International Taxation and Productivity Effects of M&As*

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Abstract

We investigate the effect of international differences in corporate taxation on the realization of productivity gains in M&A deals. We argue that tax differentials distort the efficient allocation of productive factors following an M&A and thus mitigate the resulting productivity improvement. Using firm-level data on inputs and outputs of production as well as on corporate M&As, we estimate that a 1 percentage point increase in the absolute tax differential between the locations of two merging firms reduces the subsequent total factor productivity gain by 4.5%. This effect is less pronounced when firms can use international profit shifting to attenuate effective differences in taxation. In a complementary analysis, we use an event study design and a fixed effects model to explore the timing of the response of productivity, as well as, labor and capital input to the tax rate differential after the merger separately for the acquirer and the target. We show that our findings are mainly driven by deals with targets residing in locations with a tax advantage with respect to the acquirer. In these transactions, tax differentials reduce the post-merger adjustment in the target firm and inhibit the full realization of productivity gains.

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1 Introduction

The international transmission of technologies and innovation is a major driver of global productivity growth. An important device in this process are corporate mergers and acquisitions (M&As) which provide direct inter-regional links between firms and open up channels for technology transfers (Jovanovic & Rousseau, 2008). However, whether or not the potential productivity gain in these transactions materializes strongly depends on the post-merger behavior of the combined firm.[1] In this paper, we investigate how firm-level adjustment after M&As is affected by differences in profit taxation between the target and the acquirer. These differences regularly occur in cross-border mergers and are thus likely to influence productivity improvements in the firms involved in these deals.

Our main finding is that tax differentials between the target and the acquirer location reduce post-merger productivity gains by distorting the reallocation of activity within the combined firm. Since the firm's objective is to maximize its net profit, it takes into account both the productivity and the corporate tax implications of a potential location choice. If the more productive unit resides in the location with the more favorable tax regime, the resulting allocation choice assigns production to the most productive units irrespective of the actual tax rate differential. However, if the more efficient unit happens to reside in a location with a higher tax burden, firms face a trade-off. Shifting activity to the high-tax location raises overall productivity but also increases the tax burden on the resulting profits. For large enough tax differences, the firm allocates activity to the less productive but more profitable unit. With regard to the overall productivity of the merged firm, this decision is inefficient and leads to a lower gain in productivity resulting from the M&A. This mechanism only occurs when firms cannot separate the location of productive activity from the location of its taxation. If firms were able to assign profits to the location of their preference (i.e. the location with the lowest tax rate), tax differences would not be relevant. In practice, such profit shifting activity is limited by domestic and international regulations and because firms usually incur some shifting cost. Nevertheless, the impact of tax differentials may be mitigated if firms engage in profit shifting activities such as transfer pricing.

The described effect is generally not unique to M&As but would be caused by any event that changes tax differentials within multinational groups (e.g. tax reforms). However, the reallocation of activity within existing groups of firms is usually associated with a high fixed cost and thus rarely observed. In contrast, while M&As themselves usually constitute a high fixed cost investment (Jovanovic & Rousseau, 2002), the subsequent reorganization after such a transaction provides an opportunity to exploit returns to scale at a relatively small cost and consolidate units operating in the merging firms that perform similar functions. As a consequence, substantial restructuring within the newly formed enterprise is common. In such an environment, the fixed cost of a reallocation of functions is weighted less heavily and firms are likely to react to tax differentials.

Below we formulate a simple theoretical model to demonstrate this mechanism. We then

[1] Throughout the paper we use the terms merger, acquisition and M&A interchangeably. Even though the individual deal types certainly differ in their structure, they all result in a combination of two firms which is the key issue in our analysis.

investigate the impact of tax differentials on merger-induced productivity gains empirically. For this purpose we combine data on M&As from Bureau van Dijk's Zephyr database with firm-level information on inputs and outputs from the AMADEUS and ORBIS databases. An advantage of these databases is that they provide balance sheet data that is comparable across borders which makes them a prime data source for the study of firms in an international context (e.g. Cravino & Levchenko, 2016). First, we derive total factor productivity (TFP) for each individual firm within the sample of industry peers using the estimation method of Levinsohn & Petrin (2003). We then compute the TFP change resulting from an M&A deal and relate it to the absolute tax difference between the target and the acquirer. Our estimations, which include a large set of country-, deal-, and firm-specific controls, suggest that an increase in the absolute tax differential by 1 percentage point lowers the merger-induced productivity gain by 4.5%. We also show that this effect is mitigated when transfer pricing regulations are less strict. In a complementary analysis, we turn to the underlying mechanisms of this effect. Results of a fixed effects model and an event study suggest that the impact of the tax differential is asymmetric in the sense that the observed effect is mainly driven by deals where the level of taxation in the target location is lower than the one in the acquirer location. Following these transactions, the adjustment process in the target is hampered by the distorting tax incentive as firms make less reductions to employment and capital in the target firms involved. This finding is consistent with the notion that firms leave activity in the location with the lower tax burden which raises after-tax profit but also implies that some productivity gains from the M&A are not realized and the overall increase in productivity is smaller or even negative.

Our paper thus contributes novel insights to the growing literature on corporate M&As and taxation. Various studies have identified tax policy to be an important driver of M&A activity (e.g. Di Giovanni, 2005; Erel *et al.*, 2012; Feld *et al.*, 2016a,b).[2] Furthermore, taxes do not only influence whether but also how firms conduct M&As. For example, Ayers *et al.* (2004) and Faccio & Masulis (2005) show that capital gains taxation affects the method of payment in M&As. All of these studies investigate the role of tax rates as a determinant of the observed pattern of M&As and thus essentially focus on the effect of taxation *before* the M&A is completed. In contrast, our paper highlights the importance of the tax environment *after* the M&A completion. Existing studies with regard to this aspect have mainly looked into the importance of taxation on financial variables. For instance, Ayers *et al.* (2003) and Huizinga *et al.* (2012) study realized deal values and show that shareholder-level taxation has a strong effect on deal premiums. In our analysis, we are interested in real outcomes of M&A. Huizinga & Voget (2009) and Voget (2011) show that taxes are an important determinant for the post-merger choice of headquarter location within the merged firm. However, while these allocation choices constitute real behavioral responses of firms, they have only minor effects on the structure of production within the firm. Our investigation focuses on taxation as a determinant of post-merger allocation of productive input factors

[2] In yet another study on M&A determinants, Rossi & Volpin (2004) do not include taxation in their estimations but acknowledge that taxes are a potential determinant of the deal volume which is, however, too complex an issue to deal with in the broad scope of their paper.

and therefore reveals new insights into how tax differences affect the productive process and the evolution of productivity within the firm.

Thus, we also complement the large literature on productivity effects of M&As. Generally, M&As are perceived as an opportunity for productivity improvements. Results by Li (2013) suggest that this potential is indeed realized, mostly because the acquiring firm uses input factors of the target more efficiently. Other M&A outcomes that may have a positive impact on firm productivity are an increased level of innovation (Stiebale, 2016), knowledge transfers (Bresman *et al.*, 1999; Bena & Li, 2014) and increased management efficiency (Wang & Xie, 2009). For cross-border takeovers, the positive effect of M&A on productivity is probably less pronounced. Foreign firms usually acquire the most productive firms in a country (Criscuolo & Martin, 2009) but the integration of these firms into the multinational group is more complex such that productivity improvements are realized only after a longer period of adjustment (Harris & Robinson, 2002). Indeed, a recent study by Wang & Wang (2015) finds no difference in the productivity effect of domestic and foreign acquisitions in a large sample of M&As in China. In contrast, Guadalupe *et al.* (2012) find substantial improvements of productivity and an increase of innovative activity following foreign acquisitions.[3] The impact of cross-border acquisitions on productivity probably depends on a large range of country-pair characteristics. In our analysis, we argue that international taxation is a relevant factor in this regard. We thus provide an important determinant of the realization of post-merger productivity gains which may help explain part of the ambiguity in previous studies on M&A and productivity.

Finally, our paper advances the debate on whether and how foreign profits should be taxed in the presence of international M&As. Becker & Fuest (2010) and Devereux *et al.* (2015) emphasize that the answer depends on the resource allocation mechanism within the firm after the merger. If adjustment in one part of the firm affects production in another part, tax differentials distort the allocation mechanism and lead to sub-optimal outcomes. Since a tax on foreign income may avoid these differentials, such a policy is superior to an exemption regime in this case. We argue that this situation occurs in the post-merger allocation of corporate activity and provide empirical evidence for the loss that arises in the form of foregone productivity gains from M&As when tax neutrality is not ensured.

The paper is structured as follows. In Section 2 we develop a theoretical model to formally analyze the relationship between merger-induced productivity changes and tax differentials. We explain our empirical strategy in Section 3 and describe the data in Section 4. Results are presented in Section 5. Section 6 concludes.

[3] We focus here on productivity effects within the acquired firm. However, spillover effects of foreign activity on domestic firm productivity may also occur (e.g. Javorcik, 2004; Haskel *et al.*, 2007; Balsvik & Haller, 2010).

2 M&As, Taxation and Productivity Gains

2.1 Tax Differentials and Productivity Change Through Reallocation of Activity after M&As

In this section we develop a simple theoretical framework to analyze the impact of tax rate differences on the realization of productivity gains in M&As. We consider a merger or acquisition involving two firms, a and b. Each of these firms consists of a set of separable units that each perform a different function and also differ in their total factor productivity with respect to this function. Prior to the merger, a subset of functions is performed in both firms. An obvious example are cross-divisional functions such as distribution, promotion or research and development. Once the deal is completed, the management decides for each of these functions whether the respective task is performed by a unit in a or b. This reallocation of activity is a potential source of post-merger productivity gains if a particular function is assigned to the unit that is more productive with respect to this task. However, as managers maximize net profit rather than output, the allocation decision may also be affected by other factors such as taxes, which distort the allocation decision.[4] We show that tax differentials between the merged firms may lead to an allocation of functions that is inefficient with respect to productivity. As a consequence, tax differentials reduce or even revert productivity gains resulting from the merger.

We begin by deriving the profit of a unit performing function i in firm $s = a, b$. It is given by

$$\pi_s(i) = A_s(i)\, k_s(i)^{\alpha}\, l_s(i)^{\beta} - r_s k_s(i) - w_s l_s(i) \tag{1}$$

where $k_s(i)$ and $l_s(i)$ are capital and labor input of firm s in the unit performing function i, r_s and w_s are the respective input prices and $A_s(i)$ is the total factor productivity of the unit performing function i in firm s. Within the unit, we assume decreasing returns to scale, $\alpha + \beta < 1$.[5] For given input prices, the management of the firm chooses the level of productive inputs for each individual unit i so as to maximize the unit-specific profit $\pi_s(i)$. This yields the set of optimal input choices

$$l_s^*(i) = A_s(i)^{\gamma} \left(\frac{\beta}{w_s}\right)^{(1-\alpha)\gamma} \left(\frac{\alpha}{r_s}\right)^{\alpha\gamma},\ k_s^*(i) = A_s(i)^{\gamma} \left(\frac{\beta}{w_s}\right)^{\beta\gamma} \left(\frac{\alpha}{r_s}\right)^{(1-\beta)\gamma} \tag{2}$$

where $\gamma = \frac{1}{1-\alpha-\beta}$. Substituting the input choices back into the profit function, we obtain the optimal profit

$$\pi_{i,s}^* = A_s(i)^{\gamma}\, \varphi_s \tag{3}$$

where

[4] The analysis thus follows a notion that is similar to the one proposed for firm replacement by Foster *et al.* (2008).

[5] Note that this does not preclude increasing returns to scale across the firm. For example, units may incur a fix cost f_i such that merging two units reduces the average fix cost and generates synergies through increasing returns to scale.

$$\varphi_s = \varphi_s(r_s, w_s) = \frac{1 - r_s^{(2-2\beta-\alpha)\gamma - \frac{1-\beta}{\alpha}} \alpha^{\frac{1-\beta}{\alpha}} - w_s^{(2-2\alpha-\beta)\gamma - \frac{1-\alpha}{\beta}} \beta^{\frac{1-\alpha}{\beta}}}{\left(w_s^{\beta} \beta^{-\beta} r_s^{\alpha} \alpha^{-\alpha}\right)^{\gamma}}$$

is a function of input prices and is decreasing in both r_s and w_s.

We first consider the post-merger production allocation decision without taxes. To simplify our derivation, we assume that factor prices are identical for both firms, such that $\varphi_a = \varphi_b$. This assumption is realistic, for example if capital input is purchased on the international capital market and wages reflect some form of quality-adjusted labor compensation. The latter can be assumed to be homogeneous across different locations if the labor market is sufficiently integrated. Abstracting from input price differentials allows us to clearly isolate the effect of tax differentials on post-merger productivity changes. We note, however, that frictions in the markets for labor or capital may preclude uniform input prices and we therefore relax this assumption in our empirical analysis below.

