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Tariff Rates, Offshoring and Productivity: Evidence from German and Austrian Firm-Level Data

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Abstract

This paper studies the impact of trade liberalization in terms of tariff cuts within the Eastern European enlargement on German and Austrian firm productivity. Unique matching of data from 1994 to 2003 suggests that tariff reductions raise parent firm productivity significantly. A ten percentage point decrease in tariff rates can lead to total factor productivity gains of up to 2 percent. The data allow distinction between three types of tariffs: output, intra-firm and input tariff rates. The size of the results strongly depends on the type of tariff and country analyzed.

JEL classification: **F12; F13; F23; L22; L23; O14**

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1 Introduction

The ongoing process of trade liberalization has removed much protectionism. Worldwide it has gone so far that the Economist Intelligence Unit[1] has found that business executives' fear of protectionism is relatively low compared with, for example, worries about a recession (*The Economist* 2008). *The Economist*'s article (2008) reports that the Doha round and trade barriers are seen as increasingly unimportant. On the one hand, it justifies the question whether there is additional need to study the impact of liberalized trade. On the other hand, trade liberalization is important. Conversely, owing to a new threat of protectionism, *The Economist* (2008, p.30) also argues that "multilateralism matters more than ever": inter alia, it mentions the "symbolic importance" (The Economist 2008, p.30) of Doha, restricted investments (Marchick and Slaughter 2008), as well as raised food demand, oil production quotas and relative scarcity (Mattoo and Subramanian 2008). Moreover, a recent study by Amiti and Konings (2007) focus on the importance of tariffs and the firm's international value chain, analyzing the impact of liberalized trade on intermediate inputs and productivity. Marin (2008) points out the importance of international trade through a rise in intra-firm trade and the development of international value chains. There is continuing importance of trade liberalization and its broad impact on micro as well as macro perspectives.

Trade liberalization and its impact on firm productivity are studied in different ways and for a wide span of countries. On this note there are different definitions of liberalized trade and its link to productivity. As stated by Amiti and Konings (2007), however, only a few papers study the effect on productivity of liberalized trade in terms of both output and input tariffs. Moreover, there is, to the best of my knowledge, no study about German and

[1] A sister company to *The Economist*; see *The Economist* (2008).

Austrian trade liberalization with regard to Eastern Europe. That is, there is no empirical evidence about liberalized offshoring via tariff cuts which distinguishes between different kinds of tariff rates and their impact on total factor productivity.

Particularly in the case of Germany and Austria, however, this topic is of paramount interest. First, because of the German unification in 1990 there are significant productivity differences among regions and firms, especially between the services and manufacturing sectors (Temouri et al. 2008). Second, as argued by Marin (2008), a fact of increased global competition is that Germany and Austria are the countries most affected by Eastern enlargement. They are the most important investors in Eastern European countries. Up to two-thirds of total imports within the European Union (EU27) can be ascribed to intra-firm imports between old and new EU member states. The German Federal Statistical Office (2008b) indicates that 60 percent of German companies undertaking offshoring decide in favor of the new EU member states. Within this group of firms more than 60 percent relocate their core functions and auxiliary functions, respectively. Third, within these offshoring activities firms reorganize their structure towards flatter hierarchies resulting in easier communication, greater responsibility and greater firm productivity (Marin 2008, Marin and Verdier 2008). Fourth, Germany and Austria are internationally the most integrated countries within the European Union (Marin 2008). For instance, Germany's medium-sized firms are the greatest exporters compared with other European countries like France or Italy (Mayer and Ottaviano 2007a). Moreover, Marin (2008) shows that trade openness with new member states - measured in imports plus exports over GDP - increased from 1994 to 2006 in Austria by 7.2 percentage points and in Germany by 5.4 percentage points. Fifth, there are considerable effects of trade liberalization in terms of tariff cuts the firms may respond to.[2] This

[2] More details on this follow in Section 4.3.

promotes intra-industry competition which in turn boosts productivity and therefore GDP growth (Mayer and Ottaviano 2007a).

This study deals with the analysis of tariff reductions and their impact on German and Austrian productivity. Motivated by theoretical papers like those of Grossman and Helpman (1991), Feenstra et al. (1992), Acemoglu and Zilibotti (2001), Melitz (2003), and Luong (2008), the findings are in favor of supporting trade liberalization. That is, as argued by Melitz (2003), liberalized trade exposes domestic firms to increased competition which forces inefficient establishments to exit the market. This in turn shifts the average productivity up. The described selection effect (Melitz 2003), however, does not raise within-firm productivity. Productivity growth within each firm is provided by improved access to cheaper inputs, higher quality, foreign technology (Grossman and Helpman 1991) and a greater variety of intermediates (Dixit and Stiglitz 1977, Feenstra et al. 1992, Acemoglu and Zilibotti 2001). As argued by Luong (2008) the impact of improved access to foreign inputs via tariff cuts depends on both the affected tariff rate (output vs. input tariffs) and the elasticity of substitution between existing and newly available intermediate inputs. The effects of tariff cuts on productivity gains are estimated by Amiti and Konings (2007). Section 2 gives an extensive overview of existing empirical studies and their main differences.

