement of R&D after international M&As follows efficiency related motives, the asymmetry of effects between acquirers and targets should vary with pre-acquisition differences in innovation activity between the two entities. If relocation increases the efficiency of R&D, one should also see an increase in innovation output in the merged entity as whole. These implications are tested in the empirical analysis.[9]

Another source of efficiency gains after cross-border M&As stems from the combination of complementary firm-specific assets of acquirer and target (Nocke and Yeaple,

---

[7] Knowledge transfer costs are not at odds with a concentration of R&D in one country. For instance, Keller and Yeaple (2013) argue that knowledge transfer within multinational firms is costly but the costs are larger for complex activities such as R&D. Multinationals might therefore concentrate R&D at the headquarter and knowledge transfer to foreign subsidiaries takes place in embodied form as traded intermediate inputs. See Yeaple (2013) for an overview of recent theories of multinational firms.

[8] Previous research does not show unambiguously whether targets of cross-border acquisitions are over- or under-preforming relative to non-acquired firms (see, for instance, the discussion of the literature in Blonigen et al. 2014). However, theory and evidence suggest that acquirers are generally more productive than targets (e.g. Breinlich, 2008; David, 2013). The descriptive statistics in the next section also show that acquirers are characterized by higher productivity and pre-acquisition innovation activity compared to acquisition targets.

[9] Next to firm heterogeneity, there are also country characteristics which potentially play a role for the (re)location of R&D. For instance, the transferability of innovation output leads to concerns about the dissipation of intangible assets, even when R&D is conducted within the boundaries of multinational firms (Ethier and Markusen, 1996; Bilir, 2014). Acquiring firms may thus be reluctant to conduct R&D in target countries if IP rights are relatively weak compared to the acquirer's country. In an extension of the empirical analysis, a sample split is used to analyze whether differences in IP rights or other country characteristics are likely to explain the results.

2008; Norbäck and Persson, 2007; Bertrand et al. 2012). In the context of innovation activities, these may include complementarities in research output, know-how, or patents. Even when *pre*-acquisition R&D activities in acquiring and target firms are heterogeneous and complementary, one entity's innovation activities might be (partly) relocated post-acquisition to exploit economies of scale and scope in R&D through geographic concentration (Sanna-Randaccio and Veugelers, 2007; Kumar, 2001). Complementarities in innovative assets imply positive effects on innovation for the merged entity which are concentrated among firm-pairs where both acquirer and target have been active in innovation pre-acquisition.

Further, cross-border M&As can provide access to foreign markets for either the acquiring or the target firm. Foreign acquisition targets might use the acquiring firm's existing distribution channels (Guadalupe et al., 2012) or acquirers may choose target firms that possess valuable export networks (Blonigen et al., 2014) or country-specific capabilities such as marketing expertise (Nocke and Yeaple, 2007). Improved market access via cross-border M&A can induce innovation since the costs of these activities can then be spread over a larger production output post-acquisition (Guadalupe et al., 2012).

While improved market access and efficiency gains associated with R&D imply an increase in innovation output in the merged entity post-acquisition, there are alternative channels which potentially have countervailing impacts. For instance, M&As might decrease innovation where debt financing is used, as that will tend to raise the costs of external funds for R&D (Long and Ravenscraft, 1993), or where they are non-profitable and arise only out of a manager's utility maximization (Shleifer and Vishny, 1988). M&As may also lead to a multi-divisional or conglomerate structure with an internal capital market that is detrimental to investment in R&D which is characterized by high uncertainty and information asymmetries between headquarter and divisional managers (Seru, 2014). Further, M&As can affect market power in product markets (e.g. Kamien and Zang, 1990; Neary, 2007; Horn and Persson, 2001) which has an ambiguous effect on innovation incentives.[10]

Cross-border acquisitions may also change market power in technology markets. If acquirer and target are active in related technological fields, they can pool their existing patents or file new patents to prevent other firms from developing competing technologies (e.g. Cassiman et al., 2005; Grimpe and Hussinger, 2008). Therefore, post-acquisition

[10] The theoretical and empirical literature on competition and innovation has yielded contradictory finding. On the one hand, reduced competition will increase market share and margins – and thus the output to which cost reductions or quality-improving innovations can be applied. On the other hand, in an oligopolistic market, a reduction in competition could decrease innovation incentives as it tends to lower the sensitivity of demand to enhanced efficiency or quality (Vives, 2008; Schmutzler, 2013).

patenting - the main innovation indicator used in this paper - might not only measure "true" innovation but could also be related to IP strategies. This concern is addressed in the empirical analysis by comparing the results using patent counts to those generated from R&D expenditures and citation-weighted patents which should be affected by IP strategies to a lesser extent (Blind et al., 2009).

Due to the various different channels, the net impact of international M&As on innovation in the merged entity ultimately boils down to an empirical matter. However, some of the mechanisms discussed above also have implications for the effects of cross-border M&As compared to domestic transactions. The market access channel implies that international M&As but not domestic deals are likely to induce innovation, since the latter may not provide access to new markets. Further, since investing abroad requires overcoming larger fixed costs and barriers compared to domestic M&As (see e.g. Chen, 2011), cross-border M&As might only be profitable if there are substantial gains via market access, complementary assets or relocation. Whether or not cross-border M&As spur innovation in the merged entity, they are likely to be accompanied by a relocation of R&D across countries. The potential for relocation is likely to be higher after international compared to domestic M&As since the costs of producing and conducting R&D are more likely to differ substantially across than within countries for a given industry.

Previous empirical evidence on the effects of international M&As is so far mostly limited to target firms and has yielded mixed results.[11] For instance, Guadalupe et al. (2012) find that foreign acquisitions are accompanied by technology upgrading in Spanish acquisition targets. This effect is concentrated among firms for which the acquirer provides improved market access upon acquisition. The focus of their study is, however, rather on the transfer of existing knowledge from acquirers to target firms than on innovation new to the market. Hence, their results are not necessarily contradictory to a relocation of R&D activities from targets to acquirers. Garcia-Vega et al. (2012) find negative effects on internal R&D expenditures in Spanish target firms if acquirers are located in countries with a higher technological development but positive effects if the acquirer comes from a country of lower technological development. Stiebale and Reize (2011) report that foreign acquisitions lead to a reduction of R&D expenditures in German acquisition targets on average. In contrast, Bertrand (2009), Bertrand et al. (2012), and Bandick et al. (2014) estimate positive effects of

[11] Cassiman et al. (2005) and Veugelers (2006) provide an overview of existing empirical studies on the impact of M&As on innovation, reporting mixed results as well. Most of these studies analyze domestic acquisitions or do not explicitly differentiate between international and domestic M&As. In contrast to this literature, the present paper has an explicit focus on cross-border M&As. See Stiebale and Reize (2011) for a more detailed overview of the literature on foreign ownership and innovation.

international M&As on R&D expenditures in target firms. All these papers lack evidence of how international M&As affect innovation in the merged entity as a whole and how the location of innovation within multinationals changes after acquisitions. While the present paper includes an analysis of effects on target firms as well, it also estimates impacts on acquiring firms and the merged entity and analyzes how acquirers' characteristics affect post-acquisition innovation in target firms and vice versa.

There is little evidence on the effects of cross-border M&As on innovation of acquirers.[12] To the best of my knowledge, no empirical study has simultaneously analyzed the effects of cross-border M&As on innovation in the merged entity and on acquirers and acquisition targets involved in the same deal. This paper aims to fill this gap.

3. Empirical strategy

The aim of the empirical analysis is to estimate the effects of cross-border M&As on innovation outcomes and the relocation of innovative activity. The empirical model builds on a framework for analyzing innovation outcomes developed by Blundell et al. (1995). Since innovation is measured as a count variable, the first moment of the model, the expected number of patents, is specified as:

$$E\left[P_{it}\right] = \exp(x_{it}^{'}\beta)$$

where $$x_{it}^{'}\beta = \sum_{k=1}^{3} IMA_{i,t-k}\delta_k + \sum_{k=1}^{3} DMA_{i,t-k}\phi_k + \rho G_{i,t-4} + z_{i,t-4}^{'}\alpha + c_i + v_t \,.$$

P_{it} denotes the number of patent applications in year t. If a firm does not engage in M&As in the sample period, P_{it} equals the number of patent applications of firm i. If a firm is involved in M&A activity within the sample period, P_{it} equals the sum of patent applications of acquirer and acquisition target before the acquisition and the total number of patent applications in the merged entity after the M&A. An equivalent approach is used for control variables as well. This procedure is often employed in the M&A literature (e.g. Gugler and Siebert, 2007; Conyon et al., 2002a,b).

[12] In an industry-level study, Bertrand and Zuniga (2006) find positive effects on R&D in the acquirers' sector for industries with a medium technological intensity. Stiebale (2013) estimates positive impacts on the R&D intensity of acquiring firms. His sample is, however, limited to small and medium-sized German enterprises. Desyllas and Hughes (2010) provide some evidence that cross-border M&As have a more pronounced negative effect on the acquirer's R&D intensity than domestic M&As, but international M&As are not the focus of their study. Marin and Alvarez (2009) find that acquisitions undertaken by foreign-owned firms in Spain have a negative impact on the acquirers' innovation activities, in contrast to acquisitions by domestically owned firms, but they do not analyze the impact of cross-border acquisitions explicitly. Ahuja and Katila (2001), as well as Cloodt et al. (2006), analyze differences in a sample of merging firms according to cultural distance between acquirer and target firm, but they do not address the causal effects of international acquisitions per se.

In an extension of the model, only patent applications with inventors located in the country of firm *i*'s headquarters are included in P_{it}. This variant of the model is estimated separately for acquirers and targets, together with the sample of control firms, to investigate whether cross-border M&As have asymmetric effects and lead to a relocation of innovative activity across countries.

IMA and DMA denote dummy variables that take the value of one if firm *i* has engaged in international and domestic M&A activity respectively in a given year. G_{it} is a measure of firms' lagged innovation activities. In the baseline specification, this is measured by the lagged number of patents, but alternative measures such as a lagged patent stocks and logarithmic transformations are considered as well. z_{it} denotes a vector of firm-, country-, and industry-specific control variables. c_i accounts for unobserved time-invariant firm heterogeneity, and v_t includes time dummies to capture macroeconomic changes common to all firms. All firm-specific explanatory variables are lagged to avoid including regressors that are affected by M&A variables or innovation outcomes. Industry and country dummies enter all estimations to control for permanent differences in market structure, and industry–country–pair specific trends are added to some specifications.

Several empirical challenges have to be addressed by the empirical model. First, the outcome variable, which is based on patent counts, is a non-negative integer variable with a high share of zeros. Further, it is likely that unobserved firm attributes like managerial ability, corporate culture, attitudes to risk, and technological or product characteristics are correlated with both the decision to engage in M&As and innovative activity. Finally, pre-acquisition patent applications should be taken into account because of state dependence in innovative performance and pre-acquisition differences in innovation between acquirers, targets and other firms. Due to the presence of lagged values of the dependent variable, strict exogeneity of the regressors is violated by definition. It is also likely that there is feedback from innovative activity to future decisions about M&As and other variables like productivity and firm size.

To address these econometric problems, dynamic count data models are estimated. Following Blundell et al. (1995, 2002), pre-sample information on firms' patent applications is used to control for unobserved time-invariant firm heterogeneity.[13] Compared with other

[13]This approach exploits the fact that patent applications are available for a much longer time series than other variables (see section 4 for details). Specifically, the average number of patent applications in the pre-sample periods and a dummy variable indicating at least one pre-sample patent are used for the baseline specification. Alternative measures are also considered as a robustness check in section 5.4. Blundell et al. (2002) show that

panel data techniques for count data models, this specification has the advantage that it does not assume strict exogeneity of the regressors. In contrast to the estimation techniques proposed by Wooldridge (1997) and Chamberlain (1992), this procedure does not rely on the validity of lagged variables as instruments. It is particularly advantageous if the regressors are characterized by a high persistence (as typically found for innovation indicators – see e.g. Malerba and Orsenigo, 1999), since in this case lagged values of the regressors can be weak instruments for (quasi-)differenced equations. The baseline specification can be estimated by maximizing the pseudo likelihood based on the first moment of a Poisson model. Consistency requires only the first moment to be correctly specified and does not rely on the equality of mean and variance underlying the Poisson distribution (Blundell et al., 1995).

Although the estimation technique discussed so far accounts for a variety of control variables, time-invariant unobserved firm heterogeneity, and feedback from innovation to future decisions about M&As, it is still possible that the estimated coefficients do not reflect a causal effect of international M&As on post-acquisition innovation. This is because unobserved time-varying factors such as market and technology shocks – if not sufficiently accounted for by the control variables – might affect the profitability of both M&As and innovation activities. To check whether these correlations drive the previous results, linear and non-linear IV models are estimated in two alternative specifications. For the linear specification, the transformation $\ln(P_{it}+1)$ is used to retain the exponential relationship between the dependent variable and the regressors.[14] The linear specification has the disadvantage that it does not address the count nature of patent applications, but it has the advantage that standard test statistics such as weak instrument tests can be computed.

For the non-linear IV specification, following Windmeijer and Santos Silva (1997), a GMM estimator that is based on an additive error specification is applied. It is assumed that $P_{it} = \exp(x_{it}^{'}\beta) + u_{it}$, which yields the moment condition: $E[P_{it} - \exp(x_{it}^{'}\tilde{\beta} \mid w_{it})] = 0$.[15]

pre-sample patent activity is a sufficient statistic for firms' fixed effects if the regressors follow a stationary iid process. Although the theoretical results on the properties of the estimator rely on an assumption that the number of pre-sample periods approaches infinity, Blundell et al. (2002) demonstrate that the pre-sample mean estimators perform well even when the number of time periods is small.

[14] This transformation of the dependent variable is rather arbitrary but is commonly used in empirical studies (e.g. Bloom et al., 2015). Due to this transformation, the coefficients only have a qualitative interpretation since marginal effects on P_{it} cannot be derived from this specification.

[15] The moment condition contains a transformed constant term but all slope coefficients are identical to the vector *β.* Alternative estimation techniques are a full maximum likelihood estimator and the two-stage estimation procedure suggested by Terza (1998), both of which are based on relatively strong distributional assumptions, i.e. that the error terms of the patent equation and a first-stage Probit model are jointly normally distributed. These estimation procedures produced relatively unstable results and sometimes led to convergence problems, indicating that the distributional assumptions are not met in the present application. See Windmeijer (2008) for a discussion of alternative count data models.

w_{it} is a vector of instrumental variables which contains the exogenous variables included in x and at least one exclusion restriction, i.e. a variable which affects international M&As but not innovation activity and is also uncorrelated with unobservables affecting innovation. For both linear and non-linear IV models, at least one such exclusion restriction is necessary.