To simplify notation, we define the difference in total factor productivity between a and b for the unit performing function i by $\lambda(i) = A_a(i) - A_b(i)$ and normalize $A_b(i)$ to 1 such that $A_a(i) = 1 + \lambda(i)$. The objective function of the management is the overall profit of the firm which is the aggregate of the profits of the individual functions, $\Pi_s = \int_{i \in I} \pi_s(i)\, di$. Π_s is maximized by optimally allocating the individual functions to the most profitable unit, that is, the management allocates the function i to a unit in a instead of b if

$$\pi_a^*(i) \geq \pi_b^*(i) \Longleftrightarrow \lambda(i) \geq 0. \tag{4}$$

and vice versa.[6] In this case, only the productivity differential $\lambda(i)$ determines where activity is located and the resulting post-merger productivity for the unit performing function i in the merged entity is given by

$$A(i) = \begin{cases} A_a(i) & \text{if } \lambda(i) \geq 0 \\ A_b(i) & \text{if } \lambda(i) < 0. \end{cases} \tag{5}$$

In order to derive the total productivity change in the combined firm, we aggregate the productivity of each individual unit. For analytical reasons, we assume that there is a large continuum of functions $i \in I$. The overall productivity of the merged firm is defined as the weighted aggregate of the productivity of all units, $A = \int_{i \in I} \omega(i) A(i)\, di$, where ω_i are the unit-specific weights with $\int_{i \in I} \omega(i)\, di = 1$ that depict the importance of each unit in the combined firm.[7]

We assume that in the merged entity, a subset of functions J is of the interchangeable sort described above while a subset of functions H are unique to each firm. The overall productivity prior to the merger is thus given by

[6]Without loss of generality, we assume that the management has a slight bias towards a.

[7]This setup abstracts from complementarities between individual functions. Adding this feature to the model would probably make it more realistic but would also imply that allocation decisions are interdependent. This would lead to a high degree of complexity without adding new insights to or contradicting our main result.

$$A^{Pre} = \int_{i \in I} \omega(i) A(i)\, di = \int_{i \in H} \omega(i) A(i)\, di + \int_{i \in J} \omega(i) \left(z A_a(i) + (1-z) A_b(i) \right) di \quad (6)$$

The productivity of the units performing the interchangeable functions is again given by the weighted mean of the productivity in both firms where $0 < z < 1$ is the relative weight of firm a in the merging entity. After the merger, productivity in each of these units corresponds to the productivity of the respective units in one of the firms. The overall productivity is then given by

$$A^{Post} = \int_{i \in H} \omega(i) A(i)\, di + \int_{i \in J} \omega(i) \left(A_a(i) \mathbb{1}\{\lambda(i) \geq 0\} + A_b(i) \mathbb{1}\{\lambda(i) \geq 0\} \right) di \quad (7)$$

Eventually, we are interested in the productivity change after the merger or acquisition is completed. We define this change as the difference of overall productivity before and after the merger and denote it by Γ:

$$\begin{aligned} \Gamma =& A^{Post} - A^{Pre} \\ =& \int_{i \in H} \omega(i) \left(A_a(i) \mathbb{1}\{\lambda(i) \geq 0\} + A_b(i) \mathbb{1}\{\lambda(i) < 0\} - z A_a(i) - (1-z) A_b(i) \right) di. \end{aligned} \quad (8)$$

Let $\lambda(i)$ be distributed across some interval $\left[\underline{\lambda}, \bar{\lambda}\right]$. We can then rewrite expression (8) in the following way

$$\Gamma = (1-z) \int_0^{\bar{\lambda}} \omega(i) \lambda(i)\, d\lambda(i) + z \int_{\underline{\lambda}}^0 \omega(i) \left(-\lambda(i)\right) d\lambda_i \quad (9)$$

Expression (9) defines the productivity change as the weighted sum of productivity changes realized by allocating functions. Here, we abstract from taxes and potential factor price differentials such that the management allocates each function to the most productive location with respect to this function. As a consequence, the merger-induced productivity change is positive, $\Gamma \geq 0$. Note, that expression (9) comprises both cases where each firm has a productivity advantage in some functions and cases where one firm is generally more productive than the other (e.g. $\lambda(i) > 0\ \forall i$). The latter case often occurs in acquisitions when a large market leader takes over a smaller firm.

We now introduce tax differentials to our model. For simplicity, we assume that input costs are fully deductible such that the after-tax profit of the unit performing function i in firm s is given by $(1-\tau_s) \pi_s^*(i)$. When allocating functions between the two firms, the management now maximizes the overall after-tax profit of the merged firm such that it allocates function i to a instead of b if

$$(1-\tau_a)\,\pi_a^*(i) \geq (1-\tau_b)\,\pi_b^*(i) \Longleftrightarrow \lambda(i) \geq \tilde{\tau} = \left(\frac{1-\tau_b}{1-\tau_a}\right)^{\frac{1}{\gamma}} - 1 \tag{10}$$

When taxes are identical for both firms, $\tau_a = \tau_b$, we have $\tilde{\tau} = 1$ and the setting is identical to the case without taxes as no distortions are expected without tax differentials. However, if taxation differs between the two firms, $\tilde{\tau} \neq 1$, the management may allocate some activity to the firm with lower productivity but higher after-tax profit. The expression for the productivity change now reads

$$\hat{\Gamma} = \Gamma - \underbrace{\int_0^{\tilde{\tau}} \omega(i)\,\lambda(i)\,d\lambda(i)}_{\Lambda}. \tag{11}$$

The last term $\Lambda(\tilde{\tau})$ describes the unrealized productivity gains that are caused by the distorting effect of tax differentials with regard to the allocation of functions. It disappears if $\tau_a = \tau_b$ as $\lim_{\tilde{\tau}\to 1} \Lambda = 0$. Note that we have $\Lambda \leq 0$ irrespective of the direction of the tax differential. This implies that any tax difference between the target and acquirer location may lead to distorted allocations and thus reduces productivity gains resulting from the merger. Also, $\hat{\Gamma}$ does not need to be positive. For example, consider the case where firm a is more productive in all units, but is taxed substantially more such that $\tilde{\tau}$ is very large. In this extreme case, all functions are performed by the less productive location because of the tax difference and the productivity change is negative.

Furthermore, Λ is a decreasing function of the absolute tax differential. To illustrate this, consider the situation where $\tau_b > \tau_a$ such that $\tilde{\tau} > 1$ or $\tau_a > \tau_b$ such that $\tilde{\tau} < 1$. In both cases, an increase in the absolute tax differential $\Delta\tau = |\tau_a - \tau_b|$ raises $|\tilde{\tau}|$ and leads to a decline in Λ. Thus, the merger-induced productivity change is a negative function of the absolute tax differential:

$$\frac{\partial \hat{\Gamma}}{\partial \Delta\tau} \leq 0. \tag{12}$$

2.2 Cross-Border Profit Shifting

So far, we have assumed that statutory tax rate differentials between merging firms correctly reflect the actual difference in taxation as perceived by the management. This is the case if the profit generated in each subsidiary of the merged firm is correctly attributed to the location of activity. In an integrated company, this could, for example, be achieved through adequate transfer pricing. In practice, however, firms may be able to manipulate their effective tax burden through profit shifting (e.g. see Hines & Rice, 1994; Huizinga *et al.*, 2008). While previous studies have identified various forms of international profit shifting that use very different shifting vehicles[8], all of these approaches have in common that they reduce the tax payments in high tax locations of a multinational company by shifting part of the profit generated there to low-tax locations within the group. This leads to a convergence

[8]See Dharmapala (2014) for a comprehensive survey.

of effective tax rates in the various affiliate locations of the firm towards the lowest statutory rate in the multinational enterprise.

In the context of our framework above, this implies that the presence of profit shifting leads to a decrease in the absolute tax differential. We formalize this notion by assuming that a fixed proportion $0 < \phi < 1$ may be shifted between the two entities after the merger.[9] As the firm maximizes after-tax profit, shifting occurs only towards the location with a lower tax rate. The effective tax rate in location s is then given by

$$\tau_s = (1 - \phi)\, \tau_s + \phi \min(\tau_a, \tau_b)\,. \tag{13}$$

ϕ can be viewed as a function of the strictness of transfer pricing regulations and profit shifting opportunities between a and b. Substituting this into the absolute tax rate differential, we obtain $\Delta\tau = (1 - \phi)\, |\tau_a - \tau_b|$ where it is apparent that more profit shifting opportunities (i.e. higher ϕ) imply a smaller effective tax rate differential. Furthermore, we note that

$$\frac{\partial^2 \hat{\Gamma}}{\partial \Delta\tau \partial \phi} \geq 0 \tag{14}$$

such that an increase in the share of shifted profits mitigates the negative effect of statutory tax rate differentials on the productivity change after the merger. For example, we expect that the distorting effect of tax differentials in a cross-border merger is less severe if loose regulations regarding transfer pricing allow the management to manipulate profit allocation and thus narrow the difference in the effective tax burden between the two locations.

2.3 International Taxation

In the following, we briefly describe how tax differentials between different locations of a multinational enterprise may arise in the international tax system.[10] When analyzing the impact of tax rate differentials on the productivity change after an M&A deal, the relevant perspective is that of the management of the merged firm. Most M&A deals take the form of an acquisition and it is thus reasonable to assume that allocation decisions are taken from the perspective of the acquirer country. In the following we always refer to the tax rate faced by the acquiring firm when describing a tax rate as effective. The relevant tax rate differential is thus the difference between the tax rate on profits that the acquirer firm receives from the target in the form of dividends and the tax rate on profits realized at the acquirer location. The tax burden in each location depends on the statutory corporate income tax rate and the withholding tax rate (if applicable) for inter-corporate dividends.

The resulting difference depends strongly on the approach taken by the acquirer country to relieve firms of double taxation. The exemption method, which is applied by most European countries, fully or partially exempts foreign income from corporate taxation. The

[9] Economic models usually assume that profit shifting induces some cost that is a convex function of the amount shifted (e.g. Hines & Rice, 1994). In our reduced-form expression, this would imply that ϕ is a function of the tax rate differential. However, since shifting is constrained to the realized profit, we still have $0 < \phi < 1$ and would thus obtain the same results with respect to the effect of the tax rate differential on the post-merger productivity change as described in our more simple model.

[10] See Huizinga & Voget (2009) for a comprehensive description of double-taxation of cross-border dividends.

tax burden for profits received from the target is thus determined by the corporate income and withholding taxes in the target location, and the resulting tax rate differential is mainly driven by cross-border differences in these tax rates. Some countries, like the United States and, until 2009, Japan and the United Kingdom, apply the credit method instead. With this approach, foreign income is taxed at the domestic corporate tax rate but taxes paid abroad are credited against the domestic tax liability. This credit is usually limited to the amount of domestic tax payments due. As a consequence, tax differentials only arise when the effective tax rate of the acquirer country is below that of the target country. Credit regimes differ in the scope of the credit. A direct credit only considers the withholding tax paid abroad while indirect credits also include the underlying taxation of corporate profits.

Table 1: Tax Rate Differentials

This table summarizes the computation of the difference between the effective tax rate on profits that a firm in location a receives from a firm in location b in the form of dividends and the tax rate on profits realized in location a. τ_a^{CIT} and τ_b^{CIT} are the top statutory tax rates in location a and b, respectively. τ_{ba}^{w} is the final withholding tax rate on dividends paid from location b to location a. ψ is the exemption rate.

Double Tax Relief Method	Absolute Effective Tax Rate Difference $\Delta\tau$	
Exemption	$\left\lvert\tau_a^{CIT}\psi - \left(1-(1-\psi)\,\tau_a^{CIT}\right)\left(\tau_b^{CIT} + \left(1-\tau_b^{CIT}\right)\tau_{ba}^{w}\right)\right\rvert$	
Indirect Credit	$\left\lvert\tau_a^{CIT} - \tau_b^{CIT} - \left(1-\tau_b^{CIT}\right)\tau_{ba}^{w}\right\rvert$	if $\left(1-\tau_b^{CIT}\right)\tau_{ba}^{w} \geq \tau_a^{CIT}$
	0	if $\left(1-\tau_b^{CIT}\right)\tau_{ba}^{w} < \tau_a^{CIT}$
Direct Credit	$\left\lvert\tau_a^{CIT} - \tau_b^{CIT} - \left(1-\tau_b^{CIT}\right)\left(\tau_a^{CIT} - \tau_{ba}^{w}\right)\right\rvert$	if $\tau_{ba}^{w} < \tau_a^{CIT}$
	$\left\lvert\tau_a^{CIT} - \tau_b^{CIT} - \left(1-\tau_b^{CIT}\right)\tau_{ba}^{w}\right\rvert$	if $\tau_{ba}^{w} \geq \tau_a^{CIT}$

For our empirical analysis, we compute for each individual M&A deal from the perspective of the acquiring firm the effective tax rates on profits realized by the target and the acquirer, respectively. We then use the absolute difference between these effective tax rates one year after the completion of the M&A deal as a proxy for the expected post-merger tax rate differential that determines the allocation within the merged firm. When determining the tax differential, we take into account international differences in statutory tax rates as well as the treatment of foreign profits for tax purposes in the acquirer country. Table 1 describes the computation of the absolute tax rate differential for the various double tax relief methods. The latter may either be based on unilateral approaches, bilateral tax treaties or multilateral agreements such as the Parent-subsidiary Directive which requires European Union (EU) and European Economic Area (EEA) members to exempt profits of substantial holdings in other member states from domestic taxation. Furthermore, we check whether final withholding taxes apply upon repatriation of foreign profits. Again, the level of these taxes depends on domestic legislation as well as the existence of bilateral or multilateral agreements.