Following Amiti and Konings (2007), the results of this paper are presented in two steps. In the first step I estimate the firm-specific TFP for each two-digit ISIC sector using different dependent variables and regression methods for Austria and Germany separately. The second stage presents the estimation results of productivity on tariff rates. In contrast with Amiti and Konings (2007), intra-firm tariffs are included that capture the offshoring relationship between parent firms and their Eastern European affiliates. The results of this step are obtained at plant level. The underlying sources are the *Amadeus* database provided by the Bureau van Dijk (Bureau van Dijk, Electronic Publishing 2005), the *WITS* database (World Bank and UNCTAD 2008) and a unique set of German and Austrian investments in Eastern Europe matched for the years 1994 to 2003.[3]

The study finds empirical evidence for a significant negative impact of tariffs on firm-level total factor productivity. In line with the small amount of existing literature which distinguishes between different kinds of tariffs, the effect of input tariffs exceeds that of intra-firm as well as output tariffs. The impact for a ten percentage point decrease in the tariff rates raises firm productivity between 0.3 and 2.0 percent depending on the type of tariff and country. Reducing tariffs on output goods by ten percentage points can lead to productivity gains at firm-level of 0.4 percent, whereas reducing tariffs on intermediate inputs by ten percentage points can lead to productivity gains of up to 1.6 percent. The results of reducing intra-firm tariffs by ten percentage points suggests productivity gains of 0.7 percent. The effect of liberalized trade is greater for Austria than for Germany. Moreover, foreign-owned firms located in Germany and Austria seem to benefit more from tariff cuts compared with domestic firms. Their total factor productivity gains are greater by 0.2 to 0.5 percentage points. The results also suggest that a fraction of the positive impact of offshoring on productivity is induced by reduced tariff rates. Comparison of the results with the existing literature about Brazil or Indonesia shows that the effect of Eastern European trade liberalization for Germany and Austria is much smaller. This can be traced back to some quite intuitive facts. First, Indonesia is a developing country far from the technological frontier, suggesting larger marginal effects. Second, liberalized trade with Eastern Europe explains only part of German and Austrian trade activities.

The paper is structured as follows. Section 2 gives a review, by no means exhaustive, of the related empirical literature to which the paper refers.

[3] A more detailed description of the underlying datasets follows in Section 3.

In particular, this section emphasizes the study and underlying estimation method of Amiti and Konings (2007), which provides the main motivation for this analysis. Section 3 gives an overview of the data. Section 4 describes the underlying estimation methodology, illustrates the construction of the total factor productivity and tariff variables in more detail, and gives some descriptive facts about tariff rates and the firms' productivity. Section 5 presents the estimation results of liberalized trade in terms of reduced tariffs on TFP. Section 6 gives evidence for the robustness of the empirical findings. Section 7 concludes.

2 Literature Review

This section summarizes the existing literature on the relationship between liberalized trade and firm productivity. More precisely, it cites empirical studies about the impact of trade liberalization on firms' total factor productivity. After considering this set of empirical literature arranged by country and underlying samples, the section focuses on the Indonesian study by Amiti and Konings (2007).

2.1 Related Literature

Beside the theoretical papers mentioned in the introduction a huge amount of empirical literature has addressed, both directly and indirectly, the relationship between trade liberalization and productivity.

An important strand of literature studies empirically the relationship of imports and exports with productivity. For Japanese firms, Tomiura (2007) finds that corporations investing abroad are the most productive firms. Similarly, Sjoholm (1999) argues that Indonesian firms in the manufacturing industry show increased productivities with an increasing amount of exports.

Moreover, Muuls and Pisu (2007) find that not only exports count. Their data for Belgium suggest that firms that export and import are the most productive. The same evidence for Italian firms is provided by Castellani et al. (2008). German plant level data studied by Wagner (2002) suggest that exporting firms are associated with higher labor productivity.[4] Moreover, Vogel and Wagner (2008) also give evidence for an existing self-selection in Germany. They find a positive impact of firms' productivity on their import activities.[5] In terms of Eastern Europe, Hagemejer and Kolasa (2008) find within their study on Polish data that internationalized firms are the most productive. Halpern et al. (2005) study the contribution of imports to Hungarian productivity. Their results on firm-level data show productivity boosted through access to a larger variety and different qualities of imported intermediate inputs as well as reallocation of output-determining input variables. Within the theoretical framework it is implied that the access to foreign inputs, the relative quality, and the reallocation of capital and labor can raise productivity. Using the Olley-Pakes approach (1996), Halpern et al. (2005) enhance the unobserved productivity function by the number of varieties imported. This circumvents the problem of zero investment report.[6] Halpern et al. (2005) find that from 1992 to 2001 a ten percentage point increase in the share of imports raised TFP by 1.8 percent. Aggregating the firm-level data the authors find that imports explain 30 percent of aggregated productivity growth. One half of the whole effect can be separated into the reallocation of inputs, and the other half can be traced back to import activities.