The exclusion restriction used is based on changes in accounting uniformity and is measured as the yearly growth in the number of industry peers (at the two-digit industry level across countries in the sample) that use the same accounting standards (DeFond et al., 2011; Louis and Urcan, 2014). This variable is affected by the mandatory introduction of international financial reporting standards in Europe during the sample period. Suppose a firm has used a national accounting standard used by 10 industry peers in the same country in year t-1 and there are 50 industry peers in Europe. If all of these 50 firms adopt international accounting standards in year t, the accounting uniformity measure takes a value of 4. A uniform state of accounting standards improves the comparability of financial performance across countries and thus reduces information asymmetries and facilitates cross-border investments (DeFond et al., 2011; Francis et al., 2015). Evidence on the real effects of accounting is rather limited and it seems unlikely that accounting standards have a direct effect on innovation outcomes of firms.

Several time-variant variables contained in $z_{i,t-4}$ capture firm- and market-specific characteristics (the next section details the construction of the variables). A firm's size captures the potential to spread the gain from innovation over production output. Productivity accounts for differences in efficiency and captures the selection of heterogeneous firms into foreign markets (Helpman et al. 2004; Nocke and Yeaple, 2007, 2008). Capital intensity captures differences in production technologies. A liquidity ratio accounts for financial factors which might be a prerequisite to finance innovative activities and sunk costs for entry into a foreign market (see, for instance, Greenaway et al., 2007). A firm's age enters as a proxy for experience and the stage of the product life cycle. The robustness of the model to the introduction of several time-variant industry- and country-specific variables is checked; these include domestic market growth rates, net entry rates, industry-level patent stocks, and industry-, country- and industry–country pair-specific trends.

As an alternative approach to handle potential endogeneity problems which does not require valid instrumental variables, a propensity score matching approach – combined with a difference-in-differences estimator is applied. Both nearest-neighbor matching and propensity-score reweighting estimations are conducted.[16] To implement the propensity-score matching, a Logit model for the propensity score is estimated for the consolidated merged entity (before the M&A) and the control group. Two alternative control groups are used. The first is based on non-merging firms, the second is based on domestic M&As. The dependent variable in the Logit model takes a value of one if two firms from different countries merge in the particular year. The matching procedure is performed with replacement and imposing common support. The change in $\ln(P_{it}+1)$ compared with the pre-acquisition period is used as the outcome variable and all control variables from the baseline regression are employed as covariates.[17] In addition, the lagged patent stock is included to make sure that merged firms and matched controls have a similar knowledge stock and a similar trend in patenting before acquisition.

4. Data and variables

4.1 Data sets

Several different data sources had to be merged to construct the data set used in this paper. Data on cross-border and domestic M&As were extracted from the Zephyr database which is compiled by Bureau van Dijk. Zephyr provides information about the date of a deal, the identity of acquirer and target, the stake owned by the acquirer before and after acquisition and other transaction-related information. Compared with other M&A data sources, like Thompson Financial Securities data, Zephyr has the advantage that there is no minimum deal value for a transaction to be included.[18]

The second data source used was the Amadeus database, which provides information on financial data as well as ownership and subsidiary information for European firms.[19] Different updates of the database have been merged to capture the entry and exit of firms and a broader sample to identify acquirers and acquisition targets. The Amadeus database was used to

[16] See e.g. Caliendo and Kopeinig (2008) for an overview of these methods and Busso et al. (2015) for an analysis of their finite-sample properties.

[17] Exclusion restrictions for the IV models are not used as conditioning variables in the matching approach, as recent research suggests that matching on variables which satisfy IV assumptions increases the amount of inconsistency of matching estimators (Wooldridge, 2009).

[18] A comparison of aggregate statistics derived from own calculations using the Zephyr database with those from the Thompson financial data reported in Brakman et al. (2007) shows that the coverage of transactions with a deal value above US$10 million (which is the minimum threshold for M&As to be included in the Thompson database) is very similar. Calculations are available from the author upon request.

[19] Amadeus is provided by Bureau van Dijk as well. In this paper, update numbers 88 to184 are used. The Amadeus database has been used in numerous empirical studies on international trade and FDI (see, for instance, Budd et al., 2005; Helpman et al., 2004; Konings and Vandenbussche, 2005). Although Amadeus contains information about foreign subsidiaries, the data do not allow for a distinction between greenfield FDI and cross-border acquisitions in many cases. For this reason, it is combined with the Zephyr database in the present paper.

gather information on firms' industry affiliation, location (zip codes), sales, productivity, capital intensity and liquid assets. Unconsolidated accounts were used in order to separate economic activity in acquiring firms and acquisition targets and across countries. Amadeus firms were merged with the transaction data from Zephyr by a common firm identifier.

The main estimation sample contains 229,479 firm-year observations on 62,511 firms and 941 international M&As. A 50% ownership threshold is used to define M&As, which is common in the literature (e.g. Guadalupe et al., 2012). The estimation sample is restricted to M&As within Europe and to transactions for which information on both acquirer and target are available. To isolate the effect of cross-border M&As, firms that engage in multiple acquisitions are excluded, which again is common in the M&A literature (e.g. Conyon et al., 2002a,b). This leaves 941 cross-border acquirers and 941 foreign acquisition targets in the main estimation sample. The comparison group includes non-merging firms as well as firms that were affected by domestic M&As. While the exclusion of multiple acquirers and M&As outside of Europe clearly limit the representativeness of the sample, robustness checks discussed in section 5.4 and in the Appendix show that the qualitative results obtained hold quite general and are not driven by specific countries, industries or types of M&As.

Data on patent applications were taken from the Patstat database, which has been developed by the European Patent Office and the OECD. Patent applications were extracted for the years 1978–2008 for all the companies in the sample. The data on patent applications are merged with the other firm-level data sets using a computer-supported search algorithm based on the firms' names, addresses, and zip codes. Every match was checked manually to ensure high data quality. As it is possible that some firms file patents via subsidiaries or parent companies, data on subsidiaries for each company from the Amadeus database were extracted as well.

4.2 Variables and descriptive statistics

The main outcome variable is the number of patent applications filed with the European Patent Office (EPO) per year. The focus on EPO patents avoids international differences in patenting procedures affecting the results. Only patents that were ultimately granted were used but they were dated back to the application year to account for the time lag between application and grant of a patent. A firm's patent stock is defined as the cumulative number of patent applications between 1978 and the current year, assuming a 15% yearly depreciation rate (following the procedure used by, e.g., Griliches, 1998; Hall et al., 2005).

Using patents as an innovation indicator has both advantages and disadvantages over alternative measures (e.g. Griliches, 1998). Most importantly, patents are available for a large range of firms independent of listing status and accounting regulations. Further, in contrast to R&D expenditures, patents are (at least intermediate) innovation output indicators and thus also account for the effectiveness with which innovation is pursued. As the number of patents is derived from administrative data, this indicator does not have to rely on self-reported measures of new products and processes, which are often used in innovation studies. Patenting is costly and a granted patent requires a certain degree of novelty, and this reduces the risk of counting innovations of little relevance. Finally, the number of patents is a well-established indicator of innovation which has been used in several recent studies (Aghion et al., 2009, 2013; Bena and Li, 2014; Seru, 2014 to name a few) and patent applications seem to be highly correlated with other common indicators of innovative performance (e.g. Hagedoorn and Cloodt, 2003; Griliches, 1998).

The downside of taking patents as an innovation indicator is that not every invention becomes patented, and - depending on firms' innovation strategies - firms may make more or less use of formal IP rights protection (e.g. Hall and Ziedonis, 2001; Ziedonis, 2004). This can be problematic if M&As change the incentives to patent strategically as discussed in section 2. It can also be expected that there will be substantial variation in the value of patented innovations. Further, it is likely that the propensity to patent varies across industries and countries.

To mitigate these problems, alternative measures are used. First, the results for patent counts are compared with those using citation-weighted patents, which are likely to be correlated with the importance of innovations. If cross-border M&As induce an increase (decrease) in patenting for strategic reasons, we should see a decline (rise) in the average number of citations per patent (e.g. Bloom et al., 2015). While the value of citation-weighted patents could be heterogeneous as well, previous research on stock market valuations indicates that citation-weighted patents are a reasonable measure of the importance of patents (Hall et al., 2005). Two alternative measure of citation weighted patents are constructed. The first weights patents by all forward citations which is standard in the literature. The second measures exploits EPO’s classification of patent citations. Citations that (partly) threaten the novelty of the citing patent are classified as citation category “X” (“Y”). Patents receiving these citations have a high potential to be used strategically for pre-empting competition in technology markets (e.g. Grimpe and Hussinger, 2008). To check whether these types of citations drive the results, an alternative measure of citation weighted patents excludes “X” and “Y” citations.

Second, R&D investments are used as an alternative outcome variable, although, unfortunately, most companies in Amadeus do not disclose their R&D expenditures. This information is therefore complemented with data from the European R&D scoreboard (European Commission, 2011), but it was possible to collect this information for only 2,638 firms and 9,600 observations, mostly for consolidated accounts. Hence, this variable is used only in a robustness check on a reduced sample. To mitigate the problem of heterogeneous propensities to patent across firms and countries, a variety of robustness checks with sample splits and additional control variables at the country-industry level are performed. Data from Eurostat and the OECD STAN database are used to construct regressors at the country-industry level.

The patent data include information on both applicants and inventors and their addresses. While the applicants of patents in the sample are firms, inventors are individual researchers which are usually employed by the applicant. Inventors' addresses are in the majority of cases based on their workplace and are used to construct a measure of the location of innovation. It is common in the patenting literature to use inventors' location to measure the location of innovation (e.g. Griffith et al., 2006; Guellec and van Pottelsberghe, 2001; Cantwell and Piscitello, 2002). An adequate measure of inventors' location is crucial to separate innovation in acquiring firms from acquisition targets, since multinationals might choose the country of patent ownership according to the location of the headquarter, taxes, IP protection or other factors. Hall (2011) as well as Harhoff and Thoma (2012) show that aggregate levels and trends on the internationalization of R&D expenditures by multinational firms are similar to those proxied by the international location of inventors in patent applications filed by multinationals.[20]

[20] This also holds for own calculations based on more recent aggregate data. The correlation coefficient between foreign ownership of domestic inventions and domestic R&D financed from abroad across European countries for the year 2011 is equal to 0.6. Since an innovation input and an innovation output indicator are correlated, this correlation seems very high. The correlation between log domestic R&D and log domestic patents is equal to 0.5. These numbers have been computed by correlating "foreign ownership of domestic inventions" available in the database "International co-operation in patents" compiled by the OECD with "R&D financed by abroad" compiled by UNESCO and available in the data base "Science, technology and innovation". Both datasets are available at oecd.stat.org. The data, unfortunately, provides no breakdown of R&D financed by abroad by source country. There is also, to the best of my knowledge, no data set available that provides a reliable breakdown of R&D across countries for individual European firms. However, some aggregate data for the US compiled by the Bureau of Economic Analysis (BEA) are available. Figures for the year 2011 (available at http://www.bea.gov/scb/pdf/2014/08%20August/0814_activities_of_u%20s%20multinational_enterprises.pdf) show total domestic R&D investments of $221 billion of US multinationals and foreign R&D investment of $44.7 billion of which $27.4 billion are invested in Europe and $2.96 billion in Canada. This compares to 17108 total EPO patents and 3657, 2141 and 291 EPO patents with US owners and inventors based in all other countries, in Europe, and in Canada respectively. For these regions, between 78 and 98 patents per $US billion of R&D investment are filed. Overall, there seems to be no large systematic bias associated with using inventor data instead of R&D expenditures differentiated by country.

The empirical analysis focuses on European firms which are either active in manufacturing or in knowledge-intensive (non-financial) service sectors such as information technology, telecommunications, transport, R&D, or business-related services (NACE Rev1.1 / ISIC Rev 3.1 codes 15-37, 62-64, 72-74). This is to ensure a focus on industries in which innovation and patenting are important. The time period spans the years 1997-2008.

Summary statistics and descriptions of variables used in the empirical analysis can be found in Table 1. These statistics are based on consolidated measures, that is, the sum of acquirer and target characteristics before the acquisition and merged entities after an M&A.[21] Table 2 compares statistics for firms that engage in cross-border M&A with statistics for the remaining (control) firms. The average innovation intensity of acquiring firms engaging in international M&A is considerably higher than in non-merging firms and in acquisition targets. This holds for the number of patent applications, patent stocks, citation-weighted patents and R&D expenditures. However, acquirers, targets, and control firms also differ in other dimensions which are likely to affect innovation.

Total factor productivity (TFP) is computed as a residual from a productivity regression using the method proposed by Olley and Pakes (1996). Firm size is measured by sales. Working capital is defined as current assets less current liabilities relative to total assets. Capital intensity is measured as tangible fixed assets divided by sales. The figures are in line with some stylized facts from the trade and FDI literature (e.g. Greenaway and Kneller, 2007) – multinationals are larger and more productive than domestic firms. In the present data set, this is true for both acquirers and international acquisitions targets. Further, acquirers are on average multiple times larger than acquisition targets and they are characterized by higher TFP.

Table 3 shows the sample distribution of cross-border acquisitions across regions. The largest share of acquirers and acquisition targets is located in Western Europe. It seems that most international M&As take place within rather than across regions. For instance, there are relatively few cases where acquirers from Western or Northern Europe invest into Eastern European targets and vice versa. This seems plausible as theory suggest that FDI motivated by differences in production cost is predominantly greenfield investment while cross-border M&As are conducted to access new markets or complementary firm-specific assets (e.g. Nocke and Yeaple, 2008).

[21] Consolidated measures are mainly constructed from individual unconsolidated accounts of acquirers and targets rather than from the consolidated accounts reported in Amadeus. For variables such as firm age as well as industry- and country-level variables, indicators for merging firms are based on the larger entity of the two firms (in most cases the acquiring firm).

The construction of the estimation sample is limited by data availability in Amadeus. Due to different reporting requirements, coverage of the variables used in estimation varies considerably across countries. As a result, there is, for instance, clearly an over-representation of international M&As involving firms from Spain and Italy and an under-representation of other countries including the UK and Netherlands. Table A1 shows the distribution of acquirer and target countries in the estimation sample as well as in Zephyr as a whole in more detail. In the robustness section it is shown that the main results of this paper are robust towards excluding various (groups of) countries from the estimation sample. Hence, the main conclusions of this paper are not likely to be driven by the over-representation of some countries in the estimation sample.

Table A2 in the Appendix shows the distribution of international M&As across industries. The share of cross-border M&As is above average in knowledge-intensive industries such as chemicals, machinery and equipment, and IT services, but a high share of international acquisitions also takes place in the food industry and in business-related services.

Figure 1 shows the average number of patents one year before and three years after international M&As in the combined entity and across acquirer's and target's country. Even pre-acquisition, the majority of patents is associated with inventors in the country of the acquirer's headquarter. Post-acquisition, there is a considerable increase in the average number of patents of more than 30% (from 2.7 to 3.6) compared to the pre-acquisition period in the merged entity. This increase is driven entirely by patents with inventors based in the acquirer's country which increase by more than 40%, while patents with inventors in target's country are decreasing by some 20%. These figures indicate a partly relocation of R&D from target firms to foreign acquirers.