3 Empirical Strategy

3.1 Identification

The objective of this paper is to analyze how tax differentials between the acquirer and the target firm affect the impact of the merger on the total factor productivity of the combined firm. For this purpose we estimate a reduced form of equation (11) by relating the merger-induced change in productivity to the absolute tax differential. Our empirical model takes the following form:

$$\hat{\Gamma}_{jlk} = \ln A_j^{Post} - \ln A_j^{Pre} = \alpha_0 + \alpha_1 \Delta\tau_{jlk} + \boldsymbol{\beta_1 X_j} + \boldsymbol{\beta_2 Z_{jlk}} + \boldsymbol{\psi} + \epsilon_j. \tag{15}$$

Our theoretical analysis suggests that the relationship between the productivity change and the tax rate differential is probably non-linear such that using the simple difference of TFP before and after the merger is not appropriate. Instead, we use the difference in the logarithms of TFP before and after the merger. This transformation mitigates the problem of outliers and turns out to be the most appropriate among a range of specifications (see Appendix A.2).

A_j^{Pre} and A_j^{Post} are the average estimated TFPs of the combined firm that emerges from deal j in the observable years before and after the completion of the M&A deal, respectively. Below, we explain in more detail how TFP is estimated. A major advantage of analyzing the TFP of the combined firm rather than focusing on the effect in the acquirer or target firm is that we avoid tax-driven measurement errors in the input variables. These may occur if firms engage in fictitious relocation of economic activity after the merger. For example, a firm may use transfer pricing to assign labor expenses to the high-tax location in the merged firm. This would raise labor input there without affecting the output in this location and thus would seemingly induce a decline in productivity of the high-tax affiliate while total factor productivity would appear to increase in the low-tax affiliate. However, since there was no actual reallocation of resources, this change in productivity would be misleading. More precisely, even though the perceived productivity change would certainly be a result of the tax differential between the two locations, it would not constitute the real productivity effect that we are interested in but would rather be a result of tax-optimizing financial accounting. Analyzing the TFP of the combined firm avoids this problem because artificial relocations of productive factors net out when consolidating acquirer and target firm.

The tax differential is defined as $\Delta\tau_{jlk} = |\tau_l - \tau_k|$ where τ_k is the top statutory tax rate on corporate profits realized in the acquirer location and τ_l is the effective tax rate one year after the completion of deal j from the perspective of the acquirer on profits realized by the target firm. The coefficient of interest is α_1 which measures the effect of one percentage point of absolute difference in target and acquirer tax rates on the productivity change resulting from the M&A deal. According to our theoretical model we expect α_1 to be negative.

We also check whether a certain type of tax differential drives our result by disaggregating $\Delta\tau_{jlk}$ into positive and negative differentials, $\Delta\tau_{jlk}^{+}$ and $\Delta\tau_{jlk}^{-}$ with

$$\Delta\tau^{+}_{jlk} = \begin{cases} |\tau_l - \tau_k| & \text{if } \tau_l > \tau_k \\ 0 & \text{else} \end{cases}$$

$$\Delta\tau^{-}_{jlk} = \begin{cases} |\tau_l - \tau_k| & \text{if } \tau_l < \tau_k \\ 0 & \text{else.} \end{cases}$$

In our estimation, we control for various deal-, firm- and location-specific variables that might affect the productivity change and post-merger performance more generally in line with the previous literature.[11] $\boldsymbol{X_j}$ is a vector of deal characteristics. Since most of the variation in $\Delta\tau_{lk}$ stems from cross-border deals which themselves might have a particular effect on firm productivity, we include a dummy that indicates whether a deal involves two firms located in different countries. Furthermore, we include dummies that are equal to one when the takeover resulted from a hostile bid, when target shareholders where paid in stocks rather than cash, when the deal included a capital increase and when the acquirer firm already had a toehold in the target firm before the acquisition was announced.

$\boldsymbol{Z_{jlk}}$ is a vector of characteristics of the target as well as the acquirer firm and their respective locations. On the firm level, these include the relative size of both firms measured by the acquirer to target ratio of total assets, leverage, which is defined as the ratio of current liabilities to current assets, firm age and an indicator for listed acquirers. We also account for relevant factors on the country level by controlling for wage differentials between target and acquirer location which are proxied by the logarithmic ratio of acquirer to target GDP per capita, as well as, the logarithm of GDP and GDP per capita growth. Since domestic taxes might also have direct effects on firm productivity, we include the statutory corporate tax rate of the target in our regression.[12] Furthermore, we include the logarithm of the distance between the capitals of the acquirer and target country and a dummy that indicates if the merging firms are both located inside the European Union.

Each estimation contains a set of fixed effects $\boldsymbol{\psi}$ which comprise target and acquirer country-fixed effects, target and acquirer industry-fixed effects (2-digit US SIC code) and year-fixed effects. The variable of interest $\Delta\tau_{jlk}$ mainly varies across target and acquirer country pairs such that we cluster standard errors on the country pair level.[13]

Our theoretical model predicts that the effect of the tax differential is less pronounced when firms are able to easily allocate profits to the location with the more favorable tax rate. We test this notion in our empirical framework by interacting $\Delta\tau_{jlk}$ with an indicator for the looseness of transfer pricing regulations in the target and acquirer location for a deal, $LOOSE_{jlk}$. This variable thus exploits both variation across country pairs and within country pairs as transfer pricing legislation changes over time. It is equal to one whenever in

[11] See for example Harris & Robinson (2002), Herman & Lowenstein (1988), Fu *et al.* (2013), Fee & Thomas (2004), Stiebale (2016).

[12] We note that this may be correlated with the absolute tax rate differential and also run regressions without the statutory tax rate in the target location as control variable to check whether collinearity drives our findings. In these estimations we obtain very similar results.

[13] To verify the robustness of our results, we have also conducted a regression analysis with a two-way clustering of standard errors as suggested by Cameron *et al.* (2012) and again obtained significant coefficients.

both the target and the acquirer country, the applicable transfer pricing regulations do not include a documentation requirement by law. We focus on the documentation requirement since the existence of transfer pricing regulations alone does not impose a sufficient constraint on corporate profit shifting if firms are not obliged to properly explain the assigned transfer prices to the tax authorities. Furthermore, previous studies suggest that documentation requirements indeed constrain international profit shifting (e.g. Beer & Loeprick, 2015; Beuselinck *et al.*, 2015).[14] Our empirical model is defined as follows:

$$\hat{\Gamma}_{jlk} = \alpha_0 + \alpha_1 \Delta\tau_{jlk} + \alpha_2 \Delta\tau_{jlk} \times LOOSE_{jlk} + \alpha_3 LOOSE_{jlk} + \boldsymbol{\beta_1 X_j} + \boldsymbol{\beta_2 Z_{jlk}} + \boldsymbol{\psi} + \epsilon_j. \quad (16)$$

As above, we expect α_1 to be negative while α_2 should be positive and capture the mitigating effect of loose transfer pricing rules on the impact of the tax differential. More precisely, $\alpha_1 \geq \alpha_2$ with $\alpha_1 = \alpha_2$ indicating that the effect of the tax differential on the productivity change may be completely eliminated if transfer pricing rules are sufficiently loose.

Transfer pricing regulation in the two locations of the merging firms may not be equally important for the productivity change. For example, it may be more relevant for the acquirer location if most of the transfer pricing adjustments are taken in the headquarter. Furthermore, the strictness of transfer pricing regulations may be more important in the location with the higher effective tax rate from which profit is shifted away. We investigate this asymmetry by interacting the absolute tax rate differential $\Delta\tau_{jlk}$ with a set of dummies $LOOSE^{Acq}_{jlk}$ and $LOOSE^{Tgt}_{jlk}$ that indicate whether the transfer pricing regulations do not require documentation in the acquirer or target country, respectively, and another set of dummies $LOOSE^{High}_{jlk}$ and $LOOSE^{Low}_{jlk}$, which indicate the same for the location with the higher and the lower effective tax rate, respectively. When computing the latter set of dummies, we set $LOOSE^{High}_{jlk} = LOOSE^{Acq}_{jlk}$ and $LOOSE^{Low}_{jlk} = LOOSE^{Tgt}_{jlk}$ whenever the tax rate differential is zero.

Having explored the relationship between tax differentials and productivity changes on the deal level, we conduct a further inquiry to investigate the mechanisms underlying our result. Our theoretical model makes no assertion to what extent tax differentials affect productivity gains in the acquirer or the target firm. Assuming a merger between similar firms, the effect is expected to be symmetric. However, in practice, this may not necessarily be the case: Acquirer firms are often much larger (e.g. Moeller *et al.*, 2004) and also more productive (e.g. Schoar, 2002). It is thus likely that the inefficient relocation described above which results in lower overall productivity gains occurs more often with respect to the target, that is, merged firms do not efficiently relocate to the more productive acquirer if the target location has a lower tax rate. Furthermore, the management of the merged firm often originates from the acquiring company and therefore may be less reactive towards tax differentials that induce a (inefficient) relocation away from the acquirer location. From a methodological perspective, an explanation for such a finding may be that the acquiring

[14] A comprehensive overview of the legislation regarding transfer pricing documentation in a large number of countries is provided by Zinn *et al.* (2014).

entity is so much larger than the target that a productivity change induced by the M&A deal and the following relocation of resources between the two is hard to observe in the data of the acquiring firm.

We are thus interested in whether the productivity effects of the tax differential are more pronounced in the target or the acquirer firm. Bearing in mind the potential measurement errors described above, we estimate a regression model that relates acquirer and target firm TFP to the absolute tax differential. To capture the evolution of total factor productivity more precisely, we use a panel regression for this purpose. The respective empirical model is specified as follows:

$$\ln(A_{j,t}) = \alpha_0 POST_{j,t} + \alpha_1 \Delta\tau_{jlk} \times POST_{j,t} + \boldsymbol{\beta_1 X_j} \times \boldsymbol{POST_{j,t}} + \boldsymbol{\beta_2 Z_{jlk,t}} + \boldsymbol{\psi} + \epsilon_{j,t} \quad (17)$$

where A_{jt} is the estimated total factor productivity in year t of a firm related to merger j, that is either the combined, the target or the acquirer firm. $POST_{j,t}$ switches to one in the year after the merger is completed. α_0 thus captures the general impact of the merger on the total factor productivity while α_1 again is the heterogeneity in this effect that is attributed to the tax differential. $\boldsymbol{X_j}$ and $\boldsymbol{Z_{lk,t}}$ are the same vectors of deal, target and acquirer specific variables as defined above. The effect of the time invariant variables is fully captured by firm fixed effects and we thus interact $\boldsymbol{X_j}$ with a vector of indicators for the post-merger period. Finally, $\boldsymbol{\psi}$ comprises firm- and year-industry-fixed effects. The latter capture industry-specific time trends of productivity.

We also check whether we can observe the expected pattern of allocation of productive factors after the merger. This is done by replacing the dependent variable in equation (17) with the logarithms of the employment and tangible fixed assets in the target and the acquirer firm. In this estimation, the effect of the absolute tax differential may not be symmetric. We check this by disaggregating $\Delta\tau_{jlk}$ into positive and negative differentials, $\Delta\tau^+_{jlk}$ and $\Delta\tau^-_{jlk}$ as described above. Alternatively, one could use the simple tax differential instead of the absolute one. However, the underlying assumption for such an estimation is that tax rate differentials have a symmetric effect on the productivity change which is not necessarily the case as explained above. Using $\Delta\tau^+_{jlk}$ and $\Delta\tau^-_{jlk}$ imposes a less restrictive framework.

In a final analysis, we verify our results using an event study design. This methodology was originally developed for the finance and accounting literature by Fama *et al.* (1969) but has since been adjusted and is now widely applied in economic studies (Corrado, 2011).[15] In general, an event study tracks the behavior of observed individuals around an event which is defined as the M&A deal completion for our purposes. It has two important benefits. First, it allows us to explore the timing of distortions in the post-merger adjustment process more systematically. This provides further insights with regard to the underlying mechanism and also informs us about the persistence of these distortions. Second, this method allows us to

[15] More recent applications of event studies in economics include Almond *et al.* (2011), Chetty *et al.* (2014) and Hoynes *et al.* (2016).

check whether pre-merger trends in TFP and factor input cause spurious findings. Ruling out such trends would strengthen the causal inference from our regression results.