All these studies explain possible productivity boosts and related problems mainly in terms of an underlying self-selection problem. None of them,

[4] See also Bernard and Wagner (1997) and Bernard and Jensen (1999), p.2ff.

[5] See also Altomonte and Bekes (2008), who find that self-selection holds for both importing and exporting firms.

[6] The authors point out that 25 percent of the firm data report zero investments.

however, takes account of potential triggers for rising import and export activities. That is, none of them studies the effect of liberalized trade on total factor productivity in terms of quotas, reduced tariffs or other trade policy variables.

Kasahara and Lapham (2008) consider the link between trade liberalization and intermediates, exports and productivity. Reduced trade restrictions allow for a larger amount of imported intermediates. This in turn raises productivity within the firm, which itself allows for exports. A greater demand for labor forces the less efficient firms to exit the market. De Loecker (2007a) finds that relaxing product-specific level and quota restrictions leads to productivity gains in the Belgian textile industry. Using an enhanced Olley-Pakes methodology (1996) for the production function estimations that additionally controls for unobserved price variable biases (De Loecker 2007a, p.22ff), the author finds productivity gains of 4 percent. Liberalized trade forces the inefficient producers to exit, which leads to an increase in average productivity (De Loecker 2007a, p.3ff). In Bernard et al. (2006) reduced trade costs, measured by changes in tariff and freight costs, have a positive impact on productivity growth, a negative effect on plant death and are positively associated with a switch from being a non-exporter to being an exporter as well as export growth.

A positive effect of trade liberalization on productivity is also found by Pavcnik (2002). Her data on Chilean plants in the manufacturing industries yield an aggregated rise in total factor productivity of 19 percent. On the plant level she argues that there is a difference between producers acting in import-competing sectors and plants acting in non-traded goods sectors. The effect of liberalized trade on non-traders and traders ranges between 3 and 10.4 percent, respectively, and is because of "reshuffling (of) resources from the less to more efficient plants [...]." (Schor 2004, p.261). Plants with inefficient production are forced to close down owing to foreign competition

(Schor 2004, p.265).[7] Another study on Chilean manufacturing is presented by Alvarez and Crespi (2007). Their study does not give direct evidence of liberalized trade effect on productivity. The authors study the determinants of the convergence of low-productivity firms on the technological frontier for Chilean plant-level data under (almost) free trade policy from 1979 to 1998 (Alvarez and Crespi 2007, p.3). Using the Levinsohn-Petrin technique (2003) for the productivity estimations at the three-digit industry level shows that the plant-specific productivity gap interacting with the share of foreign firms has a significant positive effect on productivity growth. Therefore it suggests that domestic firms benefit from access to foreign technology. This positive effect of importing intermediate inputs in the Chilean manufacturing industry is more precisely studied by Kasahara and Rodrigue (2008). Using a wide range of estimation techniques their results suggest that importing foreign inputs increases firm productivity by at least 2.6 percent.

Empirical results for trade liberalization in terms of a Free Trade Agreement (FTA) and reduced tariffs on productivity are more precisely studied by the following authors. Head and Ries (1999) study the impacts of FTA on output. After introducing their theoretical part, which considers different models of imperfect competition, the authors test their predictions on Canadian industry data. At industry level Canadian tariff reductions of ten percentage points reduce output by at least 11.3 percent. In contrast, a reduction of the same amount in US tariff rates increases output by 16 percent. Summarizing their findings, Head and Ries (1999, p.309ff) show that both tariff reductions offset each other in their impact on outputs. The impact of the Canadian-U.S. FTA on productivity is studied by Trefler (2004). His study offsets the short-run costs with the long-run benefits of the country-specific changes in FTA-mandated tariff concessions. Estimates of tariff concession effect on employment growth and labor productivity shows

[7] See also Luong (2008), p.2ff.

an employment loss between 12 and 24 percent for Canada and a loss of 3 percent for the US in the short run. In contrast, tariff concessions show long-run gains owing to increasing labor productivity ranging between 8 and 15 percent for Canada and between 4 and 14 percent for the US.[8] The largest, 15 percent, rise in labor productivity can be ascribed to import competition effects (Trefler 2008, p.880).