Figure 2 provides further evidence on pre- and post-acquisition patenting based on technology classes of patents filed by the combined entity before and after M&As. For this purpose, patents are classified into 3-digit IPC technology classes and grouped into categories in which only the acquirer, only the target firm, both or neither of both have filed patents until 4 years earlier.[22] Both before and after international M&A, most patents are filed in technology fields in which acquirers rather than targets have been active previously. The overall increase in patenting after M&As is also mainly driven by patents in technology fields

[22] Patents can be classified into more than one technology class, and thus a few of the patents cannot be unambiguously assigned to one of the four categories. Where this is the case, a patent is included in each category and weighted such that the sum of the weights equals one. For instance, a patent receives weight 0.5 if it falls into two categories. The graph looks, however, very similar when these patents are excluded or when these patents are counted in each category with weight one.

in which only acquirers have previous experience. The largest *relative* increase stems from patents in technology classes in which both firms have patented before, but this is only responsible for a small share of all patents. The number of patents in technology classes in which the target but not the acquirer has experience drops as well as the number of patents in fields that are new to the merged entity as a whole. These observations are consistent with the descriptive statistics on the location of inventors, suggesting that the increase in post-acquisition innovation is due to the acquiring rather than the target firm.

The next section explores whether the observed increase in patenting as well as the relocation of innovative activity after international M&As also holds after controlling for observed and unobserved firm heterogeneity and accounting for possible endogeneity of international M&As.

5. Results

5.1 Main results

Table 4 shows the results from the dynamic Poisson regression models (as described in section 3) of patent counts on a dummy variable taking on value one if there was a cross-border M&A between *t*-1 and *t*-3 and further controls for consolidated companies. In column (1), only controls for lagged patenting, pre-sample patenting (to capture unobserved heterogeneity), domestic M&As, country, industry and time dummies are included. Further selection controls, as described in the previous section, are added to the specification in column (2). Columns (3) and (4) use citation-weighted patents as the outcome variable, and in columns (5) and (6), separate effects for each year after an M&A are estimated. Full estimation results including control variables are contained in Table A3 in the Appendix.

Without selection controls (column 1), post-acquisition patenting activity in the international merged entity is more than 80 log points higher than in control firms. However, this is likely to reflect a selection effect since firms engaging in international M&As are very different in terms of size, productivity and further characteristics compared to other firms. When selection controls are added, this difference drops substantially (column 2) but remains economically and statistically highly significant, indicating an increase of about 30% in innovation measured by patenting after a cross-border M&A.[23] This regression identifies the impact of international M&As if no unobservables affect innovation and acquisitions simultaneously.

[23] Due to the exponential relationship between the dependent variable and the regressors, this is computed as exp(0.274)-1.

As discussed in section 2, a potential concern with the use of patents as innovation indicator is that M&As might not only affect incentives to innovate but may also change the incentives to patent conditional on innovating. However, if that was the case, we should see a fall in citations per patent and thus a smaller association between international M&As and citation-weighted patents compared with non-weighted patents. As column (3) shows, using citation-weighted patents instead of simple patent counts yields very similar results. In column (4), citation weighted patents are computed excluding “X” and “Y" citations, which indicate a high strategic potential as discussed in section 4, and the results remain similar. Hence, the estimates are clearly not in line with cross-border acquisitions contributing solely to changes in IP strategies.[24]

In column (5), the effects of international M&As are estimated separately for three years. The results indicate that the effect on innovative activity is increasing over time. Column (6) shows that the coefficients of the lead variables (IMA_{t+1}, IMA_{t+2}, IMA_{t+3}) as well as the contemporaneous effect (IMA_t) of international acquisitions are insignificant. This shows that increases in innovation materialize after rather than before the acquisition and that it takes some time for international M&As to affect innovation. The time lag of one year seems to be a plausible result since previous research finds the highest correlations between R&D and patenting in the contemporaneous year (e.g. Hall et al., 1986). All in all, the results indicate a considerable increase in innovation activity starting one year after an international M&A.

Results for control variables, depicted in Table A3 in the Appendix, are largely as expected. Lagged TFP, size, capital intensity and working capital are positively correlated with innovation, younger firms seem to be more innovative, and there is state dependence in innovation activities, as indicated by the positive coefficients for lagged patenting and pre-sample patents. Interestingly, in contrast to international M&As, domestic M&As seem to have a negative impact on innovation. While the coefficient is positive in column (1), this is likely to reflect a selection effect as the coefficient becomes negative once selection controls are added in all remaining columns. A possible explanation for the negative relationship is

[24] Column (6) in Table A3 in the Appendix shows that the estimated effect on simple patent counts is even more similar, and below the coefficient for citation-weighted patents, if the estimation sample is restricted to time periods for which citations are available. The reduction in sample size is due to the restriction of a 2-year period for citations to be available. Due to the reduction in sample size and the truncation problem for citations at the end of the sample period, the remaining results presented are based on patent counts. However, all results of this paper are robust to the use of citation-weighted patents. In section 5.4, it is verified that there is a positive association between international M&As and innovation input, measured by R&D expenditures, as well. Several further robustness checks such as alternative estimation methods and dynamic specifications are also discussed in this section.

that domestic –in contrast to international- M&As do not provide access to new markets. Further as discussed in section 2, there is a higher potential for efficiency increase through relocation or complementarities after international acquisitions. For domestic M&As, other mechanisms including market power, as discussed in section 2, might drive the results. In a robustness check, discussed in more detail in section 5.4 and documented in Table A12 in the Appendix, it is found find that the difference between international and domestic M&As holds if time-varying market structure variables such as industry-country specific trends, entry and market growth rates are controlled for. Hence, the effects are unlikely to be driven by domestic M&As occurring in different markets.

Despite the overall positive association between international M&As and innovation output, the allocation of innovation activity between acquiring firms and acquisition targets is of both theoretical interest and policy relevance. Table 5 compares results using only patents in which at least one inventor was located in the country of the acquirer’s and target’s headquarters with those of control firms. Control variables are based on unconsolidated companies and either acquirers or targets are included in the estimation sample together with the comparison group. Columns (1) and (3) control only for previous patenting, time, country and industry dummies, while (unconsolidated) selection controls are included in columns (2) and (4). The table shows that the effects of international M&As are highly asymmetric. While patents with inventors based in the country of the acquirer's headquarters increase by more than 35% (column 2), patenting in the target's country is reduced by about 40% (column 4). Note that, as shown in Figure 1, acquiring firms have much higher rates of pre-acquisition patenting than target firms. Hence, this translates into an overall positive effect of cross-border M&As on innovation.[25] The results indicate a relocation of innovation activity from foreign acquisition targets to acquirers - which are in most cases the more innovative and productive part of the merged entity.

Although the results discussed so far account for a variety of control variables, time-invariant unobserved heterogeneity, and feedback from innovation to future decisions about M&As, one might still be concerned that the estimated coefficients do not reflect a causal

[25] These numbers are computed as exp(0.309)-1 for acquiring firms and exp(-0.548)-1 for target firms. Note that the overall effect on the merged entity is not exactly equal to the (size-weighted) sum of target and acquirer effects, as some - although relatively little - innovation is undertaken in countries other than the location of target's and acquirer's headquarters. Full estimation results including control variables can be found in Table A4 in the Appendix. Also note that since the estimation sample is restricted to M&As for which information on both acquiring and target firm is available, and excludes firms with multiple acquisitions, the number of observations for acquirers and targets is identical. The number of observations in regressions for the merged entity is the same as well, since merging pairs are treated as one firm both before and after the M&A in these specifications. In all specifications, the comparison group consists of firms not engaged in international M&A.

effect of international M&As on post-acquisition innovation due to self-selection. As a first attempt in addressing potential selection problems, a propensity-score matching combined with a DiD estimator is applied. Two alternative control groups are constructed – non-merging firms and firms affected by domestic M&As. An advantage of this approach over the use of IVs is that it does not rely on the validity of exclusion restrictions to identify a causal effect. Further, it does not require a linear relationship between control variables and innovation, and restricts the analysis to matched controls that are similar to the merging parties pre-acquisition.

Results for the estimation of the propensity score can be found in Table A5 in the Appendix. A test of the balancing property is documented in Table A6 in the Appendix. The balancing property holds for the treatment and control group of non-merging firms for all variables (this is also true for industry and country dummies not displayed in the table), although unmatched samples are very different. For the comparison with domestic M&As, there are some differences between treated and control group but they are only weakly significant for the dummy for pre-sample patents.

The results for the estimate of average treatment effects on the treated (ATT) after matching can be found in Table 6. The estimated coefficients are somewhat smaller than in the baseline count data estimates. However, they have only a qualitative interpretation; due to the transformation of the dependent variable, ($\ln(P_{it}+1)$), it is not possible to derive marginal effects on the absolute number of patents. The matching estimates confirm the positive effect of international M&As on innovation in the merged entity. The effects are similar when international M&As are compared to domestic M&As. Hence, it is the international dimension of M&As rather than acquisitions per se that drive the results. In Panel B, separate effects for patents with innovators in the acquirer and target country are displayed. Again, the positive effect of international M&As on patenting seems to be driven by innovation in acquirer's country.[26]

A drawback of the matching estimator in the present application is that matching cannot be conducted within industry–country pairs due to a lack of the number of M&As and patenting firms for some industries and countries. Further, while the approach allows the selection into international M&As to be based on time-invariant unobservables, it imposes the assumption that only observables time-varying factors matter. There could be unobserved time-variant factors such as productivity and technology shocks – if not sufficiently accounted

---

[26] For acquirers and targets no meaningful comparison between international and domestic M&As can be performed because the country of inventors cannot be used to distinguish acquirer's from target's innovation after domestic acquisitions.

for by the control variables – which affect the incentives for both M&As and innovation activities. In particular, it is possible that acquirers and targets that expect future increases (or decreases) in innovation performance select into foreign acquisitions. Finally, matching is based on the stable unit treatment value (SUTVA) assumption, i.e. it is assumed that there is no effect of international M&As on matched controls. This assumption could be violated if matched controls are competing in the same product or technology markets. To check whether these problems drive the previous results, IV techniques are employed, as described in section 3.

Table 7 shows linear first-stage regressions for consolidated firms as well as for the probability of becoming an international acquirer or target. As discussed in section 3, international M&As are instrumented by changes in accounting uniformity. As expected, accounting uniformity increases both the probability of being acquired and the propensity to engage in an international acquisition. For instance, an increase in accounting uniformity by one standard deviation increases the probability of being acquired by 0.08 percentage points.[27] This may sound like a small effect, but it is approximately equal to a fifth of the yearly acquisition probability among all firms (which is equal to 0.42%).

Besides the economic significance, the excluded instrument is statistically highly significant. The Kleinbergen-Paap statistic - which can be regarded as an approximation of the distribution of the weak-instrument test with non-iid errors - yields values between 18 and 43. This is higher than 16.4, the critical value for a maximum IV bias of 10% of the weak identification test proposed by Stock and Yogo (2005) given the number of observations and instruments. The overall F statistic of the first stage is highly significant as well.

Results of the linear second stage are presented in columns (1)-(3) of Table 8, and results of the non-linear GMM estimator are presented in columns (4)-(6). The results of previous regressions are qualitatively confirmed. There is a sizeable and highly significantly positive effect on innovation in the merged entity. This is accompanied by a positive effect on patents with inventors located in the country of the acquirer's headquarters but a decline in innovation activity that involves inventors in the country of the target firm's headquarters. Due to the transformation of the dependent variable ($\ln(P_{it}+1)$), marginal effects on the number of patents cannot be derived from the linear specification. The estimated effects in the GMM model for the merged entity and acquirers (columns 4 and 5) are quite similar to the baseline specification, suggesting that a large part of the previously estimated positive

[27] This is calculated as 3.652*0.00018 based on the standard deviation of uniformity (reported in Table 1) and the coefficient estimate in column (3) of Table 7.

correlation between innovation and cross-border M&As stems from a causal effect of international M&As on innovation. The estimated effect for target firms (column 6) is negative and in absolute terms larger than in the baseline estimation and in the linear IV regression but less precisely estimated. A possible reason for the drop in the coefficient is that acquirers may invest in target firms with relatively large unobserved innovation potential. Therefore the causal effect on target firms may be larger than the effect that is estimated when endogeneity is not taken into account.

All in all, the results confirm that cross-border acquisitions have a positive effect on patent outcomes in the merged entity and are accompanied by a relocation of innovation activities from foreign acquisition targets to the acquiring firm's country.

5.2 Heterogeneous effects

As discussed in section 2, pre-acquisition firm heterogeneity can interact with the effect of international M&As on innovation in at least two ways. First, there could be complementarities in combining acquirer’s and target’s knowledge stock. Second, the larger pre-acquisition differences between acquiring and target firms, the larger the potential for relocation of innovative activity. As the previous results do not indicate that endogeneity is the main explanation for the patterns observed in the baseline Poisson regressions, heterogeneous effects are estimated using this specification.

The results in column (1) of Table 9 show that the positive effect of international M&As on innovation seems to increase with both the acquirer’s and the target firm’s pre-acquisition patent stock. Interestingly, the coefficient for *IMA* - which measures the effect of international M&A if both the acquirer's and the target's pre-acquisition patent stock is 0 in this specification - becomes negative. This indicates that international M&As are unlikely to induce innovation if no innovative activity has been carried out before the acquisition. For a positive impact on the merged entity, the pre-acquisition stock of the acquirer (target) has to be large if the target (acquirer) has not been innovative previously. For instance, if the target's pre-acquisitions patent stock is 0 and the acquirer's patent stock is equal to the average of all investing firms (12.98; see Table 2), the predicted effect on the merged entity is slightly above 0. The results show a positive and significant coefficient for the interaction term for acquirer's and target's patent stock. Thus, the effect of the acquirer's patent stock on post-acquisition innovation increases with the target's pre-acquisition patent stock and vice versa. This result indicates complementarities in acquirer’s and target’s pre-acquisition technology. This is consistent with trade theoretical models arguing that access to complementary firm-specific assets matters for cross-border M&As (e.g. Nocke and Yeaple, 2007, 2008).[28]

As column (2) of Table 9 shows, heterogeneous effects according to pre-acquisition patent stocks (and their interaction) cannot be explained by variation in firm size (measured by pre-acquisition sales) within acquirers and acquisition targets. In columns (3) and (4), separate effects on innovation carried out in the country of acquirer's and target firm's headquarters are depicted. The results show that pre-acquisition characteristics have an asymmetric effect on acquirers and targets. For instance, the larger the pre-acquisition knowledge stock of the acquirer, the more pronounced is the positive (negative) effect of international M&As on post-acquisition innovation in the acquirer's (target's) country. Similarly, a larger pre-acquisition patent stock of the target firm diminishes the asymmetric effect between acquirers and targets. Hence, relocation of innovation seems to be most pronounced for large pre-acquisition differences in innovative capabilities. This indicates that innovation activities are not relocated from targets to acquirers per se but to the part of the multinational firm that is more efficient in innovation. As discussed in section 2, this is line with theoretical contributions predicting a geographic concentration of innovation according to the relative costs of conducting R&D (e.g. Markusen, 2002).

While the asymmetric effects between acquirer and target are not in line with complementarities in *post*-acquisition innovation in acquiring and target firms, it is possible that the target firm's *pre-acquisition* knowledge stock is valuable to the acquirer's research program and that acquired knowledge is exploited in the acquirer's country rather than in both countries. The results are consistent with large technology-based firms acquiring smaller companies whose technologies are integrated into the acquirer's research program post-acquisition.