For the event study, we adjust the specification of Sandler & Sandler (2014) for our purposes such that the empirical model looks as follows:

$$\begin{aligned}\ln y_{j,t} =& \alpha_{-3}\sum_{n=3}^{M-t} D_{j,t-n}\times\Delta\tau_{jlk} + \sum_{n=-2}^{3}\alpha_n D_{j,t-n}\times\Delta\tau_{jlk} + \alpha_4\sum_{n=4}^{t-N} D_{j,t-n}\times\Delta\tau_{jlk}\\ &+\gamma_{-3}\sum_{n=3}^{M-t} D_{j,t-n} + \sum_{i=-2}^{3}\gamma_n D_{j,t-n} + \gamma_4\sum_{i=4}^{t-N} D_{j,t-n}\\ &+\boldsymbol{\beta_1 X_j}\times\boldsymbol{POST_{j,t}} + \boldsymbol{\beta_2 Z_{jlk,t}} + \boldsymbol{\psi} + \epsilon_{j,t}. \end{aligned} \tag{18}$$

The dependent variable $y_{j,t}$ is TFP, labor or capital input of the acquiring, target or the combined firm as described above for the panel regression. It is regressed on a range of dummies $D_{j,t-n}$ which indicate whether the deal in which entity j is involved has been completed in period $t-n$. Within the first and last data year, M and N, we define our event window to 3 years before until 4 years after the merger completion.[16] The end points of this window are open brackets, that is, they indicate whether the merger has been completed 4 or more years before (for the upper window limit) and 3 or more years after a given period (for the lower window limit). This mitigates collinearity with the year-fixed effects. The regressor for the period before the merger completion is omitted and normalized to zero such that remaining coefficients have to be interpreted relative to the pre-merger year. Our event study specification is augmented by the same set of fixed effects and control variables as the panel regression model.

While the coefficients of the individual dummies γ_n capture the direct effect of the merger on the outcome variables, we are interested in the distortive impact of tax differentials on this effect. We thus interact the dummies with the absolute tax rate differential $\Delta\tau_{jlk}$ and add this set of interactions to the regression model to obtain our coefficients of interest α_i. The latter measure how a tax differential of one percentage point changes the impact of the merger on the outcome variable n years after (if $n < 0$) or before (if $n > 0$) the merger completion relative to the year before the M&A is executed. If tax differentials only affect the adjustment process after the two firms have merged, one should not find an effect for pre-merger years, that is, we should obtain $\alpha_n = 0\ \forall n > 0$.

3.2 Productivity Estimation

An important prerequisite for analyzing the effect of within-firm tax differentials on productivity changes after M&As is a precise estimate of total factor productivity in the involved firms. A common approach is to estimate the parameters of a Cobb-Douglas production function by regressing firm output on the main input factors labor and capital, compute the predicted values and back out total factor productivity as the residual. However, the latter

[16] We experimented with alternative window definitions and obtained similar results.

contains both the total factor productivity of the entity and a potential productivity shock which is not observed by the researcher but known to the firm. Since the latter also affects the input choices of the firm, a simultaneity problem arises. Previous studies have addressed this issue by either using investments (Olley & Pakes, 1996) or intermediate inputs (Levinsohn & Petrin, 2003; Wooldridge, 2009) as proxies for the firm expectation regarding future productivity changes.

In this paper, we estimate total factor productivity using firm level data on inputs and outputs from Bureau van Dijk's AMADEUS and ORBIS databases. In doing so, we closely follow Fons-Rosen *et al.* (2013) who also use ORBIS and apply the Levinsohn & Petrin (2003) procedure. Output is measured as firm value added while inputs are labor, which is the total cost of employees, and capital, which is defined as the total assets of the firm. Following Levinsohn & Petrin (2003), firm expectations about future productivity shocks are proxied by intermediate inputs which are measured as the cost of materials.

This approach yields consistent estimates of total factor productivity but is also very demanding in terms of required data. Missing firm level data are imputed as described by Gal (2013) in order ensure a sufficient sample size. Before conducting the productivity estimation, we also check the balance sheet data obtained from Bureau van Dijk for consistency errors. The relevant steps for constructing the productivity estimation sample are described in detail in Appendix A.1.

We conduct our productivity estimation using the universe of available firms in ORBIS and AMADEUS that reside in either an OECD or an EU member country and contain sufficient observations with reliable information on the relevant variables. This sample of 1,366,343 firms with annual data between 2000 and 2013 also contains the acquirer and target firms of interest. We estimate total factor productivity using the Levinsohn & Petrin (2003) method within each 2-digit US SIC code industry. The firm- and year-specific total factor productivities for the firms involved in an M&A during the observation period are then used in the main analysis.

4 Data

We collect M&A deals from the Zephyr database. An important advantage of Zephyr is that target and acquirer firms are each assigned a unique Bureau van Dijk ID which allows us to match balance sheet data from ORBIS and AMADEUS to the deal-level data and compute total factor productivity before and after the merger. Only deals with firms for which we obtain sufficient data to estimate total factor productivity for the year before and the year after the deal completion are used in the estimation. We also exclude financial and insurance firms[17] and privatizations of state-owned enterprises.

We restrict our sample to M&A deals which constitute a full acquisition or a merger to make sure that after the completion of the deal, the management of the combined firm has full control over the target and acquirer assets and thus possesses the means to reallocate the

[17]These are defined as firms with US SIC codes 60-67.

Table 2: M&A Deal Sample

Acquirer country	Code	Target Country																			
		BE	BG	CZ	DE	EE	ES	FI	FR	GB	HR	HU	IT	NL	NO	PL	PT	RO	SE	SI	SK	Total
Austria	AT	.	.	.	.	.	.	1	1	.	1	1	.	.	.	.	.	.	.	.	.	4
Belgium	BE	36	.	1	1	.	2	.	1	.	.	.	1	.	.	.	.	1	.	.	.	43
Bulgaria	BG	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
Czechia	CZ	.	.	21	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	24
Germany	DE	4	.	2	19	.	3	1	4	3	.	1	.	.	.	2	.	3	2	.	.	44
Estonia	EE	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Spain	ES	.	.	2	1	.	192	.	3	2	.	.	6	.	.	.	5	.	.	.	.	211
Finland	FI	.	.	.	1	2	.	106	.	.	.	.	.	.	1	1	.	.	6	.	.	117
France	FR	7	.	.	.	.	4	.	77	2	.	.	5	1	.	.	.	.	2	.	.	98
UK	GB	.	.	.	.	.	4	.	4	38	.	.	.	.	.	.	.	.	1	.	.	47
Croatia	HR	.	.	.	.	.	.	.	.	.	15	.	.	.	.	.	.	.	.	3	.	18
Hungary	HU	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	5
Italy	IT	3	.	1	1	.	8	1	4	2	2	.	76	.	.	.	.	.	3	1	.	102
Norway	NO	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	2	.	.	11
Poland	PL	.	.	.	1	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	6
Portugal	PT	.	.	.	1	.	5	.	.	.	1	.	.	.	.	.	11	.	.	.	.	18
Romania	RO	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1
Sweden	SE	1	.	.	1	.	1	7	.	1	.	.	.	.	3	1	.	.	93	.	.	108
Slovenia	SI	.	.	.	.	.	1	.	.	.	2	.	1	.	.	.	.	.	.	8	.	12
Slovakia	SK	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	6
Total		51	8	28	26	4	220	116	95	48	21	8	90	1	13	9	16	4	109	12	6	885

resources. The resulting sample consists of 9,649 firm-year observations for combined firms which are involved in 896 M&A deals. For 885 deals we observe TFP before and after the merger for both the acquirer and the target firm. These deals form the estimation sample for our main analysis. Their distribution across acquirer and target countries is summarized in Table 2. 18% of them are cross-border deals and thus provide the source of variation in the tax rate differential. Table 3 displays summary statistics for the other deal-specific variables. Most of the deals are paid in cash with only 1.2% of stock-for-stock deals in our sample. Only 10.1% of acquirers are listed on the stock market. In our sample, the absolute tax differential ranges up to 20.8% with an average of 1.0%. Given that a substantial number of M&As in our sample are domestic deals with no tax difference, this points to significant tax differential among cross-border deals. Indeed, for this sub-group, the average tax differential is 4.3%. 41% of deals in our sample comprise an acquirer and target location in both of which transfer pricing documentation is not required at the completion of the deal. This figure is also high among cross-border deals with a share of 35.2% involving locations with loose transfer pricing regulations and neither differs much between target and acquirer locations nor between high and low tax locations.

The deal sample is then combined with balance sheet data from the financial databases of Bureau van Dijk as well as the estimated TFP. Table 4 provides summary statistics for these variables. On average, acquirer firms are slightly more productive than target firms before the merger. This relation reverses after the M&A is completed, possibly pointing at some within-firm reorganization after the merger. As is commonly observed, acquirer and target firms differ substantially in size. In our sample, acquirers are on average about 18 times larger than the target firm in terms of total assets. They are also older and more leveraged. A positive average of the wage difference suggests that acquirers generally invest

Table 3: Summary Statistics: Deals

Variable	Observations	Mean	Standard deviation	Min	Max
Cross-border	885	0.180	0.384	0	1
$\Delta\tau$	885	1.043	2.260	0	20.75
$\Delta\tau^{+}$	885	0.626	1.586892	0	18.43
$\Delta\tau^{-}$	885	0.417	1.764	0	20.75
$LOOSE$	885	0.410	0.492	0	1
$LOOSE^{Acq}$	885	0.437	0.496	0	1
$LOOSE^{Tgt}$	885	0.429	0.495	0	1
$LOOSE^{High}$	885	0.446	0.497	0	1
$LOOSE^{Low}$	885	0.421	0.494	0	1
Hostile	885	0.001	0.034	0	1
Stock-for-Stock	885	0.012	0.111	0	1
Capital Increase	885	0.014	0.116	0	1
Horizontal	885	0.409	0.492	0	1
Toe	885	0.045	0.208	0	1
Acquirer Listed	885	0.101	0.301	0	1
EU Member	885	0.932	0.252	0	1
Log Distance	885	5.553	0.679	3.980	7.862

in countries with a lower level of labor compensation than in their home location.

Table 4: Summary Statistics: Firms

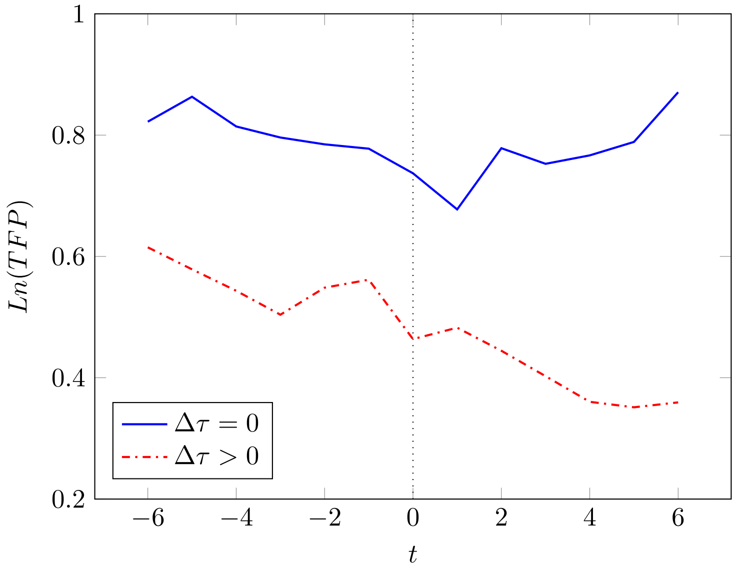
Variable	Observations	Mean	Standard deviation	Min	Max
Log TFP (combined firm)	7,379	0.652	0.951	-4.906	5.777
Log TFP (Acq.)	8,815	0.642	1.004	-6.369	7.120
Log TFP (Acq., before the merger)	4,691	0.653	0.943	-5.005	6.375
Log TFP (Tgt.)	9,672	0.586	0.976	-5.024	6.375
Log TFP (Tgt., before the merger)	4,512	0.640	0.962	-6.369	7.120
Relative Size	7,388	17.686	54.001	0.007	995.950
Leverage (Acq.)	9,262	1.762	56.786	0	4933.701
Leverage (Tgt.)	9,621	1.006	3.939	0	224.5
Log Age (Acq.)	9,493	2.972	0.870	0	5.298
Log Age (Tgt.)	9,841	2.774	0.854	0	4.942
CIT (Acq.)	14,681	0.302	0.056	0.1	0.52
CIT (Tgt.)	14,681	0.299	0.056	0.1	0.52
GDP p.c. Growth (Acq.)	11,844	0.014	0.043	-0.190	0.220
GDP p.c. Growth (Tgt.)	11,844	0.015	0.044	-0.190	0.220
Log GDP (Acq.)	13,716	27.258	1.156	23.020	28.803
Log GDP (Tgt.)	13,716	27.180	1.171	23.020	28.803
Wage Difference	13,716	0.027	0.252	-2.295	2.331

5 Results

5.1 Tax Differentials and Changes in Total Factor Productivity

Before turning to the results of our econometric analysis, we first investigate the sample graphically. Figure 1 plots the evolution of TFP of the combined firm before and after the merger. For each particular period it presents the average logarithm of TFP in our sample of merged firms. We differentiate between mergers with an absolute tax differential of zero (the blue, solid line) and deals with a positive absolute tax differential between the acquirer and target location (red, dash-dotted line). Combinations of firms with no difference in taxation between the two locations are generally more productive. However, this difference becomes more pronounced after the M&A deal is completed as TFP increases for firms with zero tax differentials while it declines for firms with positive tax differential. Consistent with our theoretical model, this indicates that M&A deals with positive tax differentials have lower productivity gains than those without distortive differences in target and acquirer taxation. Of course Figure 1 may also capture the impact on TFP of other deal characteristics that are correlated with the induced tax differential. For example, cross-border deals are more prevalent when the tax differential is positive but probably also generate lower productivity gains because integrating two firms that are located in different countries may be very costly.[18]

Figure 1: Evolution of TFP before and after the M&A



In our regression analysis, we control for these confounding effects. Table 5 presents the main findings. Column (1) displays results for a parsimonious regression with a set of fixed effects as described above but no control variables. The resulting coefficient is significantly negative, suggesting that an increase in the absolute tax differential reduces the productivity gain after the merger.