Tybout and Westbrook (1995) find that Mexican tariff rates are on the one hand positively correlated with costs and on the other negatively correlated with productivity growth. Therefore liberalized trade shifts the average cost curve downward and raises sector-specific efficiency. Fernandes (2007) explores the impact of nominal tariffs on Colombian plant productivity. Calculation of TFP in accordance with Levinsohn and Petrin (2003) shows that a 10 percentage point tariff cut raises productivity between 0.8 and 2.9 percent. Because the effect is greater for firms with higher imports of intermediate inputs, the author argues that one channel is the access to foreign innovations (Fernandes 2007, p.68). All these studies present results for the impact of output tariffs. The measurement and potential link of input tariffs with productivity are still missing.[9]

Schor (2004) studies the impact of nominal output and input tariff rates on TFP of 27 Brazilian sectors at the two-digit SIC level. Her estimates for manufacturing firms from 1986 to 1998 show a significant negative effect of both tariff measures on productivity. With the Olley-Pakes technique (1996) adding input tariffs reduces the coefficient of nominal tariffs and yields predicted impact of the input tariffs' coefficient, which gives between 1.5 and 2.7 percent productivity gains for a ten percentage point tariff cut. Schor (2004) argues that the results give evidence of two effects. The first one is the import competition effect reflected by the estimates for nominal tariffs. The

[8] The results depend on the estimation methods as well as on the underlying data (industry versus plant-level data).

[9] See also Luong (2008), p.2.

second effect is the improved access to foreign technology derived from the negative coefficient for input tariff rates (Schor 2004, p.390). These links for the Brazilian manufacturing sectors are more precisely studied by Muendler (2004). He finds that the effect of increasing foreign competition on the product market raises firm productivity enormously. The impact of foreign inputs is not, however, as large as expected; it is more the effect of inefficient firms leaving the market which leaves the internal productivity untouched.

A famous example of trade liberalization effect on productivity is the case of India. Beside the more recent studies by Goldberg et al. (2008) and Topalova (2004), Krishna and Mitra (1998) find evidence that the trade reform in India has a positive association with productivity growth. Their dummy model of liberalized trade in 1991 shows between 3 and 6 percent productivity growth. Topalova (2004) finds average productivity gains of 0.5 percent induced by a ten percentage point tariff cut. Similarly to Krishna and Mitra (1998), apart from the mentioned outcome she also finds a faster productivity growth rate using manufacturing industry and plant level data from 1986 to 1993. Goldberg at al. (2008) put more emphasis on the role of input tariffs. Their findings of a reduction in the input tariff rates in India suggest that trade liberalization makes imported intermediates cheaper and gives firms access to a greater variety of new inputs and foreign technology. This in turn increases domestic variety. To sum up their findings, lower tariff rates raise imported varieties in intermediate as well as in final good sectors. Lowering input tariffs by ten percentage points increases, among other things, total factor productivity by 4.5 percent.

Amiti and Konings (2007) find empirical evidence of plant productivity gains for Indonesian firms because of trade liberalization. A cut in both output and input tariffs raises productivity via increasing competition and variety as well as quality effects. The particular role of the growth of input tariffs is shown by the study. The productivity gains of tariff reductions on intermediate inputs is significantly negative and ranges from 3 percent for non-importing firms to 12 percent for importing firms. These findings as well as the underlying methodology are the subject of the following subsection. Closely related is Luong's (2008) study about Mexican data. Similarly to Amiti and Konings (2007), Luong (2008) distinguishes between output and input tariffs but additionally shows that there is a difference between high and low differentiated products. There is a rise in firm total factor productivity owing to lower input tariffs if inputs are highly differentiated. Productivity also increases owing to lower output tariffs if intermediate inputs are not highly differentiated. Therefore his results are driven by the elasticity of substitution among inputs (Luong, 2008, p.11ff).

To the best of my knowledge, there is no study about the relationship between German or Austrian trade liberalization and Eastern European countries and firm-level total factor productivity. Temouri et al. (2008) estimate German total factor productivity from 1995 to 2004. In their second step, however, they show productivity differences owing to foreign affiliates and parent multinationals. Unfortunately, they do not link this with trade liberalization. As stated in the introduction, however, for Germany and Austria in particular it would seem to be very valuable to study the impacts.

2.2 Study by Amiti and Konings (2007)

Amiti and Konings (2007) give empirical evidence that Indonesian firms benefit from trade liberalization. Their study provides information about Indonesian plants between 1991 and 2001 on, inter alia, revenue, labor, investments and imported inputs. Information on intermediate inputs is available for each firm in 1998. This measurement is used for creating input tariffs. It allows the authors to distinguish between the impacts of both output tariff rates and input tariff rates on firm productivity. Whereas the benefits of reduced output tariffs are realized via import competition, the gains of input tariff cuts are realized by learning, variety effects and foreign technology.[10] The output tariff is measured by the average of all HS nine-digit product codes for each five-digit ISIC sector. The input rate is constructed as a weighted average of the output tariff. In this context the weights are given by the sectoral cost shares of one input good over all imported intermediate inputs per parental sector.[11] The authors point out that the tariff rates are given at the industry level to avoid endogeneity problems (Amiti and Konings, 2007, p.1620). Importantly, Amiti and Konings (2007, p.1612) observe that the input weights are only available for 1998 with the consequence of a constant technology assumption over time.