5.3 Other outcome variables

As mentioned previously, the use of patent-based innovation indicators has the drawback that patents do not capture all innovations and that they may partly reflect strategic use of IP. An obvious alternative innovation indicator are R&D expenditures. While R&D expenditures are an innovation input indicator, they are less affected by differences in IP strategies compared to patents. Unfortunately, as discussed in the data section, only a small share of the firms in the estimation sample reports R&D expenditures. Further, regressions

[28] Although the patent data include information about technology classes, it is not straightforward to identify complementarities or substitutability within and across technology fields for a sample that includes a large range of industries and technological fields. It is thus left for future research to analyze this aspect in more detail.

using R&D expenditures can only be run for the merged entity, since R&D expenditures had to be constructed from consolidated information to end up with a reasonable number of observations.

Nonetheless, linear fixed-effects regressions with logarithmic R&D expenditures as the dependent variable are run as a robustness check. The results are documented in Table 10. The table shows that there is a positive association between international M&As and R&D which is of similar magnitude to the results for patenting.[29] When the results are split across three different years (columns 2 and 5) all lagged indicators of international M&As are positive but the impact is highly significant only after 3 years, weakly significant after 2 years and insignificant in the first post-acquisition year. While the estimates are less significant compared to the patent regressions –which is probably due to the much smaller number of observations – the previous results are qualitatively confirmed. Columns (3) and (6) show that the lead indicators of M&As are all insignificant.

Finally, some evidence on other outcome variables, sales growth and productivity growth, is provided. The results are presented in Table 11. For the consolidated entity, there seems to be a positive although only weakly significant effect on productivity (column 1) and a large and highly significantly positive effect on sales growth (column 2). Similar effects are estimated for acquiring firms: the effect on sales growth is large and significant (column 4) and the effect on productivity is positive but insignificant (column 3). The relocation of innovation activity does not seem to be accompanied by a relocation of production from target firms. In contrast, targets display higher growth of both productivity (column 5) and sales (column 6) after acquisition. This seems plausible since multinationals might locate production according to consumers to avoid trade costs while the knowledge generated from R&D can be transferred across borders at relatively low costs as discussed in section 2. Within target firms, there seems to be a reallocation of resources from innovation to production.

A possible explanation for the lack of significant productivity effects in acquiring firms might be that it takes more time for innovations to affect productivity. Target firms seem to benefit in terms of higher sales and productivity, indicating that part of the knowledge generated through innovation in acquirer's country (possibly pre-acquisition) is transferred to

[29] Although only a small fraction of the original number of observations can be used, the number of M&As is nonetheless 330 (more than a third of the original sample). The substantially larger loss in the number of observations in the control group is because small firms rarely report R&D expenditures. Ideally, one would like to study the effects of M&As on R&D, and of M&As on patents conditional on R&D. However, it would need more observations on firms with a longer time series of R&D expenditures to construct a reasonable measure of an R&D stock and to estimate a knowledge production function, as, for instance, in Aghion et al. (2013).

target firms. This interpretation is in line with recent contributions which argue that foreign target firms adopt new machines and implement organizational changes after being acquired by a foreign firm (e.g. Guadalupe et al., 2012). In the present paper, the focus is on patents, which capture innovations new to the market. Hence, the relocation of innovative activity is not at odds with a transfer of existing knowledge after foreign acquisitions.

5.4 Additional robustness checks

Several robustness checks with respect to the estimation sample, econometric methods, control variables and the usefulness of patent based metrics as a measure of the scale and location of innovation were conducted. All these robustness checks are documented and discussed in more detail in a supplementary Appendix.[30]

With respect to the measurement of innovation, one concern is that differences in IP rights across countries drive the results, particularly if the location of inventors is an imperfect proxy for the location of innovative activity. As this concern should be of little relevance for M&As in which both acquirer and target are located in Northern or Western European countries, separate regressions excluding other international M&As were conducted. [31] Table A8 in the Appendix shows that the results for acquirers, targets and the merged entity are similar to estimates using the whole sample.

A related concern is that patenting could be affected by income shifting (Karkinsky and Riedel, 2012; Griffith et al., 2014) induced by differences in tax rates across countries. While control variables for statutory corporate tax rates are significant, they do not affect the conclusions for the results of international M&As, which is documented in Table A9.

It is further explored whether the results are driven by specific kinds of industries or countries which could have different propensities to patent. As Table A10 in the Appendix shows, the results are not statistically significantly different for international M&As taking place in service compared to manufacturing or predominantly process innovating compared to product innovating industries. The effect of international M&As where Nothern/Western firms acquire targets in Southern or Eastern Europe (or vice versa) is significantly smaller, but this difference disappears once pre-acquisition firm heterogeneity - measured by lagged patent stocks - is controlled for.

[30] I would like to thank two anonymous referees for suggesting some of the robustness checks in this section.
[31] Rankings of intellectual property rights across countries are, for instance, published by the World Intellectual Property Organization (http://www.wipo.int/ipstats/en/wipi/).

With respect to the estimation sample, the results are qualitatively robust to excluding the countries with the highest number of acquirers and targets as well as the countries which are most over-represented in the estimation sample (Table A11).

The results are also robust to controlling for time-variant industry- and country-specific variables such as industry-wide patenting, sales growth, and net entry rates and to industry- and country- and industry-country pair-specific trends which mitigates concerns that industry and country-level differences in the propensity to patent drive the results. These results are depicted in Table A12, columns (1) to (3). Alternative dynamics, such as controlling for the lagged patent stock or logarithmic transformations of pre-acquisition and pre-sample patenting, do not affect the main conclusion either (columns 4 to 6). The same is true when instead of a count data model, a dynamic Logit model is used to estimate the probability of at least one patent (Table A13).

Regarding the identifying assumptions, the results are similar when propensity score reweighting instead of nearest neighbor matching is applied (see Table A14). With respect to the IV approach, the results hold when an additional instrument - distance to foreign markets - is used. The validity of this instrument is discussed in detail in the Appendix. The use of two different instruments allows conducting over-identification tests; the null hypothesis of instrument validity cannot be rejected (see Table A15 and A16).

6. Conclusion

This paper analyzes the impact of cross-border M&As on innovation output – measured by patenting – of European firms and the relocation of innovation activity within multinationals across countries. After cross-border M&A, there seems to be a large increase in innovation output within the merged entity of more than 20% within three years.

Controlling for a large set of firm-level characteristics, applying IV techniques and a propensity score matching combined with a DiD approach, it is found that these correlations seem to arise from a causal effect of cross-border M&A on innovation. The results are robust to alternative innovation indicators such as citation-weighted patents and R&D expenditures. The largest impact of cross-border M&As on innovation is found when pre-acquisition patent stocks of acquiring and target firms are both large. This indicates that access to complementary innovative assets in target firms is an important factor for post-acquisition innovation outcomes.

Decomposing the effect of cross-border M&A on innovation by inventors' countries, it is found that the positive association with post-acquisition patenting is driven by innovations generated in the country of acquirer’s headquarters, while there is on average a substantial decrease in innovations generated in target’s country. This implies that cross-border M&As are accompanied by a relocation of innovative activity across subsidiaries and countries. The main reason for this relocation seems to lie in the higher level of pre-acquisition innovation in acquiring firms. The asymmetry of effects among acquiring and target firms is most pronounced if pre-acquisition differences in patent stocks are large. This indicates that innovation activity is relocated towards the more efficient part of the multinational company rather than from target to acquiring firms per se. These results are consistent with the knowledge capital model (Markusen, 1997; 2002) and related trade theoretical contributions which predict a geographic concentration of innovation within multinationals according to the productivity of R&D.

At first glance, the results provide some rationale for decision makers in policy to block inward foreign acquisitions in their country, as innovation in target firms seems to decrease on average after international M&As. However, the results also suggest that restrictions on cross-border M&As may reduce global innovation activities - and hence long-term economic growth and welfare - as they prevent a relocation of innovation activity towards more efficient usage and enhanced innovation in acquirer’s country. Therefore, restricting inward foreign acquisitions may be a myopic strategy if it induces restrictions from other countries as a response. Further, evidence presented in this paper shows that targets can still benefit from higher sales and productivity post-acquisition which may stem from market access and technology transfer provided by the acquirer.

For future research, it might be interesting to analyze a sample of firms which contains data on innovation of acquirers and targets which is not limited to European countries. It would also be interesting to analyze other outcome variables in more detail and to link empirical results to a theoretical model that analyzes the matching between acquiring and target firms and heterogeneous effects of cross-border M&As among them.

References

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

Aghion, P., Van Reenen, J. and Zingales, L. (2013), "Innovation and institutional ownership", *American Economic Review* 103 (1), 277-304.

Ahuja, G., and Katila, R. (2001), "Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study", *Strategic Management Journal* 22, 197-220.

Arkolakis, C., Ramondo, N., Rodríguez-Clare, A., and Yeaple, S. R. (2013), “Innovation and production in the global economy”, National Bureau of Economic Research No. w18972.

Arnold, J. M. and Javorcik, B. S. (2009), “Gifted kids or pushy parents? Foreign acquisitions and plant performance in indonesia”, *Journal of International Economics* 79 (1), 42-53.

Bandick, R., Görg, H., and Karpaty, P. (2014), „Foreign acquisitions, domestic multinationals, and R&D”, *Scandinavian Journal of Economics* 116 (4), 1091-1115.

Bena, J. and Li, K. (2014), "Corporate Innovations and Mergers and Acquisitions", *Journal of Finance* 69 (5), 1923-1960.

Benfratello, L. and Sembenelli, A. (2006), “Foreign ownership and productivity: Is the direction of causality so obvious?”, *International Journal of Industrial Organization* 24 (4),733-751.

Bertrand, O. (2009), “Effects of foreign acquisitions on R&D activity: Evidence from firm-level data for France”, *Research Policy* 38 (6), 1021-1031.

Bertrand, O. and Betschinger, M. A. (2012), "Performance of domestic and cross-border acquisitions: Empirical evidence from Russian acquirers", *Journal of Comparative Economics* 40 (3), 413-437.

Bertrand, O., Hakkala, K.N., Norbäck, P. J. and Persson, L. (2012), "Should countries block foreign takeovers of R&D champions and promote greenfield entry?", *Canadian Journal of Economics* 45 (3), 1083-1124.

Bertrand, O. and Zuniga, P. (2006), “R&D and M&A: Are cross-border M&A different? An investigation on OECD countries”, *International Journal of Industrial Organization* 24, 401-423.

Bilir, L. K. (2014), "Patent Laws, Product Life-Cycle Lengths, and Multinational Activity", *American Economic Review* 104 (7), 1979-2013.

Blind, K., Cremers, K., and Mueller, E. (2009), “The influence of strategic patenting on companies’ patent portfolios”, *Research Policy* 38(2), 428-436.

Blonigen, B. A., Fontagne, L., Sly, N. and Toubal, F. (2014), "Cherries for sale: The incidence and timing of cross-border M&A", *Journal of International Economics* 94(2):341-357.

Bloom, N., Draca, M. and Van Reenen, J. (2015), "Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity", *Review of Economics and Statistics,* forthcoming.

Blundell, R. Griffith, R. and Windmeijer, F. (1995), "Dynamic count data models of technological innovation", *Economic Journal* 105 (429), 333–344.

Blundell, R. Griffith, R. and Windmeijer, F. (2002), "Individual effects and dynamics in count data models", *Journal of Econometrics* 108 (1), 113–131.

Braguinsky, S., Ohyama, A., Okazaki, T., and Syverson, C. (2015), "Acquisitions, Productivity, and Profitability: Evidence from the Japanese Cotton Spinning Industry", *American Economic Review*, forthcoming.

Brakman, S., Garretsen, H. and Van Marrewijk, C. (2007), "Cross-border mergers & acquisitions: The facts as a guide for international economics", in G. N. Gregoriou and L. Renneboog (eds.), *International Mergers and Acquisitions Activity Since 1990: Recent Research and Quantitative Analysis*, Elsevier, San Diego.

Breinlich, H. (2008), "Trade liberalization and industrial restructuring through mergers and acquisitions", *Journal of International Economic* 76 (2), 254-266.

Budd, J. W., Konings, J. and Slaughter, M. J. (2005), "Wages and international rent sharing in multinational firms", *Review of Economics and Statistics* 87 (1), 73-84.

Busso, M., DiNardo, J. and McCrary, J. (2015), "New evidence on the finite sample properties of propensity score reweighting and matching estimators", *Review of Economics and Statistics* 96 (5), 885-897.

Caliendo, M. and Kopeinig, S. (2008), "Some practical guidance for the implementation of propensity score matching", *Journal of Economic Surveys* 22 (1): 31-72.

Cassiman, B., Colombo, M., Garrone, P. and Veugelers, R. (2005), "The impact of M&A on the R&D process: An empirical analysis of the role of technological- and market-relatedness", *Research Policy* 34 (2), 195-220.

Chamberlain, G. (1992), "Comment: Sequential moment restrictions in panel data", *Journal of Business & Economic Statistics* 10, 20–26.

Cantwell, J., and Piscitello, L. (2002), "The location of technological activities of MNCs in European regions: The role of spillovers and local competencies", *Journal of International Management* 8(1), 69-96.

Chen, W. (2011), "The effect of investor origin on firm performance: Domestic and foreign direct investment in the United States", *Journal of International Economics* 83(2), 219-228.

Cloodt, M., Hagedoorn, J. and Van Kranenburg, H. (2006), "Mergers and acquisitions: Their effect on the innovative performance of companies in high-tech industries", *Research Policy* 35 (5), 642-654.

Conyon, M. J., Girma, S., Thompson, S. and Wright, P.W. (2002a), "The impact of mergers and acquisitions on company employment in the United Kingdom", *European Economic Review* 46, 31-49.

Conyon, M. J., Girma, S., Thompson, S. and Wright, P. W. (2002b), "The productivity and wage effects of foreign acquisition in the United Kingdom", *Journal of Industrial Economics* 50 (1), 85-102.

Criscuolo, C. and Martin, R. (2009), "Multinationals and US productivity leadership: Evidence from Great Britain", *Review of Economics and Statistics* 91(2), 263-281.

Criscuolo C, Haskel J. E. and Slaughter, M. J. (2010), “Global engagement and the innovation activities of firms”, *International Journal of Industrial Organization* 28 (2), 191-202.

David, J. M. (2013), "The aggregate implications of mergers and acquisitions", Working Paper, Center for Applied Financial Economics, University of Southern California.

DeFond, M., Hu, X., Hung, M. and Li, A. (2011), “The impact of mandatory IFRS adoption on foreign mutual fund ownership: The role of comparability”, *Journal of Accounting and Economics* 51 (3), 240-258.

Desyllas, P. and Hughes, A. (2010), "Do high technology acquirers become more innovative?", *Research Policy* 39 (8), 1105-1121.

Ethier, W., and Markusen, J. (1996). “Multinational Firms, Technology Diffusion, and Trade”, *Journal of International Economics* 41(1-2): 1-28.

European Commission (2011), *The 2011 EU Industrial R&D Investment Scoreboard*. JRC Science and Technical Research Series.