We augment the regression by including control variables in columns (2) and (3). Only coefficients for the firm- and deal-level variables are displayed while results for the location specific characteristics are relegated to Appendix A.3. The estimation results suggest that hostile M&As (i.e. deals that go ahead without the approval of the target firm's management) generate significantly lower productivity gains. This may reflect that the acquiring firm often faces substantial resistance by executives of the target firm when integrating it after the merger. Furthermore, deals which are financed via a capital increase also yield lower productivity gains which may be related to the observation that these deals often involve a large number of participants on the acquirer side. Such a consortium may find it more difficult to make decisions regarding the firm reorganization after the M&A completion.

In column (3), we account for industry-level variation. M&A often coincide with shifts in specific industries (see Mitchell & Mulherin, 1996). These may, for example, be caused by substantial deregulation within certain industries or an increase in competition that leads to a consolidation in particular production sectors. Any of these events may both be related to

[18] Note however, that a tax differential of zero does not necessarily imply that the deal is domestic. Some countries have identical tax rates for some time (e.g. Norway and Sweden) while others applied the credit regime with respect to foreign dividends (e.g. the United Kingdom) which, assuming zero withholding taxes, also leads to a zero tax differential in the case of cross-border acquisitions of targets with lower tax rates relative to the acquirer location.

Table 5: Benchmark

OLS regression. The dependent variable in columns (1), (2), (4) and (5) is the difference in the logarithm of average productivity after and before the merger. In columns (3) and (6) the dependent variable is the difference in the logarithm of average productivity before and after the merger relative to the industry mean (SIC 2 digit code). Columns (2), (3), (5) and (6) contain regression results with country-level controls for which estimated coefficients are reported in Table A.1 in the Appendix. All regressions include target and acquirer country fixed effects, target and acquirer industry fixed effects and year fixed effects. Cluster robust standard errors (clustered at the acquirer-target country-pair level) are provided in parentheses. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau$	-0.030***	-0.045**	-0.038***			
	(0.010)	(0.018)	(0.014)			
$\Delta\tau^-$				-0.047**	-0.051*	-0.055**
				(0.019)	(0.026)	(0.026)
$\Delta\tau^+$				-0.018	-0.040	-0.022
				(0.011)	(0.024)	(0.017)
Cross-border		0.028	0.021		0.029	0.025
		(0.146)	(0.132)		(0.146)	(0.131)
Hostile		-0.930**	-0.171		-0.931**	-0.178
		(0.397)	(0.324)		(0.394)	(0.319)
Stock-for-Stock		0.249	0.239		0.253	0.251
		(0.172)	(0.196)		(0.172)	(0.196)
Capital Increase		-0.311***	-0.355***		-0.313***	-0.362***
		(0.098)	(0.085)		(0.098)	(0.086)
Horizontal		-0.041	-0.022		-0.040	-0.019
		(0.034)	(0.026)		(0.034)	(0.026)
Toe		0.044	0.118		0.042	0.111
		(0.093)	(0.095)		(0.092)	(0.094)
Relative Size		-0.000	-0.000		-0.000	-0.000
		(0.000)	(0.000)		(0.000)	(0.000)
Leverage (Acq.)		0.026	0.000		0.026	-0.000
		(0.040)	(0.039)		(0.041)	(0.039)
Acquirer Listed		-0.081*	-0.058		-0.080	-0.054
		(0.048)	(0.045)		(0.048)	(0.045)
Log Age (Acq.)		-0.012	-0.003		-0.012	-0.003
		(0.016)	(0.020)		(0.016)	(0.021)
Intercept	-0.605*	19.329	0.960	-0.669*	19.104	0.365
	(0.337)	(29.693)	(25.995)	(0.344)	(29.610)	(25.783)
Country-level controls	No	Yes	Yes	No	Yes	Yes
N	885	785	782	885	785	782
R^2	0.244	0.288	0.285	0.245	0.288	0.286

changes in productivity and increased foreign acquisition activity within the specific industry, the latter being generally associated with higher tax rate differentials. For instance, a slowdown in productivity growth of an industry in a particular country makes firms in this industry potential takeover targets for foreign, more competitive firms. This implies larger tax rate differentials for acquisitions in this industry but also lower productivity gains if the foreign acquisition cannot completely reverse the downward trend in productivity growth.

Ignoring within-industry developments may thus induce a spurious correlation between merger-induced TFP changes and tax rate differentials that is unrelated to the mechanism suggested in our theoretical model above. We account for this effect by conducting an additional estimation in which we scale the dependent variable by the industry average. In particular, we use the difference in the logarithm of average productivity before and after the merger relative to the industry mean (SIC 2 digit code). Results are presented in column (3) of Table 5 which otherwise repeats the specifications of column (2). The effect of the tax differential on the change in TFP is still significantly negative and potentially mitigated by loose transfer pricing regulations. These findings suggest that our results are robust to accounting for industry trends in productivity and are thus not driven by industry-specific shifts.

In all of the augmented regressions, the coefficient for the absolute tax differential remains significantly negative. Using regression (2) with the full set of controls and a straight-forward interpretation of the observed effect as a conservative benchmark, we find that an increase in the absolute tax differential between acquirer and target location by 1 percentage point drives down the merger-induced productivity gain by about 4.5%.

We complement our analysis in columns (4) to (6) by allowing for different coefficients for positive and negative tax differentials. Again, column (4) presents the results for regressing the tax differentials on the variables of interest and a set of fixed effects. The coefficient for negative tax differentials (i.e. tax differences where the effective tax rate of the target location is below that of the acquirer location) is significantly negative while the coefficient for positive tax differences is insignificant. This suggests that deals with targets in low-tax jurisdictions drive our main result. When adding control variables in column (5) or controlling for industry-specific trends in column (6), we again obtain the result that deals involving low-tax targets have a particularly negative impact on the post-merger productivity change.

One explanation for this finding is that the potential for productivity improvement is probably higher in the target firm. Thus, negative tax differences, that induce the management to continue the operation of some less productive units in the target have a more negative impact on overall productivity than positive tax differences that would only reduce the post-merger productivity gain by a substantial amount if there is a sufficient number of units in the acquirer location whose productivity is inferior to that of the corresponding units in the target firm. If generally most of the adjustment takes place in the target firm, one may also refer to asymmetric adjustment costs in factor demand (Hamermesh & Pfann, 1996) as a complementary explanation. Jaramillo *et al.* (1993) show that the cost for lowering labor demand is much higher than for increasing it and the persistent nature of capital investment implies that downward adjustment is also more expensive for this factor (Pindyck, 1988). The excessive reduction in resources in the target firm that would be induced by positive tax differentials is thus likely to be more costly than the relative increase of resources resulting from negative tax differences, especially if this means that resources remain where they are and no net adjustment takes place. In this setting, negative tax differences are more likely to have an impact on management decisions and thus affect productivity changes more strongly.

Table 6: Transfer Pricing Regulation

OLS regression. The dependent variable in columns (1), (2), (4) and (5) is the difference in the logarithm of average productivity after and before the merger. In column (3) the dependent variable is the difference in the logarithm of average productivity before and after the merger relative to the industry mean (SIC 2 digit code). Columns (2)-(5) contain regression results with control variables for which estimated coefficients are reported in Table A.2 in the Appendix. All regressions include target and acquirer country fixed effects, target and acquirer industry fixed effects and year fixed effects. Cluster robust standard errors (clustered at the acquirer-target country-pair level) are provided in parentheses. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	(1)	(2)	(3)	(4)	(5)
$\Delta\tau$	-0.041***	-0.062***	-0.048***	-0.072***	-0.071**
	(0.013)	(0.020)	(0.016)	(0.027)	(0.028)
$\Delta\tau \times LOOSE$	0.042*	0.058**	0.035*		
	(0.021)	(0.022)	(0.019)		
$LOOSE$	-0.010	-0.052	0.021		
	(0.060)	(0.082)	(0.071)		
$\Delta\tau \times LOOSE^{Acq}$				0.059***	
				(0.021)	
$\Delta\tau \times LOOSE^{Tgt}$				-0.005	
				(0.021)	
$LOOSE^{Acq}$				-0.196	
				(0.157)	
$LOOSE^{Tgt}$				0.176	
				(0.177)	
$\Delta\tau \times LOOSE^{High}$					0.048**
					(0.024)
$\Delta\tau \times LOOSE^{Low}$					0.006
					(0.024)
$LOOSE^{High}$					-0.085
					(0.125)
$LOOSE^{Low}$					0.061
					(0.139)
Intercept	-0.669*	28.887	6.007	23.562	25.153
	(0.349)	(31.473)	(26.900)	(31.612)	(31.327)
Country-level controls	No	Yes	Yes	Yes	Yes
N	885	785	782	785	785
R^2	0.249	0.296	0.290	0.296	0.295

In the next set of regressions, which is presented in Table 6, we analyze how transfer pricing regulation affects our results. In the regression in column (1) of Table 6 we add the interaction of the tax rate differential and $LOOSE$, our indicator for the strictness of transfer pricing regulation, to the benchmark specification displayed in columns (1) to (3) in Table 5. As before, the coefficient of the absolute tax differential $\Delta\tau$ is significantly negative. The coefficient of the interaction between $\Delta\tau$ and an indicator for loose transfer pricing regulations is significantly positive. This suggests that the impact of the tax differential on the productivity change is mitigated if transfer pricing regulation is not very strict and firms are able to reduce the effective tax rate difference between the locations by engaging in profit shifting activities. Furthermore, our results suggest that if the tax law in the acquirer and the target country either does not contain transfer pricing regulations or does not require firms to provide a written documentation of their transfer pricing system, this may neutralize the effect of the tax differential. In particular, we cannot reject the hypothesis that $\alpha_1+\alpha_2 = 0$ in our sample.[19] This finding is robust to adding control variables and controlling for industry trends in columns (2) and (3), respectively.

Does transfer pricing legislation matter more in the target or in the acquirer location? We answer this question by disaggregating $LOOSE$ into two indicators for the strictness of transfer pricing regulation in the acquirer and the target country, $LOOSE^{Acq}$ and $LOOSE^{Tgt}$. Results presented in column (4) suggest that legislation in the acquirer location is much more important than in the target location. Given our findings above, this is not surprising. Our estimation results in Table 5 indicate that the results are mainly driven by negative tax differences, that is, when profits of the target are taxed at a lower rate than profits of the acquirer. In this case firms would like to shift profits away from the acquirer location to the target firm. This is what stricter transfer pricing legislation in the former would be implemented to inhibit. On the contrary, raising transfer pricing documentation requirements in the low-tax target location might increase overall transparency but is probably not designed to prevent profit shifting to this location (Bucovetsky & Haufler, 2008) and is therefore less relevant.

An alternative disaggregation would be to differentiate between the strictness of transfer pricing legislation in the location with the higher and the lower effective tax rate, $LOOSE^{High}$ and $LOOSE^{Low}$. Results for this approach are presented in column (5) of Table 6. Consistent with the idea described above that legislation to curb profit shifting via transfer pricing is more important in the high-tax location, we find that the estimated coefficient for $LOOSE^{High}$ is much bigger than the one for $LOOSE^{Low}$. The latter is not significantly different from zero.