To test the impact of trade liberalization on productivity, Amiti and Konings (2007) run an OLS regression with fixed effects. Assuming a Cobb-Douglas production function the authors estimate the total factor productivity for each three-digit ISIC sector via an enhanced Olley-Pakes technique (1996) to avoid unobserved productivity impacts on the input coefficients. The estimation method takes account of the problem of simultaneous causality between the error term, including the productivity shock and the dependent variable within the firm's decision on input factors. To control for the correlation between the inputs and the error term a strict positive correlation between investments and the unobserved productivity shock is assumed (Olley and Pakes 1996). It controls for the simultaneity problem and provides a consistent coefficient for labor. Moreover, the method also takes account of a selection bias resulting from firms leaving the market. The semi-parametric estimation method also controls for this problem by estimating survival probabilities (Yasar et al. 2008). It allows me to obtain in a second step a consistent coefficient for capital.[12] Besides controlling for

[10] See Amiti and Konings (2007), p.1613ff.

[11] See Amiti and Konings (2007), p.1619ff.

[12] For a detailed discussion of the underlying estimation method see Amiti and Konings (2007), p.1635, Olley and Pakes (1996) and Section 4.2 about the total factor productivity.

unobserved productivity shocks and exits of firms, the authors modify the Olley-Pakes (1996) technique by controlling for the firm's import and export decision (Amiti and Konings 2007, p.l635ff). The Olley-Pakes (1996) method implies that investment function depends on trade, productivity shock and capital. Hence, within the underlying data the existence of data on firm investments and the import and export decision allows estimation of consistent values for the input coefficients. In a further step the authors run a fixed-effect regression to estimate how trade liberalization affects TFP.

Their estimation results show a negative impact of output tariffs on productivity. The coefficient in terms of absolute values ranges from 0.7 percent to 6.4 percent with a ten percentage point change in output tariffs. The value as well as the significance depends strongly on the underlying specification. A larger and significant negative effect is provided by the results for input tariff rates. For a ten percentage point decrease the coefficient for input tariffs ranges from 1.8 percent to 7.9 percent for non-importing plants and from 4.1 to 11.8 percent for importing firms. Therefore the effect for firms importing intermediate inputs is much larger than the gains for firms that compete with foreign inputs (Amiti and Konings, 2007, p.l621ff). In this context, Amiti and Konings (2007, p.1614) argue that trade liberalization and therefore lower tariff rates can be thought of as lowering the price of international outsourcing and therefore raising firm productivity.

The findings are robust owing to a large number of alternative specifications and estimation methods. They show that in terms of a potential omitted variable bias problem it is necessary to include input tariff rates when estimating the effect of trade liberalization on firm productivity (Amiti and Konings 2007, p.1621). Due to the coefficient's value and significance the impact of input tariffs is existent and even larger than the impact of import competition itself.

3 Dataset

The empirical analysis relies mainly on the matching of two datasets. The first is a detailed cross-sectional dataset of 660 global corporations based in Germany and Austria. The survey was conducted from 1990 to 2001 by the Chair of International Economics at the University of Munich. The sample represents 80 percent of German total investments in Eastern Europe and 100 percent of total Austrian investments in Eastern Europe. As a whole it consists of 2,123 German and Austrian investment projects. The employed version provides firm-level information on the parent investors in Austria and Germany, their corresponding affiliates in Eastern Europe and the actual investment and the parties' relationship. The survey reports, inter alia, detailed information on parent and affiliate firm-specific measures like capital stock, labor endowments, research and development investments and skill endowments. It also includes detailed information on underlying relationships like ownership share, investments and imports. Out of the unique data this study uses measures about intra-firm imports, more precisely, the type and amount of intermediate inputs between the parent firm and her corresponding Eastern European affiliate.[13]

The second dataset is the pan-European micro database *Amadeus* released by the Bureau van Dijk (Bureau van Dijk, Electronic Publishing 2005). The version used includes firm-level data for more than 1.5 million national and multinational establishments in 38 European countries for up to 13 years, finishing in 2005. I use unconsolidated data provided on tangible assets, employees, material costs, and revenue as well as added value and the ultimate owner for over 209,000 German and more than 30,000 Austrian firms.[14] In addition to that I match the cross-sectional dataset on Eastern European

[13] See Marin (2004, 2008) for further description of the data.

[14] For further information on the *Amadeus* dataset (Bureau van Dijk 2005) available online see http://www.bvdep.com/en/Amadeus.html [September, 16th, 2009].

investment projects with *Amadeus* (Bureau van Dijk 2005) to obtain an enhanced panel structure. It results in an unbalanced panel of 417 German and Austrian firms covering a period of ten years from 1994 to 2003. Data are collected until the end of 2003 to avoid potential bias by the eastern enlargement from the beginning of 2004.