Francis, J. R., Huang, S. X., and Khurana, I. K. (2015), “The Role of Similar Accounting Standards in Cross-Border Mergers and Acquisitions”, *Contemporary Accounting Research*, forthcoming.

Garcia-Vega, M. Hoffmann, P. and Kneller, R. (2012), "The internationalisation of R&D and the knowledge production function", Nottingham University Research Paper 2012/02.

Greenaway, D., and Kneller, R. (2007), "Firm heterogeneity, exporting and foreign direct investment", *Economic Journal* 117 (517), F134-F161.

Greenaway, D., Guariglia, A., and Kneller, R. (2007), "Financial factors and exporting decisions", *Journal of International Economics* 73 (2), 377-395.

Griliches, Z. (1998), "Patent statistics as economic indicators: A survey", in Z. Griliches (ed.), *R&D and Productivity: The Econometric Evidence*, pp. 287–343, University of Chicago Press, Chicago.

Griffith, R., Harrison, R., and van Reenen, J. (2006), “How Special Is the Special Relationship? Using the Impact of US R&D Spillovers on UK Firms as a Test of Technology Sourcing”, *American Economic Review* 96 (5), 1859-1875.

Griffith, R., Miller, H., and O'Connell, M. (2014) “Ownership of intellectual property and corporate taxation”, *Journal of Public Economics* 112, 12-23.

Grimpe, C., and Hussinger, K. (2008), “Pre-empting technology competition through firm acquisitions”, *Economics Letters* 100 (2), 189-191.

Guadalupe, M., Kuzmina, O. and Thomas, C. (2012), "Innovation and foreign ownership", *American Economic Review* 102(7), 3594-3627.

Guellec, D., and van Pottelsberghe de la Potterie, B. (2001). The internationalisation of technology analysed with patent data. *Research Policy* 30 (8), 1253-1266.

Gugler, K. and Siebert, R. (2007), "Market power versus efficiency effects of mergers and research joint ventures: Evidence from the semiconductor industry", *Review of Economics and Statistics* 89(4), 645–659.

Hagedoorn, J. and Cloodt, M. (2003), "Measuring innovative performance: Is there an advantage in using multiple indicators?", *Research Policy* 32 (8), 1365–1379.

Hall, B. H. (2011), “The internationalization of R&D”, Unu-Merit Working Paper #2011-049.

Harhoff, D. and Thoma, G. (2011), “Inventor Location and the Globalization of R&D”, Mimeo, University of Munich.

Hall, B. H. and Ziedonis, R. H. (2001), "The patent paradox revisited: An empirical study of patenting in the U.S. semiconductor industry, 1979-1995", *RAND Journal of Economics* 32 (1), 101-128.

Hall, B. H., Griliches, Z. and Hausman, J. A. (1986), "Patents and R&D: Is there a lag?" *International Economic Review* 27 (2), 265–284.

Hall, B. H., Jaffe, A. and Trajtenberg, M. (2005), "Market value and patent citations", *RAND Journal of Economics* 36 (1), 16-38.

Helpman, E., Melitz, M. J. and Yeaple, S. R. (2004), “Export versus FDI with heterogeneous firms”, *American Economic Review* 94 (1), 300-316.

Horn H. and Persson, L. (2001), “The equilibrium ownership of an international oligopoly”, *Journal of International Economics* 53, 307-333.

Jovanovic, B. and Rousseau, P. L. (2008) “Mergers as reallocation”, *Review of Economics and Statistics* 90 (4), 765–776.

Kamien, M. I. and Zang, I. (1990), “The limits of monopolization through acquisition”, *Quarterly Journal of Economics*, 105 (2), 465–99.

Karkinsky, T. and Riedel, N. (2012), "Corporate taxation and the choice of patent location within multinational firms", *Journal of International Economics* 88(1), 176-185.

Keller, W. and Yeaple, S. R. (2013), “The Gravity of Knowledge”, *American Economic Review* 103 (4), 1414-1444.

Konings, J. and Vandenbussche, H. (2005), "Antidumping protection and markups of domestic firms", *Journal of International Economics* 65(1), 151-165.

Kumar, N. (2001), “Determinants of location of overseas R&D activity of multinational enterprises: The case of US and Japanese corporations”, *Research Policy* 30, 159-174.

Long, W. F. and Ravenscraft, D. J. (1993), “LBOs, debt and R&D intensity”, *Strategic Management Journal* 14; 119-135.

Louis, H. and Urcan, O. (2012), "The effect of IFRS on cross-border acquisitions", available at SSRN 2164995.

Maksimovic, V., Phillips, G., and Prabhala, N. R. (2011), “Post-merger restructuring and the boundaries of the firm”, *Journal of Financial Economics* 102 (2), 317-343.

Malerba, F. and Orsenigo, L. (1999), "Technological entry, exit and survival: An empirical analysis of patent data", *Research Policy* 28 (6), 643-660.

Marin, R. and Alvarez, I. (2009), “Technological effects of M&As in Spanish manufacturing”, *Industrial and Corporate Change* 18 (4), 761-784.

Markusen, J. R. (1997), “Trade versus Investment Liberalization”, NBER working paper 6231.

Markusen, J. R. (2002), *Multinational Firms and the Theory of International Trade*, MIT Press, Massachusetts.

Motta, M. and Ruta, M. (2012), “A political economy model of merger policy in international markets”, *Economica* 79 (313), 115-136.

Neary, J. P. (2007), “Cross-border mergers as instruments of comparative advantage”, *Review of Economic Studies* 74 (4), 1229-1257.

Nocke, V. and Yeaple, S. R. (2007), “Cross-border mergers and acquisitions vs. greenfield foreign direct investment: The role of firm heterogeneity”, *Journal of International Economics* 72 (2), 336-365.

Nocke, V. and Yeaple, S. R. (2008), “An assignment theory of foreign direct investment”, *Review of Economic Studies* 75 (2), 529-557

Norbäck, P-J. and Persson, L. (2007), “Investment liberalization - Why a restrictive cross-border merger policy can be counterproductive”, *Journal of International Economics* 72 (2), 366-380.

Olley, G. S. and Pakes, A. (1996), "The dynamics of productivity in the telecommunications equipment industry", *Econometrica* 64 (6), 1263-1297.

Sanna-Randaccio, F. and Veugelers (2007), “Multinational knowledge spillover with decentralized R&D: A game-theoretic approach”, *Journal of International Business Studies* 38 (1), 47-63.

Schmutzler, A. (2013), "Competition and investment - A unified approach", *International Journal of Industrial Organization* 31, 477-487.

Seru, A. (2014), "Firm boundaries matter: Evidence from conglomerates and R&D activity", *Journal of Financial Economics* 111, 381-405.

Shleifer, A. and Vishny, R. W. (1988) "Value maximization and the acquisition process", *Journal of Economic Perspectives* 2, 7–20.

Stiebale, J. (2013), “The impact of cross-border mergers and acquisitions on the acquirers' R&D—Firm-level evidence”, *International Journal of Industrial Organization* 31(4), 307-321.

Stiebale, J. and Reize, F. (2011), “The impact of FDI through mergers and acquisitions on innovation in target firms”, *International Journal of Industrial Organization* 29 (2), 155-167.

Stiebale, J. and Trax, M. (2011), "The effects of cross-border M&As on the acquirers’ domestic performance: firm-level evidence", *Canadian Journal of Economics* 44 (3), 957-990.

Stock, J. H. and Yogo, M. (2005), "Testing for weak instruments in linear IV regression", in D. W. K. Andrews and J. H. Stock (eds.), *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, pp. 80–108, Cambridge University Press, Cambridge.

Terza, J. V. (1998), "Estimating count data models with endogenous switching: Sample selection and endogenous treatment effects", *Journal of Econometrics* 84, 129-154.

UNCTAD (2005), World Investment Report 2005: *Transnational Corporations and the Internationalization of R&D*. United Nations.

UNCTAD (2007), World Investment Report 2007: *Transnational Corporations, Extractive Industries and Development.* United Nations.

Veugelers, R. (2006), “Literature review on M&A and R&D”. in Cassiman, B. and Colombo, M. G., *Mergers and Acquisitions-The Innovation Impact*, Edward Elgar Publishing, Northampton, MA.

Vives, X. (2008), "Innovation and competitive pressure", *Journal of Industrial Economics* LVI (3), 419-467.

Windmeijer, F. (2008), "GMM for Panel Data Count Models", in Mátyás, L. and Sevestre, P.: *The Econometrics of Panel Data - Fundamentals and Recent Developments in Theory and Practice*, Springer, Heidelberg.

Windmeijer, F. and Santos Silva, J. (1997), “Endogeneity in count data models: An application to demand for health care”, *Journal of Applied Econometrics* 12 (3), 281-294.

Wooldridge, J.M. (1997), “Multiplicative panel data models without the strict exogeneity assumption”, *Econometric Theory* 13, 667–678.

Wooldridge, J. M. (2009), "Should instrumental variables be used as matching variables?" Tech. Report, Michigan State University, MI.

Yeaple, S. (2013), “The Multinational Firm”, *Annual Review of Economics* 5, 193-217.

Ziedonis, R. H. (2004), "Don’t fence me in: Fragmented markets for technology and the patent acquisition strategies of firms", *Management Science* 50 (6), 804-820.

Tables

Table 1: Summary statistics

Variable		Mean	SD
patent stock	cumulated number of patents, 15% depreciation	5.271	32.676
patents	number of patent applications per year	1.031	7.729
patent cites	number of patents, weighted by forward citations	7.178	65.461
sales	sales in €1,000	15,383	131,739
working capital	(current assets - current liabilities)/total assets	0.165	0.329
TFP	total factor productivity, relative to industry mean	-0.039	1.003
capital intensity	tangible fixed assets / sales	0.577	18.483
age	firm age in years	18.425	21.631
pre sample patents	average number of pre-sample patents (1978-2000)	0.095	0.845
D(pre sample patents)	=1 if pre sample patents (1978-2000) > 0	0.014	0.116
IMA	= 1 if international M&A in current year	0.004	0.064
DMA	= 1 if domestic M&A in current year	0.015	0.121
R&D	R&D expenditures in €1,000 (reduced sample)	20,510	234,688
accounting uniformity	growth #industry peers with same accounting practice	2.533	3.652
distance	distance to closest foreign market in 100km	2.744	1.547

Notes: Statistics are based on 229,479 observations of consolidated companies.

Table 2: Mean values of key variables: merging firms and controls

		international M&A	
	control firms	acquirers	targets
patent stock	4.186	12.980	2.566
patents	0.783	3.081	0.236
patent cites	6.996	51.069	4.929
sales	9,694	181,917	47,818
working capital	0.161	0.136	0.128
TFP	-0.053	0.259	0.219
capital intensity	0.588	0.789	8.013
age	17.963	32.634	27.730
pre-sample patents	0.081	0.251	0.089
D(pre sample patents)	0.011	0.108	0.051
R&D	18,181	49,228	13,790

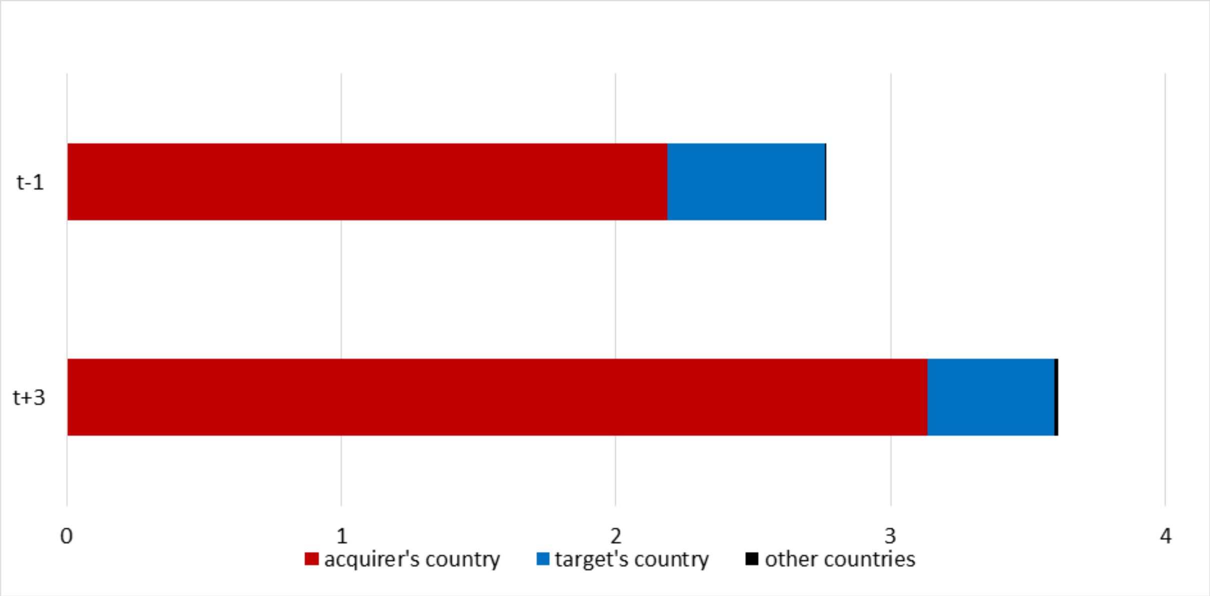
Notes: Statistics are based on unconsolidated companies. See Table 1 for definitions of variables.

Table 3: International M&As across regions

	target region				
acquirer region	west	north	south	CEE	all
west	203	40	66	53	362
north	46	126	10	39	221
south	135	8	88	30	261
CEE	8	1	6	82	97
All	392	175	170	204	941

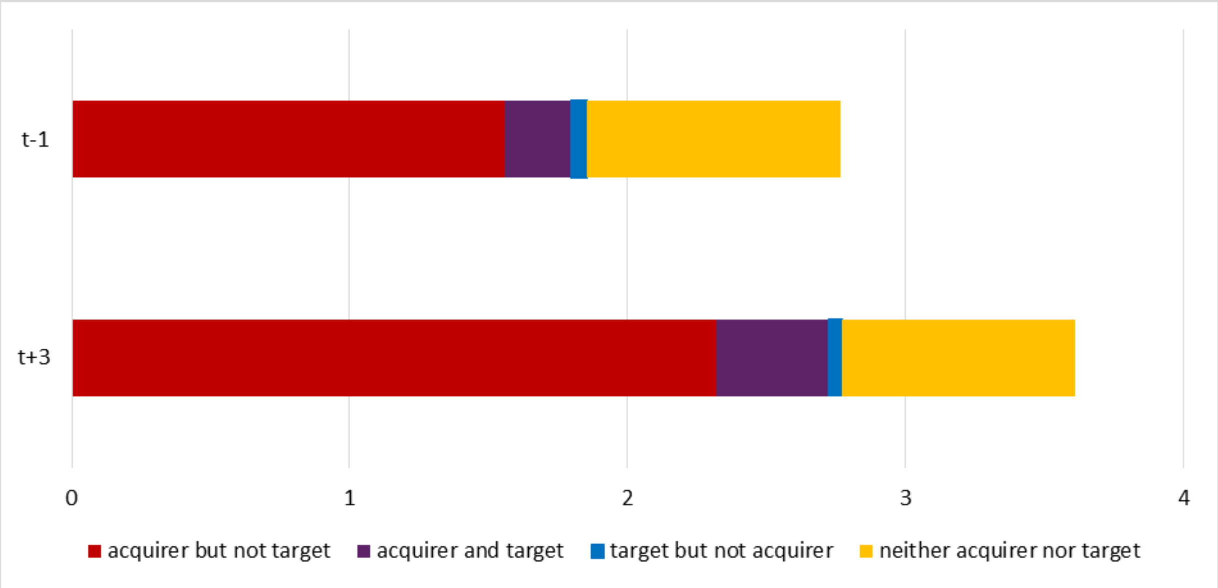
Notes: Western Europe includes Germany, UK, Netherlands, Ireland, Belgium, France, Austria, Switzerland, Luxemburg; Southern Europe includes Spain, Italy, Portugal, Greece, Malta, Cyprus; Northern Europe includes Sweden, Norway, Finland, Denmark, Iceland; Central and Eastern Europe (CEE) includes Estonia, Latvia, Lithuania, Croatia, Czech Republic, Romania, Russia, Serbia, Slovakia, Slovenia, Ukraine.