5.2 Allocation of Productive Factors

We now extend our analysis to explore the mechanisms that underlie our main result. Inefficient reallocations after M&As can take various forms. The management can either allocate too many or too few resources to either the acquirer or the target depending on the sign of the tax difference between the locations of the two firms. Our theoretical model is not conditional on such biases which has the advantage of very general results but also precludes

[19]Conducting a simple Wald test, we obtain F-Statistics of 0.00, 0.13 and 0.62 for the regressions in columns (1), (2) and (3) of Table 6, respectively.

us from forming any expectations about how the effect evolves in practice. Instead, we rely on empirical evidence to identify particular channels.

Table 7: Panel Regression: Total Factor Productivity

OLS regression. The dependent variable is the logarithm of total factor productivity of the combined firm in columns (1)-(2), of the target firm in columns (3)-(4) and the acquirer firm in columns (5)-(6). All regressions include country-level controls for which estimated coefficients are reported in Table A.3 in the Appendix. Cluster robust standard errors (clustered at the firm level) are provided in parentheses. All regressions include firm and industry-year fixed effects. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	(1) Combined Firm	(2) Combined Firm	(3) Target Firm	(4) Target Firm	(5) Acquirer Firm	(6) Acquirer Firm
$POST$	-0.805***	-0.809***	-0.851***	-0.847***	-0.667**	-0.664**
	(0.217)	(0.212)	(0.315)	(0.312)	(0.281)	(0.275)
$POST \times \Delta\tau$	-0.035***		-0.042***		-0.020*	
	(0.011)		(0.015)		(0.011)	
$POST \times \Delta\tau^{-}$		-0.035***		-0.046**		-0.017
		(0.012)		(0.020)		(0.011)
$POST \times \Delta\tau^{+}$		-0.034**		-0.036*		-0.025
		(0.016)		(0.020)		(0.017)
$POST \times$Cross-border	-0.040	-0.045	-0.017	-0.050	-0.061	-0.057
	(0.086)	(0.086)	(0.122)	(0.121)	(0.103)	(0.104)
$POST \times$Hostile	-0.294	-0.301	-0.292	-0.311	-0.223**	-0.228**
	(0.188)	(0.187)	(0.338)	(0.343)	(0.098)	(0.098)
$POST \times$Stock-for-Stock	-0.097	-0.095	-0.706***	-0.707***	0.252	0.243
	(0.159)	(0.160)	(0.196)	(0.199)	(0.179)	(0.182)
$POST \times$Capital Increase	0.010	0.010	0.638***	0.653***	-0.371***	-0.369***
	(0.102)	(0.102)	(0.169)	(0.170)	(0.108)	(0.109)
$POST \times$Horizontal	0.025	0.023	-0.053	-0.062	0.041	0.040
	(0.033)	(0.033)	(0.054)	(0.054)	(0.036)	(0.036)
$POST \times$Toehold	0.142*	0.140*	0.087	0.080	0.108	0.109
	(0.078)	(0.079)	(0.119)	(0.118)	(0.081)	(0.081)
$POST \times$Acquirer Listed	-0.036	-0.037	-0.190*	-0.192*	0.055	0.052
	(0.059)	(0.060)	(0.099)	(0.101)	(0.064)	(0.065)
Relative Size	-0.001**	-0.001**	0.001	0.001	-0.001*	-0.001**
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Leverage (Acq.)	0.000	0.000	-0.000	-0.000	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage (Tgt.)	0.001	0.002	-0.016	-0.016	0.007	0.007
	(0.020)	(0.020)	(0.034)	(0.034)	(0.011)	(0.011)
Log Age (Acq.)	0.005	0.006	0.047	0.043	0.030	0.032
	(0.054)	(0.054)	(0.079)	(0.078)	(0.063)	(0.062)
Log Age (Tgt.)	0.032	0.028	0.094	0.089	-0.039	-0.041
	(0.042)	(0.042)	(0.069)	(0.069)	(0.044)	(0.044)
Country-level controls	Yes	Yes	Yes	Yes	Yes	Yes
N	5,075	5,102	5,072	5,099	5,072	5,099
R^2	0.239	0.236	0.191	0.187	0.295	0.293

For this purpose, we turn to a panel analysis in order to follow the evolution of important determinants of total factor productivity over time. This allows us to control for co-moving variables and general time trends. In columns (1) and (2) of Table 7 we repeat our main analysis in a panel regression framework to demonstrate that this approach also captures the negative effect of the tax differential on TFP. The coefficient of the interaction between the absolute tax difference and the post-merger dummy is significantly negative. This is the case both for positive and for negative tax differences although we note that negative tax differences appear to be somewhat more important with a slightly larger magnitude for the corresponding coefficient.

Next, we turn to the target firm, that is, instead of the TFP of the combined firm we relate the tax differential to the estimated TFP of the target firm only. Our results in column (3) suggest, that the productivity gain on the target level is substantially lower when the absolute tax differential is positive.[20] In particular, we find that a one percentage point increase in the absolute tax difference lowers the merged-induced change in target productivity by 4.2%. We also explore whether this result is rather driven by negative or positive tax differentials, that is, whether lower productivity gains are a result of the target being located in a low-tax or high-tax country with respect to the acquirer location. The results for the corresponding estimation are presented in column (4). The coefficient for the interaction of the post-merger dummy with the absolute magnitude of the negative tax differential, $\Delta\tau^-$, is negative and highly significant. In contrast, the coefficient for the related interaction with the positive tax differential, $\Delta\tau^+$, is only marginally significant and much smaller in magnitude. This finding suggests that the negative effect of tax differentials on the post-merger productivity change in the target in our sample is mainly driven by deals where profits received from the target are taxed at a lower rate than those generated in the acquirer country.

We then conduct a similar analysis for the acquiring firm in columns (5) and (6). Our results indicate that tax differentials have a much smaller impact on acquirer productivity. With a coefficient of -0.02 the estimated effect is less then half the magnitude found for target firms and only marginally significant. When relating the TFP of the acquirer to negative and positive tax differentials separately, we do not obtain precise results. The respective coefficients are negative but insignificant.

These findings point to the target firm as the entity within the merged firm where tax differentials are most harmful for productivity gains. Although the estimated impact of the tax differential is a novel effect with regard to M&A outcomes, it is not surprising that the main impact relates to the target firm as this is the place where probably most of the reorganization occurs after the merger. How the tax differential affects this process should also be visible in the data. In our next estimation we therefore trace the evolution of the input factors labor and capital before and after the M&A completion and analyze how their use is affected by tax differentials.

We begin this analysis with employment and present our findings in Table 8. The first

[20] The results presented here are estimated including the full set of controls. We also estimated the corresponding models without firm-, country- and deal-level controls and obtained very similar results.

two columns show results with respect to the target firm. A negative, albeit insignificant coefficient for the post-merger dummy in column (1) suggests that firms reduce employment in the target firm after the merger. However, this reduction is mitigated when there is a positive absolute tax differential. The estimation suggests that the post-merger employment cut is reduced by 2% per percentage point of absolute tax difference. As we focus on the target firm in this estimation, it is again useful to separate the absolute tax differential into positive and negative tax differences. We do this in column (2). Consistent with our theoretical explanations above, target employment is mainly affected by negative rather than positive tax differences.

The opposite effect is observed with regard to the acquiring firm for which we present results in columns (3) and (4). Higher absolute tax differentials enhance the post-merger employment cut in the acquirer by 1.9% points for each percentage point in tax difference. Again, separating the tax differential in positive and negative differences suggests that this result is driven by M&As where a firm in a high-tax country takes over a firm located in a low-tax country.

We repeat this analysis for the other input factor capital which is measured as the logarithm of tangible fixed assets. Results are shown in Table 9 where the first two columns refer to the target firm. Similar to the effect on labor input, the estimation suggests that an increase in the absolute tax differential has a positive effect on the use of capital in the target after the merger. Furthermore, the significantly positive coefficient of the interaction between the post-merger dummy and $\Delta\tau^-$ in column (2) indicates that this is mainly driven by negative tax differences. An increase in the magnitude of the negative tax difference between target and acquirer raises merger-induced change in capital employed in the target by 4.6% per percentage point. In contrast, we do not find a significant effect of positive tax differences on the post-merger level of capital in the target which mirrors the asymmetry observed for labor input. Firms only adjust the post-merger use of input factors in the target to tax rate differentials if the target is located in a country with an effective tax rate below that of the acquirer location. If the acquirer resides in a country with a more favorable tax regime, no reaction occurs.

Turning to capital employment in the acquirer firm we cannot identify a significant effect of the absolute tax differential. The corresponding coefficient in column (3) is negative but relatively small and not significant. We also do not find a significant impact if we differentiate between positive and negative differences. Thus, acquirer firms in our sample do not adjust their post-merger investment policies to tax differences. On the one hand, this may reflect that firms find it easier to adjust labor input than to decrease or increase capital. On the other hand, acquirer firms are usually much bigger than target firms, especially in terms of assets, and may adjust their capital stock because of various factors unrelated to taxation. Such noise in the data would prevent us from precisely measuring the effect of the tax difference on changes in the capital employment of the acquirer following the M&A.

The main channel through which tax differentials affect the realization of productivity changes in M&As thus appears to be that they reduce the scale of adjustment in the target firm when the tax burden for profits is lower there. Previous empirical studies have already

Table 8: Panel Regression: Employment

OLS regression. The dependent variable is the logarithm of the total number of employees of the target firm in columns (1)-(2) and the acquirer firm in columns (3)-(4). All regression results contain country-level controls for which estimated coefficients are reported in Table A.4 in the Appendix. Cluster robust standard errors (clustered at the firm level) are provided in parentheses. All regressions include firm and industry-year fixed effects. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	(1) Target Firm	(2) Target Firm	(3) Acquirer Firm	(4) Acquirer Firm
$POST$	-0.402	-0.166	-0.126	-0.127
	(0.288)	(0.278)	(0.206)	(0.204)
$POST \times \Delta$	0.021*		-0.019*	
	(0.012)		(0.010)	
$POST \times \Delta\tau^{-}$		0.033***		-0.019*
		(0.011)		(0.010)
$POST \times \Delta\tau^{+}$		0.005		-0.019
		(0.018)		(0.014)
$POST\times$Cross-border	-0.083	-0.006	0.024	0.032
	(0.102)	(0.098)	(0.079)	(0.078)
$POST\times$Hostile	-0.473***	-0.242	-0.449**	-0.443**
	(0.101)	(0.167)	(0.210)	(0.210)
$POST\times$Stock-for-Stock	-0.435**	-0.519***	0.949***	0.948***
	(0.186)	(0.187)	(0.190)	(0.192)
$POST\times$Capital Increase	0.037	0.014	-1.004***	-1.007***
	(0.131)	(0.127)	(0.112)	(0.113)
$POST\times$Horizontal	-0.009	-0.004	-0.004	-0.002
	(0.051)	(0.049)	(0.040)	(0.040)
$POST\times$Toehold	0.172	0.185	-0.103	-0.101
	(0.118)	(0.117)	(0.112)	(0.112)
$POST\times$Acquirer Listed	0.138*	0.155**	0.094	0.098
	(0.075)	(0.071)	(0.081)	(0.083)
Leverage (Acq.)	0.000**	0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Leverage (Tgt.)	-0.065***	-0.059***	0.017	0.015
	(0.018)	(0.019)	(0.013)	(0.014)
Log Age (Acq.)	0.000	0.040	0.265***	0.263***
	(0.071)	(0.048)	(0.067)	(0.067)
Log Age (Tgt.)	0.250***	0.242***	0.034	0.039
	(0.082)	(0.061)	(0.050)	(0.050)
Country-level controls	Yes	Yes	Yes	Yes
N	5,096	5,123	5,096	5,123
R^2	0.209	0.185	0.317	0.314

shown that target firms often undergo a period of substantial restructuring after the completion of an M&A (e.g. Maksimovic *et al.*, 2011; Li, 2013). However, our results suggest that differences in taxation are relevant with regard to the magnitude and the speed of such adjustments. For instance, our results suggest that firms reallocate less activity away from targets that are located in low-tax locations. This distortion hampers the realization of productivity gains in these firms and thus has a negative impact on the overall productivity gain in the merged enterprise.

We complement our analysis using the event study design described above. Results are displayed in Figure 2 which plots the coefficients of the interactions between the event dummies and the tax rate differential against the number of years relative to the merger completion. In panel (a), the dependent variable is the TFP of the combined firm. After an M&A is completed, TFP declines relative to one year prior to the merger. This decrease is persistent over time and even increases in later periods. Panels (b) and (c) present results for acquirer and target firms separately. For the latter, we observe a significant decrease in TFP two and three years after the merger. This suggests that the effect of tax rate differentials on merger-induced productivity continues at least over the medium run. In contrast, there is no effect of tax rate differentials on TFP of the acquirer neither before nor after the merger.