To answer the question how trade liberalization affects firm-level productivity I take the simple average of effectively applied tariff rates for each three-digit Eastern European affiliate industry provided by the World Integrated Trade Solution database (*WITS*) (World Bank and UNCTAD 2008).[15] In the period 1994 to 2003 these data are merged for each year with the outcome of the first two matchings mentioned above. The new dataset allows me to identify the impact of tariff rates on productivity between Eastern Europe and the old European members Germany and Austria. A detailed description of the variables and the procedure follows in the next section.

4 Estimation methodology

4.1 Basic Estimation Equation

The empirical analysis studies the question whether liberalized trade has a significant positive impact on German and Austrian firm-level total factor productivity. Considering the related literature, I expect different contributions owing to the kind and character of the observed tariff rates. Therefore I expect a negative sign for all tariff rates raising firm-level productivity in the following ascending order: a decrease in output tariff raising productivity less than a cut in intra-firm tariffs; the largest contribution is expected from a cut in input tariff rates. The reason behind this expectation is access to

[15] *WITS* (World Bank and UNCTAD 2008) gives access to the major trade and tariff data from the *UN COMTRADE* database, the *TRAINS* database, and the *IDB* and *CTS* databases. For these and further information on *WITS* (World Bank and UNCTAD 2008) see http://wits.worldbank.org/witsweb [September, 16th, 2009].

foreign inputs as well as the mentioned competition effects. This should hold for both Austria and Germany, whereas the impact of a tariff reduction for Austrian firms is expected to be larger than for German corporations. Moreover, the study tries to answer whether foreign-owned and importing firms benefit more than purely domestic and non-importing firms. I expect multinationals that are more familiar with foreign environments to enjoy greater productivity effects from tariff reductions than domestic firms (Temouri et al. 2008, p.44ff). The estimation strategy also suggests that trade liberalization makes offshoring cheaper and this in turn is positively linked with productivity.[16]

Thus, the main estimation equation of interest is

$$\begin{aligned} TFP_{it}^{k} = \beta_0 + \beta_1 (Outtr)_t^k + \beta_2 (Inttr)_t^k + \beta_3 (Inptr)_t^k \\ + \beta_4 \delta_t^k + \eta_i + \eta_j + \eta_t + \epsilon_{it}, \end{aligned} \tag{1}$$

where $(Outtr)_t^k$ is the average of the effectively-applied output tariffs with which each parent firm's three-digit ISIC sector level is confronted. $(Inttr)_t^k$ and $(Inptr)_t^k$ are weighted averages of the sectoral output tariffs. $(Inttr)_t^k$ measures intra-firm tariffs, that is, nominal tariffs at the affiliates' sectoral product level weighted with intra-firm imports from industry j to the parent industry k over all intra-firm imports of sector k. This measure contains all kinds of offshored products. $(Inptr)_t^k$ weights tariff rates with the amount of each intermediate input imported from a three-digit affiliate sector j over all imports of sector k. I also include a set of variables δ_t^k containing the number of shareholders, foreign ownership, a dummy for importing firms and their related interaction terms with tariff rates. The number of shareholders and the nationality of the owner are provided by the *Amadeus* dataset (Bureau van Dijk 2005). In this context a foreign owner is defined as the firm's global ultimate owner who is not of German (or Austrian) nationality and holds

[16] See Amiti and Konings (2007), p.1614.

directly or indirectly at least 50.01 percent. The results are estimated by ordinary least square (OLS) with robust standard errors. Firm, industry and year fixed effects are included to avoid endogeneity problems owing to time-invariant and time-variant effects given by η_i, η_j and η_t.

4.2 Total Factor Productivity

Following the methodology of Amiti and Konings (2007), in a first step I estimate the firm's total factor productivity. It is defined as the residual of the production function, and hence the difference between the actual value Y_{it} and the estimated value $\hat{Y}_{it}$. Therefore I consider a simple Cobb-Douglas production function in the following way:

$$Y_{it} = A_{it}(\tau) L_{it}^{\gamma_l} K_{it}^{\gamma_k}, \tag{2}$$

where Y_{it} is measured by the value added of firm i at time t, L_{it} is the number of employees in i at time t and K_{it} is the capital endowment of firm i at time t. Except for labor, all variables are deflated.[17] I estimate the following log-log specification,

$$y_{it} = \gamma_0 + \gamma_1 l_{it} + \gamma_2 k_{it} + u_{it}, \tag{3}$$

for each country and each sector separately. It allows identification of the firm's TFP as mentioned above. For comparison, I proceed with the same specification with revenue as dependent variable. Thus, the specification is

$$y_{it} = \gamma_0 + \gamma_1 l_{it} + \gamma_2 k_{it} + \gamma_3 m_{it} + v_{it}, \tag{4}$$

where m_{it} measures applied materials. All variables are given in natural logs.