Figure 1: Patents before and after international M&A by inventor's country in the consolidated company



Notes: The bars show the number of patents in the consolidated entity 1 year before and 3 years after an international M&A which takes place at year t and the distribution of patents by country of inventor.

Figure 2: Patents before and after international M&A in the consolidated company by technology classes previously part of the patent portfolio of parts of the merged entity



Notes: The bars show the number of patents in the consolidated entity 1 year before and 3 years after an international M&A which takes place at year t. The bars also show the distribution of patents by 3-digit IPC technology classes which have been part of the patent portfolio of acquirer but not target, both, target but not acquirer or none of both 4 years earlier.

Table 4: Cross-border M&As and innovation in the merged entity

	(1)	(2)	(3)	(4)	(5)	(6)
	patents	patents	patent cites	patent cites 2	patents	patents
IMA(t-1/t-3)	0.865***	0.274***	0.262***	0.259***		
	(0.045)	(0.046)	(0.059)	(0.049)		
IMA(t-1)					0.236***	0.239***
					(0.077)	(0.077)
IMA(t-2)					0.263***	0.266***
					(0.072)	(0.072)
IMA(t-3)					0.384***	0.386***
					(0.078)	(0.079)
IMA(t)						0.034
						(0.089)
IMA(t+1)						-0.010
						(0.107)
IMA(t+2)						0.042
						(0.129)
Selection controls	no	yes	yes	yes	yes	yes
Observations	229,479	229,479	191,451	191,451	229,479	229,479
Pseudo R squared	0.629	0.702	0.780	0.779	0.703	0.703
Pseudo log likelihood	-17,886	-14,358	-51,128	-57056	-14,321	-14,321

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count data regressions for consolidated companies. The dependent variable is the number of patents per year. In column (3), patents are weighted by forward citations. In column (4), patents are weighted by forward citations excluding "X" and "Y" citations. IMA is an indicator variable taking a value of one if two firms from different countries merged in the respective years. t refers to the year in which patent applications are measured. IMA(t-1)(t-2, t-3) therefore measures the correlation between IMA and patenting one (two, three) years after the international M&A, while IMA(t+k) measures the association between IMA and patenting k years before the M&A. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, as well as for the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents and domestic M&As. Selection controls include log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital. Results for control variables can be found in Table A3.

Table 5: Cross-border M&A and innovation in the acquirer's and target's countries

	(1) acquirer	(2) acquirer	(3) target	(4) target
IMA(t-1/t-3)	0.429***	0.309***	-0.947***	-0.548***
	(0.053)	(0.047)	(0.188)	(0.184)
Selection controls	no	yes	no	yes
Observations	229,479	229,479	229,479	229,479
Pseudo R squared	0.433	0.602	0.395	0.543
Pseudo log likelihood	-26,522	-18,630	-19,557	-14,759

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. IMA is an indicator variable taking a value of one if a firm acquired a foreign firm (was acquired by a foreign firm) in the respective year. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, as well as for the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents and domestic M&As. Selection controls include log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital. Results for control variables can be found in Table A4. Only patents with inventors located in the country of firms' headquarters are counted. Patent counts and control variables are based on the acquirer in columns (1) and (2) and on the target in columns (3) and (4).

Table 6: Propensity-score matching and DiD: average treatment effects on the treated

Panel A: ATT for consolidated company

	(1)	(2)	(3)	(4)	(5)	(6)
Patents in period	t+1	t+2	t+3	t+1	t+2	t+3
Comparison group	Non-M&A	Non-M&A	Non-M&A	Domestic M&A	Domestic M&A	Domestic M&A
IMA(t)	0.084***	0.112***	0.133***	0.101***	0.131***	0.149***
	(0.031)	(0.035)	(0.038)	(0.034)	(0.039)	(0.042)
Observations	1,759	1,759	1,759	1,564	1,564	1,564
R squared	0.005	0.006	0.008	0.011	0.011	0.011

Panel B: ATT for foreign acquirers and targets based on comparison with non-merging firms

	(1)	(2)	(3)	(4)	(5)	(6)
Patents in period	t+1	t+2	t+3	t+1	t+2	t+3
Patents in country of	acquirer	acquirer	acquirer	target	target	target
IMA(t)	0.096*	0.129**	0.166**	-0.240***	-0.269***	-0.291***
	(0.057)	(0.064)	(0.068)	(0.043)	(0.048)	(0.051)
Observations	1,759	1,759	1,759	1,759	1,759	1,759
R squared	0.003	0.004	0.005	0.023	0.023	0.026

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Standard errors (clustered by firm) are shown in parentheses. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective years. The outcome variables is ln(patents(j)+1)-ln(patents(t-1)+1), where t is the year of the international M&A and j=t+1, t+2 or t+3. All regressions include time dummies.

Table 7: First-stage regressions

	(1) consolidated	(2) Acquirer	(3) target
accounting uniformity	0.00021***	0.00021***	0.00018***
	(0.00005)	(0.00005)	(0.00003)
Observations	229,479	229,479	229,479
R squared	0.040	0.048	0.118
F-test	15.02	15.33	17.52
Kleinbergen Paap rk Wald F	18.39	18.81	43.13

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Standard errors (clustered by industry) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, as well as for the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents and domestic M&As. Further selection controls include log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital. Results for control variables can be found in Table A7. In column 1 (2, 3) variables are based on the merged entity (acquirer, target firm).

Table 8: Controlling for endogeneity: GMM and linear IV

	(1) linear IV consolidated ln(patents+1)	(2) linear IV acquirer ln(patents+1)	(3) linear IV target ln(patents+1)	(4) GMM consolidated patents	(5) GMM acquirer patents	(6) GMM target patents
IMA(t-1/t-3)	0.623**	0.597**	-0.633***	0.275**	0.509***	-1.540*
	(0.267)	(0.278)	(0.213)	(0.119)	(0.138)	(0.832)
Observations	229,479	229,479	229,479	229,479	229,479	229,479
(pseudo) R squared	0.277	0.189	0.102	0.785	0.560	0.711
F-test	22.85	18.58	13.70	-	-	-

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Standard errors (clustered by industry) are shown in parentheses. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective years. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital. In columns 1&4 (2&5,3&6), variables are based on the merged entity (acquirer, target firm).

Table 9: Heterogeneous effects

	(1) consolidated	(2) consolidated	(3) acquirer	(4) target
IMA(t-1/t-3)	-0.254***	0.366***	-0.027	-0.558***
	(0.059)	(0.107)	(0.061)	(0.216)
IMA *patent stock acquirer (t-4)	0.021***	0.019***	0.012***	-1.377*
	(0.001)	(0.001)	(0.001)	(0.810)
IMA *patent stock target (t-4)	0.014***	0.014***	-0.062*	0.218***
	(0.001)	(0.002)	(0.035)	(0.040)
IMA * patent stock acquirer (t-4)	0.010***	0.012***	0.010***	0.203
* patent stock target (t-4)	(0.001)	(0.001)	(0.001)	(0.127)
IMA *size acquirer (t-4)		-0.033		
		(0.024)		
IMA *size target (t-4)		-0.007		
		(0.040)		
IMA * size acquirer (t-4)		-0.003		
* size target (t-4)		(0.005)		
Observations	229,479	229,479	229,479	229,479
Pseudo R squared	0.705	0.702	0.702	0.707
Pseudo log likelihood	-14,241	-14,358	-14,353	-14,120

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count-data regressions. The dependent variable is the number of patents per year. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective years. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital.

Table 10: Cross-border M&As and R&D in the merged entity

	(1)	(2)	(3)	(4)	(5)	(6)
IMA(t-1/t-3)	0.219***			0.224***		
	(0.056)			(0.056)		
IMA(t-1)		0.127	0.096		0.127	0.099
		(0.100)	(0.111)		(0.100)	(0.111)
IMA(t-2)		0.148*	0.125		0.147*	0.126
		(0.079)	(0.087)		(0.079)	(0.087)
IMA(t-3)		0.262***	0.244***		0.271***	0.255***
		(0.082)	(0.087)		(0.082)	(0.087)
IMA(t)			0.029			0.030
			(0.101)			(0.101)
IMA(t+1)			-0.090			-0.082
			(0.115)			(0.115)
IMA(t+2)			-0.188			-0.180
			(0.128)			(0.128)
Selection controls	no	no	no	yes	yes	yes
Observations	9,607	9,607	9,607	9,607	9,607	9,607
R squared	0.014	0.014	0.014	0.016	0.016	0.016

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from linear fixed effects regressions for consolidated companies. The dependent variable is the logarithm of R&D expenditures. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective year. Standard errors (clustered by firm) are shown in parentheses. All regressions include firm and time fixed effects and a dummy variable for domestic M&As. Selection controls include log age and 4-year lagged values of patents, log sales, log capital intensity, log total factor productivity and working capital.

Table 11: Cross-border M&As and growth of sales and TFP

	(1) TFP consolidated	(2) sales consolidated	(3) TFP acquirer	(4) sales acquirer	(5) TFP target	(6) sales target
IMA(t-1/t-3)	0.047*	0.172***	0.038	0.176***	0.164***	0.269***
	(0.025)	(0.033)	(0.029)	(0.040)	(0.037)	(0.051)
Observations	163,134	187,273	165,784	189,487	164,241	188,115
R squared	0.150	0.069	0.154	0.070	0.150	0.068

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from linear logarithmic growth regressions. IMA is an indicator variable taking a value of one if two firms from different countries merged in the respective year. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital.

Appendix: Additional robustness checks (not for publication)

This section discusses the robustness checks documented in Tables A9-A16 in more detail. A possible concern with patent indicators as a measure of innovation is that patenting could be affected by income shifting induced by differences in tax rates across countries (see, for instance, Karkinsky and Riedel, 2012; Griffith et al., 2014). Although income shifting might be of relatively low importance in this paper, as the location of inventors rather than the location of ownership is analyzed, it is still possible that tax rates affect the location of R&D activities within firms in general. If the results obtained were affected by taxes, we should see that relocation of innovative activity is particularly pronounced for M&As in which the statutory corporate tax rates are lower in the acquirer's than in the target's country. For this purpose, differences in statutory corporate tax rates between acquirer and target firm were computed for each merging pair and interacted with *IMA*. Statutory corporate tax rates are available from Eurostat.[32]

Results including this additional regressor are reported in Table A9. It seems indeed that higher tax rates in the acquirer's country are associated with fewer patents in the merged entity (column 1) and the acquirer's country (column 2) and more patents in target's country (column 3). However, this does not explain the previous results, as the coefficient for *IMA* - which measures the effect of international M&As if the tax rate differential equals 0 in this specification - is (in absolute terms) even larger than in the baseline specification for all three specifications. Further, the role of tax rates for the relocation of innovation in the estimation sample is limited, as, for the merging pairs, the average statutory tax rate in the acquirer's country is slightly higher than in the target's country - the difference is equal to 0.53 percentage points on average.

Previous research has mostly analyzed effects of M&As on innovation of manufacturing firms. To ease comparison with these studies, column (1) of Table A10 shows separate effects across manufacturing (the base group) and service industries. However, the results do not reveal significant differences across the two types of industry. Another aspect of industry heterogeneity refers to the type of innovation typically undertaken in an industry. For this purpose, industries were classified according to whether process innovations are likely to be of more importance than product innovations. For this purpose, tobacco (NACE Rev 1.1. code 16), basic metals (27), fabricated metals (28), transport (62), post and telecommunications (64) and various business related services (741, 745, 746, 747) were classified as

[32]Please see http://ec.europa.eu/taxation_customs/taxation/gen_info/economic_analysis/.

predominantly process innovating industries (process industry = 1) and all others as product innovating industries (process industry = 0, the base group). As column (2) shows, the effects of international M&As in predominantly process innovating industries is a bit less pronounced, but the difference is not statistically significant. Hence, the overall positive effect of international M&As on innovation seems to hold across different types of industries.

As discussed in the data section, acquirers and targets from certain regions and countries are over-represented in the estimation sample. To check, whether the results are driven by this sample selection, several regressions excluding part of the estimation sample are presented in Table A11. Column (1) excludes the Netherlands, Belgium and Luxemburg which presumably host a high number of holdings with limited manufacturing activity but engaged in international M&As. In column (2), Germany, France, Italy and Spain – the countries with the highest share of acquirers and targets - are excluded. In column (3), northern European countries – which have a relatively large share of acquirers and targets relative to GDP – are excluded. All the subsamples confirm the positive effects of cross-border M&As on innovation within the merged entity. The magnitude of the coefficient varies but this is what one would expect given that countries differ in size and firms are heterogeneous, as this heterogeneity affects the channels discussed in section 2.

The results are also robust to controlling for time-variant industry- and country-specific variables such as industry-level patenting, sales growth, and net entry rates (column 1) and to industry- and country- (column 2) and industry–country pair-specific trends (column 3). This mitigates concerns that differences in the propensity to patent across industries and countries drive the result. Alternative dynamics, such as controlling for a lagged patent stock and logarithmic transformations of pre-acquisition and pre-sample patenting, do not affect the main conclusion either, as columns (4)-(6) of Table A12 in the Appendix show.

In Table A13, results from dynamic Logit regressions are presented. The dependent variable in this regression takes on value one if at least one patent was filed in the respective time period. The table confirms the qualitative results obtained from count data regressions. The probability of innovation increases post-acquisition in the merged entity as a whole (column 1), increases in acquirer's country (column 2) and decreases in target's country (column 3).

In Table A14, treatment effects calculated from a propensity score reweighting estimator instead of one-to-one nearest neighbour matching are depicted. In this specification, all firms in the treatment groups are assigned a weight equal to one, while all firms in the comparison group are assigned a weight equal to $\hat{\Pr}(IMA_t \mid X_{t-1})/(1-\hat{\Pr}(IMA_t \mid X_{t-1}))$, where

$\hat{\Pr}(IMA_t \mid X_{t-1})$ is the predicted probability of international M&A estimated from the Logit model for the propensity score depicted in Table A5 and X_{t-1} are the conditioning variables. The results for the estimated treatment effects in Table A14 are similar to those obtained from nearest neighbour matching.