Turning to the effect of the tax differential on employment, we observe in panels (d) and (e) that it has opposite directions for the target and the acquirer. Relative to the year before the merger, employment significantly increases in the target from 2 years after the M&A completion onward. The effect increases over time. For the acquirer, the effect is negative, albeit of much smaller magnitude. It only persists in the short-run but is zero in year 4 after the merger. The impact of tax differences on capital is less clear-cut. There is a marginally significant positive effect on target capital two years after the M&A is executed but this quickly reverses. For the acquirer, we find no significant change in capital in any post-merger year. These results point to employment as the factor whose adjustment is affected most strongly by tax differences between target and acquirer firm. At least for the acquirer, these responses are not quickly reversed but continue over a substantial period of time. For capital, the effect is less pronounced which probably reflects that adjustment cost is higher for this factor as indicated, for example, by Hall (2004).

In none of the event study analyses do we observe a significant response of the outcome variable prior to the merger.[21] This rules out that pre-merger trends in the outcome variable drive our results and strongly points to the M&A completion as the event that triggers the effect of the tax differential which strengthens the causal interpretation of our results.

6 Conclusion

In this paper, we investigate how the productivity change after corporate M&As is affected by differences in profit taxation between the target and the acquirer location. In our theoretical model, tax differentials between the locations of firms involved in an M&A distort the

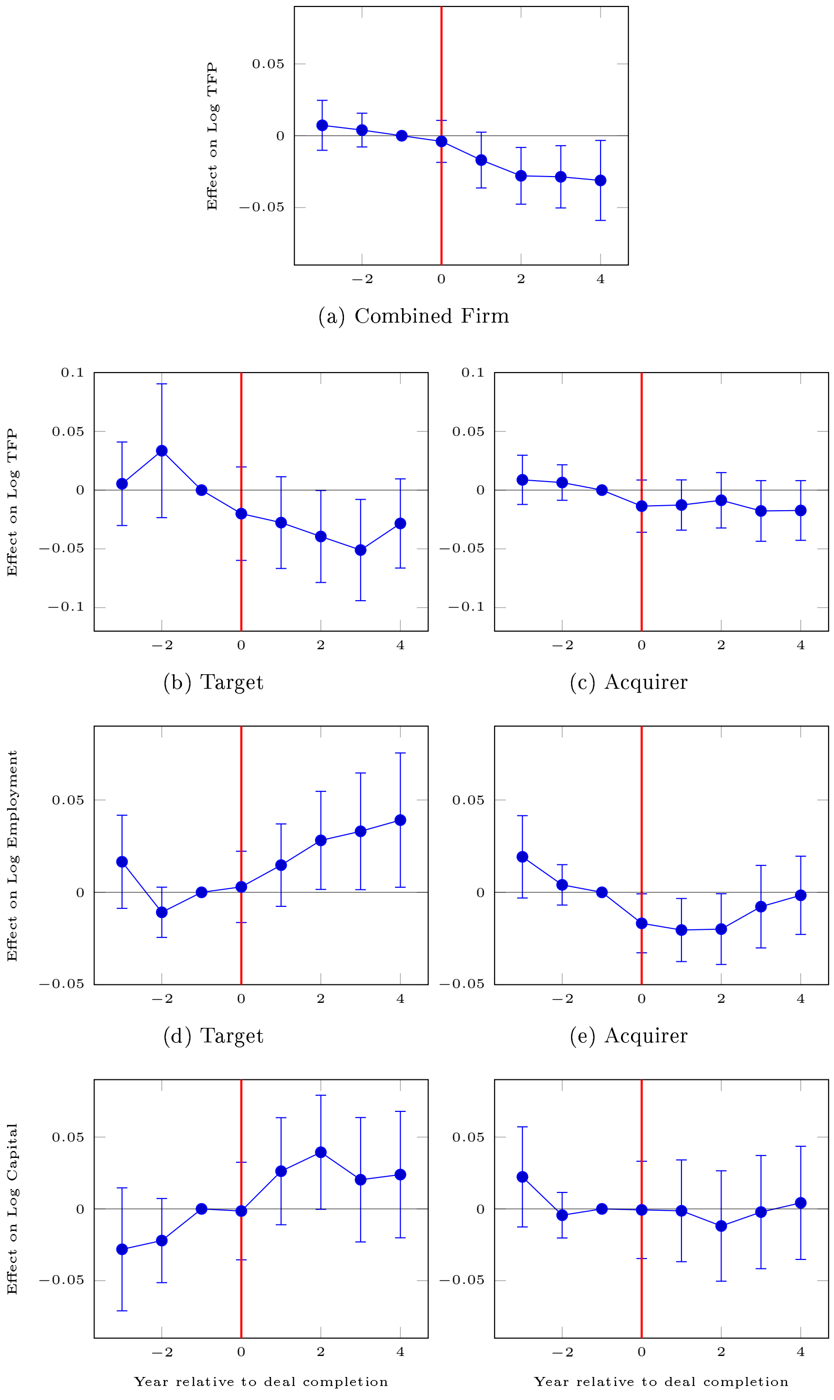
[21]The graphical observation is confirmed using a Wald test for the joint insignificance of the interaction of the pre-merger dummies with the absolute tax rate differential.

Table 9: Panel Regression: Capital

OLS regression. The dependent variable is the logarithm of tangible fixed assets of the target firm in columns (1)-(2) and the acquirer firm in columns (3)-(4). All regression results contain country-level controls for which estimated coefficients are reported in Table A.4 in the Appendix. Cluster robust standard errors (clustered at the firm level) are provided in parentheses. All regressions include firm and industry-year fixed effects. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	Assets			
	(1)	(2)	(3)	(4)
	Target	Target	Acquirer	Acquirer
$POST$	-0.065	-0.083	-0.009	-0.049
	(0.440)	(0.436)	(0.348)	(0.344)
$POST \times \Delta\tau$	0.031*		-0.005	
	(0.017)		(0.018)	
$POST \times \Delta\tau^-$		0.040**		-0.014
		(0.018)		(0.021)
$POST \times \Delta\tau^+$		0.023		0.011
		(0.026)		(0.021)
$POST\times$Cross-border	0.118	0.113	-0.135	-0.137
	(0.193)	(0.188)	(0.153)	(0.150)
$POST\times$Hostile	-0.274	-0.275	-0.227	-0.220
	(0.290)	(0.290)	(0.139)	(0.140)
$POST\times$Stock-for-Stock	-0.169	-0.190	2.061***	2.093***
	(0.351)	(0.356)	(0.313)	(0.315)
$POST\times$Capital Increase	0.040	0.039	-2.315***	-2.333***
	(0.244)	(0.245)	(0.185)	(0.184)
$POST\times$Horizontal	0.089	0.090	-0.081	-0.077
	(0.092)	(0.092)	(0.068)	(0.067)
$POST\times$Toehold	-0.033	-0.029	0.139	0.142
	(0.174)	(0.173)	(0.183)	(0.183)
$POST\times$Acquirer Listed	0.198	0.195	0.224	0.235
	(0.178)	(0.180)	(0.143)	(0.143)
Leverage (Acq.)	0.000	0.000	0.036	0.037
	(0.000)	(0.000)	(0.055)	(0.055)
Leverage (Tgt.)	0.081***	0.081***	0.038**	0.037**
	(0.030)	(0.030)	(0.018)	(0.018)
Log Age (Acq.)	-0.220*	-0.209	0.250**	0.249**
	(0.132)	(0.131)	(0.109)	(0.108)
Log Age (Tgt.)	0.205	0.204	0.181*	0.187*
	(0.139)	(0.139)	(0.104)	(0.103)
Country-level controls	Yes	Yes	Yes	Yes
N	5,075	5,102	5,084	5,111
R^2	0.199	0.198	0.307	0.307

Figure 2: Event Study



(a) Combined Firm

(b) Target

(c) Acquirer

(d) Target

(e) Acquirer

(f) Target

(g) Acquirer

Standard errors are clustered on firm level. 95% confidence intervals are reported. Estimations include firm-fixed and industry-year-fixed effects.

post-merger reallocation of productive activity. If tax differences are large enough, firms assign some activity to units that are less productive but more profitable due to a lower tax burden. With respect to overall productivity in the combined firm, this choice is inefficient and reduces the productivity gain after the M&A.

We then employ firm-level data to test this notion empirically. First, we derive firm-level estimates of TFP using the Levinsohn & Petrin (2003) method. We then compute the merger-induced change in TFP in the combined firm and relate it to the absolute value of the difference between the effective tax rate on profits received from the target in the form of inter-corporate dividends and the tax rate applied to profits generated by the acquirer. Our results suggest that an increase in the absolute tax differential by one percentage point reduces the merger-induced productivity gains by 4.5%. Consistent with our expectation that tax differentials are less distortive if firms are able to reattribute part of their profit from high-tax to low-tax locations, we find that the impact of the tax differential is mitigated when transfer pricing regulations are less strict such that firms can more easily engage in profit shifting. In a complementary analysis, we explore the mechanisms that drive the impact of tax differences on overall firm productivity. Our findings indicate that the effect is asymmetric. It is mainly driven by M&A deals where firms located in high-tax countries acquire a firm in a low-tax country and fail to efficiently adjust the input factors of production in the target to fully realize the productivity gain. In contrast, tax differentials that would induce a relocation of activity to the acquirer location have no significant impact on overall firm productivity. This probably reflects the observation that post-merger adjustment relative to firm size is usually much larger in the target entity.

An important limitation to our analysis, which is inherent to many empirical studies of corporate M&A, is that we only observe completed deals. Both potential productivity gains and the tax differential affect the expected benefit from an M&A deal in terms of future profits. These factors may thus influence whether or not a deal is completed. In particular, we may be less likely to observe M&As with low productivity gains and small tax differentials because these deals lack two important sources of future benefits. Due to the large number of domestic deals, this is, however, not observed in practice. Alternatively, productivity gains and tax rates may interact in their potential to increase post-merger returns. However, they do so only with respect to the *level* of tax rates in the individual locations. An increase in production is more valuable if the resulting profit is taxed at a lower rate. However, there is no obvious interaction in this regard between productivity gains and the tax rate *difference*. Thus, even though our estimations are exposed to biases similar to those of other M&A studies, this is unlikely to drive our empirical results. In particular, the results of an event study analysis reject the presence of pre-merger trends which strengthens the causal inference from our estimations.

The findings of this paper have several important implications. First, they point to a potential advantage of tax regimes that are neutral with respect to the location of investment. These are mainly regimes with high domestic corporate tax rates that avoid international double taxation through a credit on foreign tax payments such as the United States. In contrast, systems that exempt foreign profits from domestic taxation usually imply effective international tax differences. Devereux *et al.* (2015) suggest higher tax administration costs as a potential motive for switching from a credit to an exemption regime despite the distortive impact of the latter. In the light of our findings, these benefits should, however, be carefully weighted against negative effects on the efficiency of international factor allocation.

Second, tax differentials turn out to be an additional impediment to cross-border knowledge flows that has so far been largely ignored. Given that a large fraction of conventional trade barriers has been eliminated in comprehensive bilateral and multilateral agreements, substantial differences in tax policy across countries are likely to emerge as an important obstacle to the international transmission of technology.

Finally, while the analysis of firm reactions to international tax competition has so far mostly focused on its relevance for financial accounting (see Hines Jr, 1999), our results highlight that differences in taxation are also harmful in real terms by reducing productivity growth. We show that firms make real adjustments not only with respect to the level of domestic tax rates but also with regard to the international tax system. Furthermore, in contrast to financial effects such as profit shifting for which tax competition between developed countries and so-called tax havens is an important driver, the real effect that we identify in this paper mainly refers to tax differentials between developed economies. These are more likely to be linked by real cross-border investments and are thus more exposed to the negative impact of distortive tax rate differences.