[17] I deflate in two different ways. On the one hand manufacturing and service sectors are deflated by the producer price index and the consumer price index, respectively. On the other hand I include year dummies while estimating TFP. The methods result in similar outcomes, especially in the second step when the impact of tariffs on productivity is considered.

To obtain unbiased coefficients for the input variables the ordinary least square (OLS) procedure is not very reliable (Olley and Pakes 1996, Levinsohn and Petrin 2003, Ackerberg et al. 2005). Yasar et al. (2008) show that an estimation technique not controlling for simultaneity and the mentioned selection bias provides upwards-biased coefficients for labor, capital, and materials. That is, the residuals u_{it} in Equation 3 and v_{it} in Equation 4 contain an unobserved productivity shock which has an impact on the firm's decision on the input factors. Unfortunately, the impact is unobserved by econometricians. Firms, however, take the shock within their productivity process into account. The so-called transmitted component results in a simultaneous causality problem between the explained and the explanatory variables. This in turn induces biased coefficients by OLS related to a correlation, especially between capital and the error term as stated by Levinsohn and Petrin (2003, p.319ff).[18] Owing to this problem the coefficients $\hat{\gamma}_l$, $\hat{\gamma}_k$, and, in the case of revenue as dependent variable, $\hat{\gamma}_m$, are estimated for each two-digit ISIC classification by use of the Levinsohn-Petrin (2003) approach. This estimation method avoids the simultaneity problem via intermediate inputs in order to control for the unobserved productivity shock. Hence, contrary to Olley and Pakes (1996), the Levinsohn-Petrin (2003) technique does not require any measurement of investments. This is important because the underlying data within this study report many zero investments or provide insufficient data on firm-level investments. In addition, Levinsohn and Petrin (2003) argue that investments do not entirely catch productivity shocks owing to adjustment costs. Therefore the authors suggest intermediate inputs as proxy to circumvent data-specific problems and to solve the endogeneity problems. Similarly to the investment proxy, by assuming a strictly monotonous relationship between the proxy (intermediate inputs), capital accumulation and

[18] See also Olley and Pakes (1996), Ackerberg et al. (2005), and Alvarez and Crespi (2007).

the unobserved shock, the approach controls for the transmitted component which has an influence on the firm's decision itself (Olley and Pakes 1996, Pakes 1996). Hence, it is part of the error term in Equations 3 and 4, respectively. Thus, the transmitted component ν_{it} is specified by $\nu_{it} = f_t(k_{it}, m_{it})$. It allows me to estimate a consistent $\hat{\gamma}_l$ by approximating the relationship between materials, capital and productivity shock via a fourth-order polynomial in k_{it} and m_{it}. Considering value added as dependent variable the estimation equation can be written as:

$$y_{it} = \gamma_1 l_{it} + \theta_t(k_{it}, m_{it}) + u_{it} \tag{5}$$

defining

$$\theta_t(k_{it}, m_{it}) = \gamma_0 + \gamma_2 k_{it} + f_t(k_{it}, m_{it}). \tag{6}$$

In a first step the elasticity of labor is obtained by approximating $\theta_t(k_{it}, m_{it})$ by a fourth-order polynomial. The consistent results provided in the first stage allow me estimating a consistent coefficient on capital in a second step by again approximating an unknown function of lagged values of θ_t.[19] That is, the following equation is estimated:

$$y_{it} - \gamma_1 l_{it} = \gamma_2 k_{it} + g(\theta_{t-1} - \gamma_2 k_{i,t-1}) + u_{it} + \tau_{it}. \tag{7}$$

Following the described procedure I implement overall material costs as proxy to estimate a reliable production function. I concentrate more on value added as dependent variable than firm revenue. The reason is that value added is expected to give more serious results owing to the fact that within the value added specifications material costs are used as pure proxy compared with the revenue estimates where an additional coefficient is estimated for materials. This avoids the danger of collinearity problems.[20] Tangible fixed

[19] In the case of revenue as dependent variable the elasticity of material inputs m_{it} is also obtained in the second step.

[20] See also Ackerberg et al. (2005).

assets are used for capital measurement and labor is measured by the number of employees. Owing to the fact that the number of observations per sector in the underlying panel of the 417 German and Austrian firms is very low, I do not expect to obtain reliable results on industry level. For this reason I run the Levinsohn-Petrin technique (2003) in two different ways. First, I do not distinguish between each industry, using the whole underlying sample of 417 firms in the period from 1994 to 2003 to estimate the designated elasticities. This method relies on the assumption that there are no productivity differences between the sectors. Owing to this weakness I alternatively estimate the TFP in each two-digit sector for each country separately for over 209,000 German and more than 30,000 Austrian firms from 1994 to 2003. These results are obtained from the *Amadeus* dataset (Bureau van Dijk 2005). For comparative reasons the coefficients are also estimated by simple OLS. Tables T3.2 and T3.3 in the Appendix report the results obtained by OLS and Levinsohn and Petrin (2003) with value added as dependent variable Y_{it} for Germany and Austria.[21]