As a further robustness check, an additional IV is used which measures the (physical) distance between (potential) acquirers and (potential) foreign acquisition targets. It is defined as the logarithm of the minimum distance of acquiring or target firm's headquarter (based on zip codes) to the closest border. This variable captures the well-known proximity–concentration tradeoff (see e.g. Brainard, 1997) and the effect of trade costs on cross-border M&As in particular (Hijzen et al., 2008). There is evidence that distance indeed plays an important role in the selection of acquisition targets (see e.g. Chakrabarti and Mitchell, 2013; Stiebale and Reize, 2011). If acquirers use foreign acquisitions as an alternative to exporting, distance to the border should have a positive effect on the probability of undertaking a foreign acquisition. An acquirer might still choose to acquire a close-by firm within the acquisition target country to reduce transport and transaction costs, as theory and evidence suggest that the costs of monitoring and transmitting knowledge increase with distance (Head and Rise, 2008; Blanc and Sierra, 1999; Degryse and Ongena, 2005). Hence, distance to the border should have a negative effect on the probability that a firm becomes a target for foreign acquisition. Distance to the border may matter directly for acquirers from neighbor countries (about 45% in the estimation sample) but also for investors from other countries if targets are chosen to access export networks. There is evidence that acquisition targets export a substantial share of their output to close-by countries and that export networks matter in target firm selection (Blonigen et al., 2014; Hanson et al., 2001)

A similar IV is used, for instance, by Vannoorenberghe (2012) to instrument trade openness and by Stiebale (2013) to instrument foreign acquisitions. A drawback of this measure in the current data set is that zip codes which are used to calculate distance have to be based on firms' headquarters since regional information is not available for all domestic subsidiaries. I still argue that distance from a firm's headquarter may matter in international M&A decisions since a lot of intra-firm transactions require inputs from corporate headquarters. Further, if the relevant channel by which distance affects the probability that targets are acquired is monitoring costs (as in the model of Head and Ries, 2008), the relevant distance is indeed between firms' headquarters.

Another potential concern with the measure of distance to foreign markets is that it might be correlated with regional characteristics that determine investment opportunities.

However, most differences in regional innovativeness should be accounted for by the control variables. For the distance measure to be an invalid instrument, it would have to be correlated with the growth of patenting conditional on variables such as industry and country dummies, firm size, productivity and lagged patenting.

Results of the first stage using both instruments –distance and accounting uniformity- are shown in Table A15, second stage results in Table A16. As in previous IV regressions, accounting uniformity increases both the probability of being acquired and the propensity to engage in an international M&A. Distance to the border has a negative impact on the propensity of being acquired but a positive effect on the likelihood of acquiring a foreign firm. For instance, an increase in the logarithm of distance by one standard deviation (about 60 log points, 190 kilometers or 118 miles) decreases the probability of being acquired in a given year by about 0.11 percentage points, more than a quarter of the yearly acquisition probability.

Besides the economic significance, both excluded instruments are individually and jointly highly significant. The Kleinbergen-Paap statistic yields values between 24 and 32. This is higher than 19.9, the critical value for a maximum IV bias of 10% of the weak identification test proposed by Stock and Yogo (2005) given the number of observations and instruments. The overall F statistic of the first stage is highly significant as well. The use of two different exclusion restrictions allows the application of over-identification tests. Results of the Hansen test statistics, depicted in Table A16, show that the null hypothesis of orthogonality between the residuals and the IVs cannot be rejected at conventional levels of significance in both linear and non-linear IV models. Hence, once we accept accounting uniformity as a valid IV, the test indicates exogeneity of distance to foreign markets and vice versa. It was also found that distance is not significantly correlated with domestic acquisitions which indicates that this variable is not correlated with unobservable investment opportunities per se. For instance, running the first stage regression for targets with domestic instead of international M&As as the dependent variable, yields a coefficient equal to -0.00004 with a p-value above 0.9.

Additional References

Brainard, S. L. (1997), “An empirical assessment of the proximity-concentration trade-off between multinational sales and trade”, *American Economic Review* 87 (4), 520-544.

Blanc H. and Sierra C. (1999), "The internationalisation of R&D by multinationals: A trade-off between external and internal proximity", *Cambridge Journal of Economics* 23, 187-206.

Blonigen, B. A., Fontagne, L., Sly, N. and Toubal, F. (2014), "Cherries for sale: The incidence and timing of cross-border M&A", *Journal of International Economics* 94 (2):341-357.

Chakrabarti, A. and Mitchell, W. (2013), "The persistent effect of geographic distance in acquisition target selection", *Organization Science* 24 (6), 1805-1826.

Degryse H and Ongena S. (2005), "Distance, lending relationships, and competition", *Journal of Finance* 60, 231-266.

Griffith, R., Miller, H., and O'Connell, M. (2014), “Ownership of intellectual property and corporate taxation”, *Journal of Public Economics* 112, 12-23.

Hanson, G. H., Raymond J. M., and Slaughter, M. J., (2001), “Expansion strategies of U.S. multinational firms”, in Dani Rodrik and Susan Collins (eds.), *Brookings Trade Forum 2001*, Washington, D.C.: Brookings.

Head, K. and Ries, J. (2008), “FDI as an Outcome of the Market for Corporate Control: Theory and Evidence”, *Journal of International Economics* 74 (1), 2-20.

Hijzen, A., Görg, H. and Manchin, M. (2008), "Cross-border mergers and acquisitions and the role of trade costs”, *European Economic Review* 52 (5), 849-866.

Karkinsky, T. and Riedel, N. (2012), "Corporate taxation and the choice of patent location within multinational firms", *Journal of International Economics* 88(1), 176-185.

Stiebale, J. (2013), “The impact of cross-border mergers and acquisitions on the acquirers' R&D—Firm-level evidence”, *International Journal of Industrial Organization* 31 (4), 307-321.

Stiebale, J. and Reize, F. (2011), “The impact of FDI through mergers and acquisitions on innovation in target firms”, *International Journal of Industrial Organization* 29 (2), 155-167.

Stock, J. H. and Yogo, M. (2005), "Testing for weak instruments in linear IV regression", in D. W. K. Andrews and J. H. Stock (eds), *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, pp. 80–108, Cambridge University Press, Cambridge.

Vannoorenberghe, G. (2012), “Firm-level volatility and exports”, *Journal of International Economics* 86 (1), 57-67.

Additional tables (not for publication)

Table A1: Acquirers and targets in international M&As across countries

Country	share of acquirers in %		share of targets in %	
	sample	ZEPHYR	sample	ZEPHYR
Austria	2.98	3.94	1.18	2.03
Belgium	6.80	5.02	5.56	5.44
Bulgaria	0.85	0.08	1.07	0.89
Switzerland	0.11	4.2	0.21	2.48
Cyprus	0.00	0.08	0.32	0.11
Czech Republic	0.85	0.43	2.89	2.27
Germany	9.99	10.63	5.24	11.95
Denmark	7.55	3.67	2.25	3.4
Estonia	1.06	0.4	1.93	0.9
Spain	6.06	3.19	11.34	6.28
Finland	3.93	4.65	5.03	3.11
France	11.69	10.48	20.53	10.33
UK	8.08	17.96	7.06	13.24
Greece	2.55	1.18	0.32	0.43
Croatia	0.11	0.28	2.03	0.74
Hungary	0.32	0.48	0.86	1.18
Ireland	1.91	2.83	0.43	2.44
Iceland	0.53	1.24	0	0.05
Italy	11.58	4.32	5.03	4.21
Lithuania	0.85	0.05	1.18	0.86
Luxembourg	0.43	1.3	0.11	0.52
Latvia	0.43	0.13	0.96	0.73
Netherlands	1.28	9.08	1.5	6.65
Norway	3.08	3.31	2.89	3.11
Poland	0.64	0.65	3.32	2.13
Portugal	2.76	0.57	0.64	1.18
Romania	0.43	0.04	1.71	1.61
Serbia	0.21	0.01	1.6	0.9
Russia	1.49	1.32	1.18	2.29
Sweden	8.4	7.67	8.56	5.76
Slovenia	2.44	0.42	0.21	0.35
Slovakia	0.32	0.22	1.18	0.83
Ukraine	0.32	0.16	1.07	0.96

Table A2: International M&As by industry

Industry	Share of M&As in %
Manufacture of food, beverages & tobacco	10.2
Manufacture of textiles	3.08
Manufacture of wearing apparel	0.32
Manufacture of leather and leather products	0.11
Manufacture of wood and wood products	1.38
Manufacture of pulp, paper and paper products	2.23
Publishing, printing and reproduction of recorded media	2.98
Manufacture of coke, refined petroleum products and nuclear fuel	0.43
Manufacture of chemicals and chemical products	9.78
Manufacture of rubber and plastic products	5.31
Manufacture of other non-metallic mineral products	2.66
Manufacture of basic metals	3.83
Manufacture of fabricated metals	4.68
Manufacture of machinery and equipment n.e.c.	7.97
Manufacture of office machinery and computers	0.64
Manufacture of electrical machinery and apparatus n.e.c.	2.55
Manufacture of radio, television and communication equipment	1.28
Manufacture of medical, precision and optical instruments	2.34
Manufacture of motor vehicles, trailers and semi-trailers	2.34
Manufacture of other transport equipment	0.64
Manufacturing n.e.c.	2.23
Air transport	0.43
Supporting and auxiliary transport activities	3.61
Post and telecommunication	0.74
IT-related services	5.31
Research and development	0.53
Business-related services	22.42

Note: The table shows the distribution of international M&As across acquirer’s main industry

Table A3: Cross-border M&As and innovation in the merged entity
- results including selection controls used in Table 4

	(1) patents	(2) patents	(3) citations	(4) patents	(5) patents	(6) patents
IMA(t-1/t-3)	0.865*** (0.045)	0.274*** (0.046)	0.262*** (0.059)			0.261*** (0.051)
IMA(t-1)				0.236*** (0.077)	0.239*** (0.077)	
IMA(t-2)				0.263*** (0.072)	0.266*** (0.072)	
IMA(t-3)				0.384*** (0.078)	0.386*** (0.079)	
IMA(t)					0.034 (0.089)	
IMA(t+1)					-0.010 (0.107)	
IMA(t+2)					0.042 (0.129)	
patents(t-4)	0.025*** (0.001)	0.010*** (0.000)	0.002*** (0.000)	0.010*** (0.000)	0.010*** (0.000)	0.020*** (0.001)
D(pre-sample patents)	5.374*** (0.041)	3.906*** (0.043)	5.065*** (0.020)	3.909*** (0.043)	3.909*** (0.043)	3.984*** (0.046)
pre-sample patents	0.041*** (0.003)	0.066*** (0.003)	0.021*** (0.000)	0.067*** (0.003)	0.067*** (0.003)	0.043*** (0.003)
DMA(t-1/t-3)	0.222*** (0.049)	-0.361*** (0.048)	-0.217*** (0.150)	-0.271*** (0.055)	-0.271*** (0.055)	-0.271*** (0.055)
log sales(t-4)		0.521*** (0.008)	0.496*** (0.005)	0.523*** (0.008)	0.522*** (0.008)	0.489*** (0.009)
working capital(t-4)		0.694*** (0.043)	0.142*** (0.028)	0.698*** (0.043)	0.697*** (0.043)	0.416*** (0.047)
TFP(t-4)		0.343*** (0.024)	-0.015 (0.011)	0.343*** (0.024)	0.343*** (0.024)	0.305*** (0.025)
capital intensity (t-4)		0.241*** (0.016)	0.064*** (0.008)	0.243*** (0.016)	0.243*** (0.016)	0.197*** (0.017)
log age		-0.165*** (0.017)	-0.684*** (0.009)	-0.162*** (0.017)	-0.161*** (0.017)	-0.120*** (0.019)
Observations	229,479	229,479	191,451	229,479	229,479	191,451
Pseudo R squared	0.629	0.702	0.780	0.703	0.703	0.708
Pseudo log likelihood	-17,886	-14,358	-51,128	-14,321	-14,321	-12,514

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count-data regressions for consolidated companies. The dependent variable is the number of patents per year. In column (3), patents are weighted by forward citations. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective year. t refers to the year in which patent applications are counted. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies.

Table A4: Cross-border M&As and innovation in the acquirer's and the target's country - results including selection controls used in Table 5

	(1) acquirer	(2) acquirer	(3) target	(4) target
IMA(t-1/t-3)	0.429***	0.309***	-0.947***	-0.548***
	(0.053)	(0.047)	(0.188)	(0.184)
patents(t-4)	0.047***	0.024***	0.041***	0.027***
	(0.001)	(0.001)	(0.001)	(0.001)
D(pre-sample patents)	3.568***	1.971***	2.361***	1.202***
	(0.041)	(0.040)	(0.100)	(0.099)
pre-sample patents	0.349***	0.256***	1.221***	0.679***
	(0.013)	(0.014)	(0.050)	(0.050)
DMA(t-1/t-3)	0.063	-0.535***	-0.086	-0.801***
	(0.057)	(0.052)	(0.131)	(0.131)
log sales(t-4)		0.806***		0.754***
		(0.008)		(0.010)
working capital(t-4)		0.463***		0.289***
		(0.059)		(0.070)
TFP(t-4)		0.121***		0.236***
		(0.020)		(0.024)
log capital intensity (t-4)		0.236***		0.256***
		(0.015)		(0.018)
log age		-0.161***		-0.162***
		(0.017)		(0.017)
Observations	229,479	229,479	229,479	229,479
Pseudo R squared	0.433	0.602	0.395	0.543
Pseudo log likelihood	-26,522	-18,630	-19,557	-14,759

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. IMA is an indicator variable taking a value of one if a firm acquired a foreign firm (was acquired by a foreign firm) in the respective year. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and controls for domestic M&As. Only patents with inventors located in the firms' headquarters country are counted. Patent counts and control variables are based on the acquirer in columns (1) and (2) and on target in columns (3) and (4).

Table A5: Propensity score estimation: dependent variable: Pr(IMA_t=1)

Control group	(1) Non-M&As	(2) Domestic M&As
log patent stock (t-1)	0.605***	0.356*
	(0.149)	(0.195)
log patents(t-1)	-0.516***	-0.125
	(0.165)	(0.216)
D(pre-sample patents)	0.085	0.220
	(0.172)	(0.202)
pre-sample patents	-1.213***	-0.571
	(0.319)	(0.432)
log sales(t-1)	1.171***	0.185***
	(0.025)	(0.035)
working capital(t-1)	1.956***	-0.222**
	(0.142)	(0.106)
TFP(t-1)	-0.471***	0.116
	(0.062)	(0.079)
log capital intensity (t-1)	0.178***	0.079
	(0.040)	(0.049)
log age	-0.001	0.054
	(0.051)	(0.058)
Observations	219,465	4099
Pseudo R squared	0.410	0.176
Pseudo log likelihood	-3,579	-1,819

Note: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the coefficients from Logit regressions. The dependent variable takes a value of one if an international M&A takes place in year t. Standard errors (clustered by firm) are shown in parentheses. Regressions include industry, country and time dummies. The comparison group in column (1) are firms not engaged in M&A while the comparison group in column (2) are firm-pairs combined in domestic M&As.