Appendix

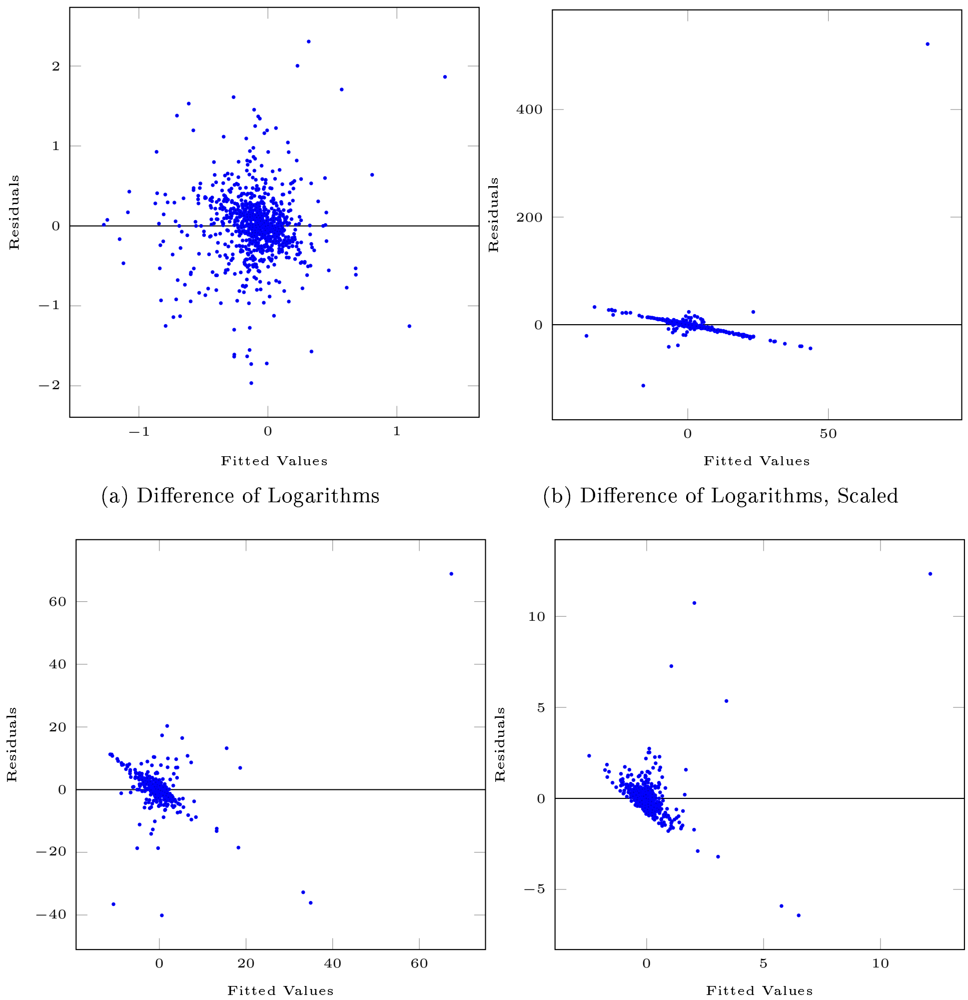
A.1 Productivity Estimation Data Sample

We obtain unconsolidated balance sheet data for the productivity estimation from Bureau van Dijk's ORBIS and AMADEUS databases. In a first step, missing values are imputed as described in Gal (2013). In particular, firm value added is replaced by the sum of operating revenue and material cost if missing. Conversely, material cost is replaced by the difference between operating revenue and value added if both items are available.

The second step is to eliminate inconsistent data points from the sample. We drop all firm-year observations with a sum of EBIT and cost of employees that is not strictly positive. Furthermore, we drop observations with negative operating revenue or material cost as well as those with total assets below 1,000 USD. Further potential mistakes in the accounts are captured by deleting extreme outliers. We drop observations for which any of the following ratios lies below the 0.1% or above the 99.9% quantile of the sample within a year: operating revenue to total assets, number of employees to total assets, number of employees to operating revenue, operating revenue less material cost to operating revenue, operating revenue less material cost to number of employees. We also drop observations where the sum of fixed intangible assets, fixed tangible assets and other fixed assets does not add up to a figure that is close to the entry for total fixed assets ($\pm$5%).

Finally, we adjust the balance sheet items for inflation and cross-border differences in purchasing power to obtain the evolution of productive factors and output in real terms. For this purpose we apply the GDP deflator and the Purchasing Power Parity conversion factor for the GDP for 2005 prices to the nominal balance sheet items.

Figure 3: Transformations of Dependent Variable



(a) Difference of Logarithms

(b) Difference of Logarithms, Scaled

(c) Simple Difference

(d) Simple Difference, Scaled

A.2 Choice of Specification

There are several ways to transform the dependent variable in the deal-level regression model. Here, we consider four alternatives: the simple difference of TFP before and after the merger, $\hat{\Gamma}_{jlk} = A_j^{Post} - A_j^{Pre}$, the simple difference scaled by TFP before the merger, $\hat{\Gamma}_{jlk} = \frac{A_j^{Post} - A_j^{Pre}}{A_j^{Pre}}$, the difference in logarithms, $\hat{\Gamma}_{jlk} = \ln A_j^{Post} - \ln A_j^{Pre}$ and the difference in logarithms scaled by the logarithm of TFP before the merger, $\hat{\Gamma}_{jlk} = \frac{\ln A_j^{Post} - \ln A_j^{Pre}}{\ln A_j^{Pre}}$. We regress each of these measures on the absolute tax differential $\Delta\tau_{jlk}$ and a set of fixed effects which corresponds to the model estimated in column (1) of Table 5 and plot the fitted values against the residuals. These plots are presented in Figure 3. Among the suggested transformations, only the difference in logarithms, depicted in the upper left panel, generates a random pattern that is required to assume a linear relationship after transforming the dependent variable. All other transformations generate a non-random pattern of residuals which implies that heteroskedasticity of the error terms is inherent in these models.

A.3 Additional Control Variables

Table A.1: Results for Country-level Controls of Regression Table 5

This table contains the coefficients for the OLS regressions of columns (2), (3), (5) and (6) of Table 5. Cluster robust standard errors (clustered at the acquirer-target country-pair level) are provided in parentheses. All regressions include firm- and year-fixed effects. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	Change in Total Factor Productivity			
	(2)	(3)	(5)	(6)
CIT (Tgt.)	-0.575	-0.108	-0.659	-0.366
	(2.072)	(2.082)	(2.142)	(2.143)
Wage Difference	3.315	1.925	3.135	1.373
	(2.576)	(2.509)	(2.561)	(2.509)
GDP p.c. Growth (Acq.)	-3.857*	-3.351	-3.806*	-3.202
	(2.201)	(2.115)	(2.170)	(2.053)
GDP p.c. Growth (Tgt.)	4.150*	3.052	4.095*	2.888
	(2.366)	(2.091)	(2.350)	(2.054)
Log GDP (Acq.)	-2.910	-1.303	-2.716	-0.711
	(2.233)	(2.137)	(2.240)	(2.159)
Log GDP (Tgt.)	2.143	1.247	1.959	0.684
	(2.195)	(2.110)	(2.208)	(2.107)
EU Member	0.017	-0.101	0.012	-0.115
	(0.366)	(0.390)	(0.368)	(0.391)
Log Distance	0.019	0.013	0.018	0.009
	(0.080)	(0.067)	(0.081)	(0.067)

Table A.2: Results for Country-level Controls of Regression Table 6

This table contains the coefficients for the control variables in the OLS regressions of columns (2), (3), (5) and (6) of Table 6. Cluster robust standard errors (clustered at the acquirer-target country-pair level) are provided in parentheses. All regressions include firm- and year-fixed effects. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	Change in Total Factor Productivity			
	(2)	(3)	(5)	(6)
Cross-border	0.086	0.060	0.101	0.083
	(0.147)	(0.131)	(0.148)	(0.147)
Hostile	-1.001**	-0.226	-0.972**	-0.968**
	(0.403)	(0.327)	(0.408)	(0.409)
Stock-for-Stock	0.292*	0.266	0.264	0.276
	(0.171)	(0.192)	(0.179)	(0.175)
Capital Increase	-0.344***	-0.368***	-0.331***	-0.327***
	(0.096)	(0.083)	(0.095)	(0.096)
Horizontal	-0.040	-0.021	-0.041	-0.041
	(0.034)	(0.026)	(0.034)	(0.034)
Toe	0.052	0.120	0.054	0.054
	(0.094)	(0.095)	(0.093)	(0.093)
Relative Size	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Leverage (Acq.)	0.029	0.003	0.034	0.031
	(0.041)	(0.039)	(0.042)	(0.042)
Acquirer Listed	-0.067	-0.051	-0.071	-0.074
	(0.046)	(0.043)	(0.046)	(0.048)
Log Age (Acq.)	-0.009	0.000	-0.011	-0.012
	(0.016)	(0.020)	(0.016)	(0.016)
CIT (Tgt.)	-0.918	-0.292	-0.823	-0.806
	(1.899)	(1.919)	(1.904)	(1.936)
Wage Difference	3.089	1.745	2.958	2.828
	(2.443)	(2.407)	(2.748)	(2.467)
GDP p.c. Growth (Acq.)	-4.167*	-3.731*	-3.884*	-4.023*
	(2.171)	(2.037)	(2.144)	(2.139)
GDP p.c. Growth (Tgt)	4.702**	3.477	4.417*	4.510*
	(2.344)	(2.097)	(2.334)	(2.282)
Log GDP (Acq.)	-2.866	-1.193	-3.042	-2.704
	(2.104)	(2.035)	(2.417)	(2.195)
Log GDP (Tgt.)	1.752	0.953	2.124	1.726
	(2.090)	(2.021)	(2.438)	(2.152)
EU Member	0.010	-0.114	-0.004	0.020
	(0.360)	(0.394)	(0.374)	(0.366)
Log Distance	-0.032	-0.018	-0.031	-0.023
	(0.080)	(0.067)	(0.078)	(0.075)

Table A.3: Results for Country-level Controls of Regression Table 7

This table contains the coefficients for the OLS regressions of Table 7. Cluster robust standard errors (clustered at the firm level) are provided in parentheses. All regressions include firm and industry-year fixed effects. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	(1) Combined Firm	(2) Combined Firm	(3) Target Firm	(4) Target Firm	(5) Acquirer Firm	(6) Acquirer Firm
CIT (Tgt.)	1.049*	1.134**	0.105	0.063		
	(0.568)	(0.567)	(0.831)	(0.829)		
CIT (Acq.)					1.963***	2.024***
					(0.599)	(0.598)
Wage Difference	1.274	1.176	3.343**	3.057**	0.614	0.739
	(1.213)	(1.190)	(1.392)	(1.373)	(1.395)	(1.363)
GDP p.c. Growth (Acq.)	0.869	0.896	1.334	1.307	0.493	0.502
	(0.568)	(0.560)	(0.823)	(0.798)	(0.619)	(0.614)
GDP p.c. Growth (Tgt.)	-0.414	-0.385	-2.037***	-2.012***	0.384	0.455
	(0.501)	(0.488)	(0.788)	(0.747)	(0.606)	(0.595)
Log GDP (Acq.)	-1.416	-1.354	-2.878*	-2.779*	-1.309	-1.329
	(1.087)	(1.069)	(1.516)	(1.483)	(1.298)	(1.279)
Log GDP (Tgt.)	1.099	1.091	1.506	1.526	1.278	1.308
	(1.091)	(1.078)	(1.434)	(1.406)	(1.318)	(1.307)
$POST \times$EU Member	0.193	0.183	0.069	-0.016	0.153	0.157
	(0.124)	(0.113)	(0.175)	(0.179)	(0.111)	(0.103)
$POST \times$Log Distance	0.107***	0.109***	0.151***	0.166***	0.082	0.081
	(0.040)	(0.040)	(0.057)	(0.058)	(0.053)	(0.052)

Table A.4: Results for Country-level Controls of Regression Tables 8 and 9
This table contains the coefficients for the OLS regressions of Table 8 in columns (1a)-(4a) of Table 9 in columns (1b)-(4b). Cluster robust standard errors (clustered at the firm level) are provided in parentheses. All regressions include firm and industry-year fixed effects. Stars behind coefficients indicate the significance level, * 10%, ** 5%, *** 1%.

	Employment				Assets			
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)	(4b)
	Target	Target	Acquirer	Acquirer	Target	Target	Acquirer	Acquirer
CIT (Tgt.)	0.949	0.899			-1.794	-1.617		
	(0.736)	(0.717)			(1.247)	(1.238)		
CIT (Acq.)			0.230	0.151			-0.864	-0.941
			(0.592)	(0.591)			(1.068)	(1.062)
Wage Difference	1.706	0.949***	-0.547	-0.467	0.498	1.052	2.160	1.712
	(1.349)	(0.213)	(1.186)	(1.174)	(2.266)	(2.298)	(2.062)	(2.036)
GDP p.c. Growth (Acq.)	1.045	1.156*	0.303	0.327	0.584	0.461	-0.045	0.119
	(0.755)	(0.696)	(0.526)	(0.526)	(1.062)	(1.045)	(0.979)	(0.938)
GDP p.c. Growth (Tgt.)	-0.698	-0.529	0.160	0.177	-0.383	-0.260	0.144	-0.033
	(0.758)	(0.709)	(0.480)	(0.475)	(1.038)	(1.013)	(0.934)	(0.881)
Log GDP (Acq.)	-1.494	-0.094	-0.006	-0.018	-0.273	-0.491	-2.670	-2.494
	(1.419)	(0.088)	(1.114)	(1.110)	(2.525)	(2.536)	(2.010)	(1.991)
Log GDP (Tgt.)	1.970	0.195**	0.243	0.237	1.001	1.083	2.010	1.885
	(1.364)	(0.095)	(1.090)	(1.089)	(2.438)	(2.438)	(1.976)	(1.966)
$POST \times$EU Member	0.090	0.085	-0.037	-0.021	0.088	0.132	-0.227*	-0.190
	(0.166)	(0.145)	(0.091)	(0.084)	(0.217)	(0.197)	(0.130)	(0.125)
$POST \times$Log Distance	0.045	0.004	0.035	0.032	-0.052	-0.056	0.053	0.052
	(0.049)	(0.048)	(0.039)	(0.038)	(0.090)	(0.089)	(0.068)	(0.067)

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