Table A6: Balancing property for propensity score matching

Variable	sample	Treated	control	t-test, p>|t|
Panel A: Test of the balancing property, control group: non M&As				
propensity score	Unmatched	0.15956	0.00362	0.000
	Matched	0.15956	0.15949	0.993
log patent stock (t-1)	Unmatched	2.2482	0.07881	0.000
	Matched	2.2482	1.8861	0.448
log patents(t-1)	Unmatched	0.51541	0.01972	0.000
	Matched	0.51541	0.45909	0.650
log sales(t-1)	Unmatched	10.978	6.7585	0.000
	Matched	10.978	11.039	0.459
working capital(t-1)	Unmatched	0.25506	0.16052	0.000
	Matched	0.25506	0.24649	0.599
TFP(t-1)	Unmatched	0.36316	-0.05294	0.000
	Matched	0.36316	0.35728	0.891
log capital intensity (t-1)	Unmatched	0.29887	0.58816	0.639
	Matched	0.29887	0.35927	0.143
log age	Unmatched	3.1184	2.6514	0.000
	Matched	3.1184	3.1185	0.999
D(pre-sample patents)	Unmatched	0.17747	0.01551	0.000
	Matched	0.17747	0.15728	0.241
pre-sample patents	Unmatched	0.09513	0.034	0.000
	Matched	0.09513	0.07552	0.419
Panel B: Test of the balancing property, control group based on domestic M&A				
propensity score	Unmatched	0.38614	0.18291	0.000
	Matched	0.38614	0.38575	0.973
log patent stock (t-1)	Unmatched	2.2482	0.71574	0.000
	Matched	2.2482	3.543826	0.210
log patents(t-1)	Unmatched	0.51541	0.19664	0.016
	Matched	0.51541	1.0308	0.109
log sales(t-1)	Unmatched	10.978	10.163	0.000
	Matched	10.978	10.98	0.972
working capital(t-1)	Unmatched	0.25506	0.20159	0.009
	Matched	0.25506	0.26018	0.755
TFP(t-1)	Unmatched	0.36316	0.24183	0.000
	Matched	0.36316	0.34566	0.644
log capital intensity (t-1)	Unmatched	0.29887	0.38069	0.024
	Matched	0.29887	0.31993	0.530
log age	Unmatched	3.1184	2.9494	0.000
	Matched	3.1184	3.0934	0.513
D(pre-sample patents)	Unmatched	0.17747	0.06365	0.000
	Matched	0.17747	0.14665	0.070
pre-sample patents	Unmatched	0.09513	0.0132	0.000
	Matched	0.09513	0.06148	0.418

Table A7: Instrumental variable estimation first-stage results
- results including selection controls used in Table 7

	(1) merged entity	(2) acquirer	(3) Target
accounting uniformity	0.00021*** (0.00005)	0.00021*** (0.00005)	0.00018*** (0.00003)
patents(t-4)	0.00021 (0.00056)	0.00005 (0.00026)	-0.00021*** (0.00007)
D(pre-sample patents)	0.02180*** (0.00282)	0.17712*** (0.01872)	-0.11382*** (0.00360)
pre-sample patents	0.00309 (0.00395)	0.02491 (0.02068)	0.17479*** (0.04370)
DMA(t-1/t-3)	-0.02180*** (0.00282)	-0.02545*** (0.00105)	-0.11476*** (0.00359)
log sales(t-4)	0.00369*** (0.00017)	0.00487*** (0.00019)	0.00054*** (0.00010)
working capital(t-4)	0.00264*** (0.00059)	0.00349*** (0.00059)	-0.00095* (0.00057)
TFP(t-4)	-0.00270*** (0.00026)	-0.00364*** (0.00027)	-0.00020 (0.00023)
log capital intensity (t-4)	0.00009 (0.00011)	0.00007 (0.00011)	-0.00003 (0.00011)
log age	-0.00050 (0.00031)	-0.00099*** (0.00030)	0.00016 (0.00029)
Observations	229479	229479	229479
R squared	0.040	0.048	0.118
F test	15.02	15.33	17.52
Kleinbergen Paap rk Wald F	18.38	18.80	43.13

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Standard errors (clustered by industry) are shown in parentheses. All regressions include industry, country and time dummies. In column 1 (2,3) variables are based on the merged entity (acquirer, target firm).

Table A8: Excluding M&As involving firms from Eastern and Southern Europe

	(1) consolidated	(2) acquirer	(3) target
IMA(t-1/t-3)	0.236***	0.349***	-0.591**
	(0.067)	(0.069)	(0.270)
Observations	228,322	228,322	228,322
Pseudo R squared	0.700	0.593	0.544
Pseudo log likelihood	-13,536	-17,781	-14,668

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count-data regressions. The dependent variable is the number of patents per year. IMA is an indicator variable taking a value of one if two firms in different countries merge in the respective years. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital.

Table A9: Controlling for differences in statutory corporate tax rates

	(1) consolidated	(2) acquirer	(3) target
IMA(t-1/t-3)	0.345***	0.424***	-0.672***
	(0.047)	(0.048)	(0.206)
IMA*tax rate differential	-0.065***	-0.082***	0.117***
(acquirer - target country)	(0.009)	(0.008)	(0.028)
Observations	229,479	229,479	229,479
Pseudo R squared	0.703	0.603	0.543
Pseudo log likelihood	-14,306	-18,546	-14,750

Note: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count-data regressions. The dependent variable is the number of patents per year. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective year. "IMA*tax rate differential" measures the difference in statutory corporate tax rates between the acquirer's and the target's country. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital.

Table A10: Heterogeneous effects – industry, country, and firm characteristics

	(1)	(2)	(3)	(4)
IMA(t-1/t-3)	0.260***	0.314***	0.365***	-0.269***
	(0.050)	(0.048)	(0.053)	(0.071)
IMA *service industry	0.071			
	(0.105)			
IMA * process industry		-0.109		
		(0.122)		
IMA(north/south, east/west)			- 0.264***	-0.042
			(0.087)	(0.104)
IMA *patent stock acquirer (t-4)				0.020***
				(0.001)
IMA *patent stock target (t-4)				0.015***
				(0.002)
IMA * patent stock acquirer (t-4)				0.011***
* patent stock target (t-4)				(0.001)
Observations	229,479	229,479	229,479	229,479
Pseudo R squared	0.702	0.705	0.702	0.707
Pseudo log likelihood	-14,358	-14,241	-14,353	-14,120

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count-data regressions. The dependent variable is the number of patents per year. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective years. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital.

Table A11: Excluding countries/ regions

	(1)	(2)	(3)
Countries excluded	BE, NL, LU	DE, FR, IT, ES	NO, DK, FI, SE
IMA(t-1/t-3)	0.164***	0.158**	0.380***
	(0.048)	(0.078)	(0.053)
Observations	217,207	127,287	154,325
Pseudo R squared	0.709	0.675	0.721
Pseudo log likelihood	-13188	-6151	-9750

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count-data regressions. The dependent variable is the number of patents per year. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective years. Standard errors (clustered by firm) are shown in parentheses. BE=Belgium, NL=Netherlands, LU=Luxembourg, DE=Germany, FR=France, IT=Italy, ES=Spain, NO=Norway, DK=Denmark, FI=Finland, SE=Sweden. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital.

Table A12: Cross-border M&As and innovation: alternative dynamics

	(1)	(2)	(3)	(4)	(5)	(6)
IMA(t-1/t-3)	0.265***	0.237***	0.227***	0.265***	0.183***	0.276***
	(0.046)	(0.046)	(0.051)	(0.046)	(0.047)	(0.047)
patent stock(t-4)				0.002***		
				(0.000)		
log patents(t-4)					0.696***	
					(0.018)	
D(patents(t-4)>0)					1.272***	
					(0.054)	
log patent stock(t-4)						1.058***
						(0.017)
D(patent stock(t-4)>0)						2.653***
						(0.083)
patent count (t-4)	0.005***	0.011***	0.010***			
	(0.001)	(0.001)	(0.001)			
log pre-sample patents					0.319***	-0.255***
					(0.027)	(0.031)
pre-sample patents	0.079***	0.064***	0.112***	0.005***		
	(0.003)	(0.003)	(0.006)	(0.000)		
D(pre-sample patents)	3.849***	3.906***	3.827***	3.934***	2.780***	0.193***
	(0.043)	(0.043)	(0.044)	(0.043)	(0.058)	(0.074)
DMA(t-1/t-3)	-0.281***	-0.403***	-0.419***	-0.331***	-0.233***	-0.385***
	(0.048)	(0.049)	(0.050)	(0.048)	(0.049)	(0.049)
log sales(t-4)	0.505***	0.519***	0.498***	0.527***	0.337***	0.312***
	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)
working capital(t-4)	0.500***	0.714***	0.437***	0.733***	0.183***	0.009
	(0.043)	(0.044)	(0.046)	(0.043)	(0.040)	(0.040)
TFP(t-4)	0.342***	0.341***	0.399***	0.361***	0.084***	0.016
	(0.025)	(0.023)	(0.025)	(0.023)	(0.023)	(0.023)
log capital intensity (t-	0.265***	0.251***	0.282***	0.217***	0.140***	0.085***
	(0.017)	(0.016)	(0.017)	(0.016)	(0.016)	(0.016)
log age	-0.100***	-0.152***	-0.258***	-0.224***	-0.065***	-0.003
	(0.018)	(0.018)	(0.020)	(0.018)	(0.018)	(0.018)
industry patents	0.502***					
	(0.024)					
market growth	-0.012					
	(0.014)					
entry rate	-0.044**					
	(0.018)					
Ind.& country trends	no	yes	no	no	no	no
Ind-country pair	no	no	yes	no	no	no
Observations	229,479	229,479	229,479	229,479	229,479	229,479
Pseudo R squared	0.707	0.707	0.743	0.705	0.768	0.773
Pseudo log likelihood	-14,121	-14,113	-12,383	-14,203	-11,164	-10,938

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the results from count-data regressions for consolidated companies. The dependent variable is the number of patents per year. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective year. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies.

Table A13: Alternative outcome variable: Logit model for number of patents>0

	(1) consolidated	(2) acquirer	(3) target
IMA(t-1/t-3)	0.638***	0.581***	-0.549*
	(0.157)	(0.160)	(0.318)
sales(t-4)	0.513***	0.556***	0.442***
	(0.019)	(0.018)	(0.021)
working capital(t-4)	0.775***	0.786***	0.599***
	(0.108)	(0.109)	(0.125)
TFP(t-4)	0.030	0.060	0.062
	(0.057)	(0.055)	(0.064)
log capital intensity (t-4)	0.198***	0.206***	0.175***
	(0.037)	(0.037)	(0.041)
log age	-0.181***	-0.230***	-0.206***
	(0.045)	(0.045)	(0.052)
D(patents(t-4))	3.005***	2.433***	3.151***
	(0.081)	(0.139)	(0.094)
D(pre-sample patents)	2.361***	2.433***	2.641***
	(0.112)	(0.139)	(0.123)
DMA(t-1/t-3)	-0.018	-0.481***	-0.570**
	(0.139)	(0.155)	(0.221)
Observations	229,479	229,479	229,479
Pseudo R squared	0.413	0.360	0.378
Log likelihood	-5,060	-5,257	-4,299

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Table shows the coefficients from Logit regressions. The dependent variable takes a value of one if at least one patent was filed in year t. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective year. Standard errors (clustered by firm) are shown in parentheses. All regressions include industry, country and time dummies and controls for pre-merger and pre-sample patenting and domestic M&As.

Table A14: Alternative matching estimator: propensity score reweighting

Panel A: ATT for consolidated company – propensity score reweighting

	(1)	(2)	(3)	(4)	(5)	(6)
Patents in period	t+1	t+2	t+3	t+1	t+2	t+3
comparison group	Non-M&A	Non-M&A	Non-M&A	Domestic M&A	Domestic M&A	Domestic M&A
IMA	0.087***	0.111***	0.126***	0.083***	0.109***	0.123***
	(0.024)	(0.028)	(0.031)	(0.025)	(0.029)	(0.031)
Observations	219,465	219,465	219,465	8,936	8,936	8,936
R squared	0.004	0.004	0.003	0.005	0.005	0.005

Panel B: ATT for acquirers and targets - comparison with non-merging firms

	(1)	(2)	(3)	(4)	(5)	(6)
Patents in period	t+1	t+1	t+2	t+2	t+3	t+3
Patents in country of	acquirer	acquirer	acquirer	target	target	target
IMA	0.100**	0.131***	0.158***	-0.231***	-0.264***	-0.294***
	(0.044)	(0.049)	(0.053)	(0.024)	(0.028)	(0.029)
Observations	219,465	219,465	219,465	219,465	219,465	219,465
R squared	0.001	0.002	0.002	0.008	0.008	0.009

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Standard errors (clustered by firm) are shown in parentheses. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective years. The outcome variables is ln(patents(j)+1)-ln(patents(t-1)+1), where t is the year of the international M&A and j=t+1, t+2 or t+3. All regressions include time dummies.

Table A15: First-stage regressions: distance to foreign markets as additional IV

	(1) consolidated	(2) acquirer	(3) target
accounting uniformity	0.00019***	0.00021***	0.00029***
	(0.00006)	(0.00006)	(0.00007)
ln(distance)	0.00213***	0.00215***	-0.00171***
	(0.00049)	(0.00049)	(0.00027)
Observations	229,479	229,479	229,479
R squared	0.040	0.048	0.118
F-test	14.78	15.10	17.25
Kleinbergen Paap rk Wald F	28.94	32.19	24.53

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Standard errors (clustered by industry) are shown in parentheses. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital. In column 1 (2, 3) variables are based on the merged entity (acquirer, target firm).

Table A16: GMM and linear IV: distance to foreign markets as additional IV

	(1) linear IV consolidated	(2) linear IV acquirer	(3) linear IV Target	(4) GMM consolidated	(5) GMM acquirer	(6) GMM target
IMA(t-1/t-3)	0.610***	0.454**	-0.435***	0.270**	0.509***	-1.567*
	(0.236)	(0.213)	(0.138)	(0.119)	(0.138)	(0.876)
Observations	229,479	229,479	229,479	229,479	229,479	229,479
(pseudo) R squared	0.227	0.239	0.184	0.616	0.312	0.287
F-test	20.923	19.712	14.479	-	-	-
Hansen (p-value)	0.105	0.585	0.192	0.796	0.154	0.748

Notes: *** (**,*) denotes significance at the 1% (5%, 10%) level. Standard errors (clustered by industry) are shown in parentheses. IMA is an indicator variable taking a value of one if two firms in different countries merged in the respective years. All regressions include industry, country and time dummies and control for 4-year lagged values of patent counts, the number of pre-sample patents, a dummy variable indicating non-zero pre sample patents, domestic M&As, log age and 4-year lagged values of log sales, log capital intensity, log total factor productivity and working capital. In columns 1&4 (2&5,3&6), variables are based on the merged entity (acquirer, target firm).