4.3 Tariff Rates: Construction and Descriptives

The data on tariff rates between parent firms and their Eastern European affiliates are provided by the *WITS* database (World Bank and UNCTAD 2008). As shown by Mattoo and Subramanian (2008) it is important to consider applied tariff rates.[22] Output tariff rates are translated from the product level into the four-digit ISIC industry classification as a simple average for each parent sector. Following Amiti and Konings (2007), to obtain

[21] Owing to the fact that a huge amount of literature exists which criticizes Olley and Pakes (1996) as well as Levinsohn and Petrin (2003) (e.g. Ackerberg et al. 2005, Wooldridge 2005) I have to point out that this discussion is beyond the scope of my analysis.

[22] Contrary to bounded tariff rates the by countries effectively applied tariff rates show an significant decrease from 1986 to 2006. This accompanies with increasing trade in goods. See Mattoo and Subramanian (2008) as well as *The Economist* (2008).

intra-firm and input tariff rates the effectively applied tariffs are weighted as follows. The sample of 417 firms provides information on intra-firm imports as well as intermediate inputs directly imported mainly for one year in the period from 1997 to 2001. Therefore the sector-specific intra-firm weights, $v_{jk}^{1997/2001}$, are calculated by the ratio of industry k's imported products from industry j to all imported products by industry k.[23] Similarly, input tariffs are calculated by weighting nominal tariff rates with the aggregated ratio of imported inputs between each parent-affiliate relationship. That is, the value of imported inputs of industry j in the production of a good in the parent sector k over all inputs imported by sector k. This procedure allows me to estimate the relationship between trade liberalization in terms of tariff cuts at industry level and firm productivity. Formally, the weights are:

$$(Inttr)_t^k = \sum_j v_{jk}^{1997/2001} * (Outtr)_t^j, \tag{8}$$

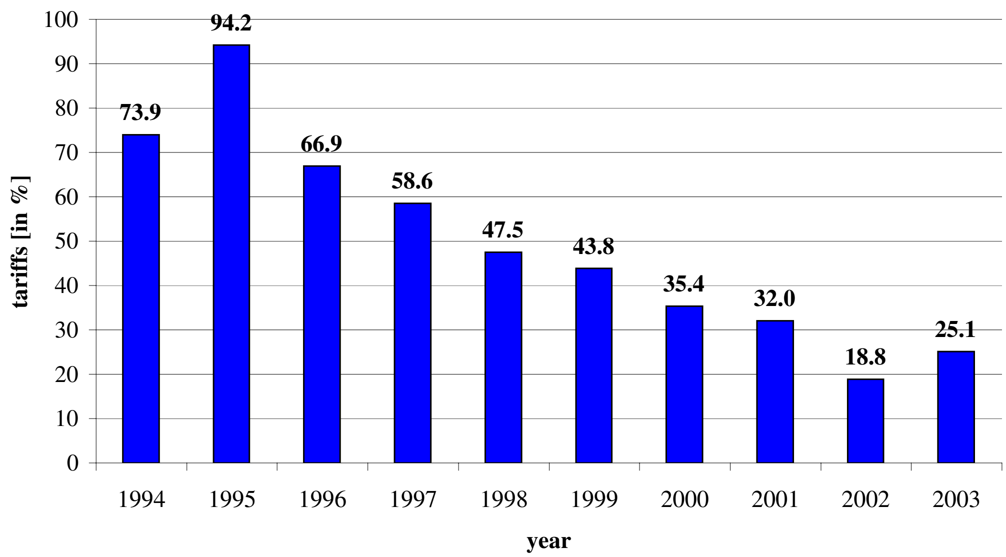
$$(Inptr)_t^k = \sum_j w_{jk}^{1997/2001} * (Outtr)_t^j. \tag{9}$$

The intuition is as follows. The most important import industry for a parent firm in sector k over all existing affiliate industries is weighted the most.[24] Following Amiti and Konings (2007), tariff rates are calculated at an aggregated industry level. The larger the tariff rate on a core good the larger is its importance in analyzing the impact of trade liberalization.

The underlying data show that there are significant tariff reductions between Germany, Austria and Central and Eastern European region.[25] Significant reductions are important because firms may respond to the liberalized environment and this could lead to a change in the productivity structure, outside the firm as well as within the firm boundaries. From 1994 to 2003

[23] All values are aggregated from plant level up to industry level and measured in Euros.
[24] See Amiti and Konings (2007), p.1620.
[25] See Appendix, Table T3.4 for the whole list of Eastern European countries considered in this study.

the maximum rates of nominal tariffs for all reported products between the parent EU countries (Germany and Austria, respectively) and Eastern Europe fell from 74 percent to 25 percent, a reduction by roughly 50 percentage points. Figure 1 shows how the maximum values of effectively-applied tariff rates change over time.



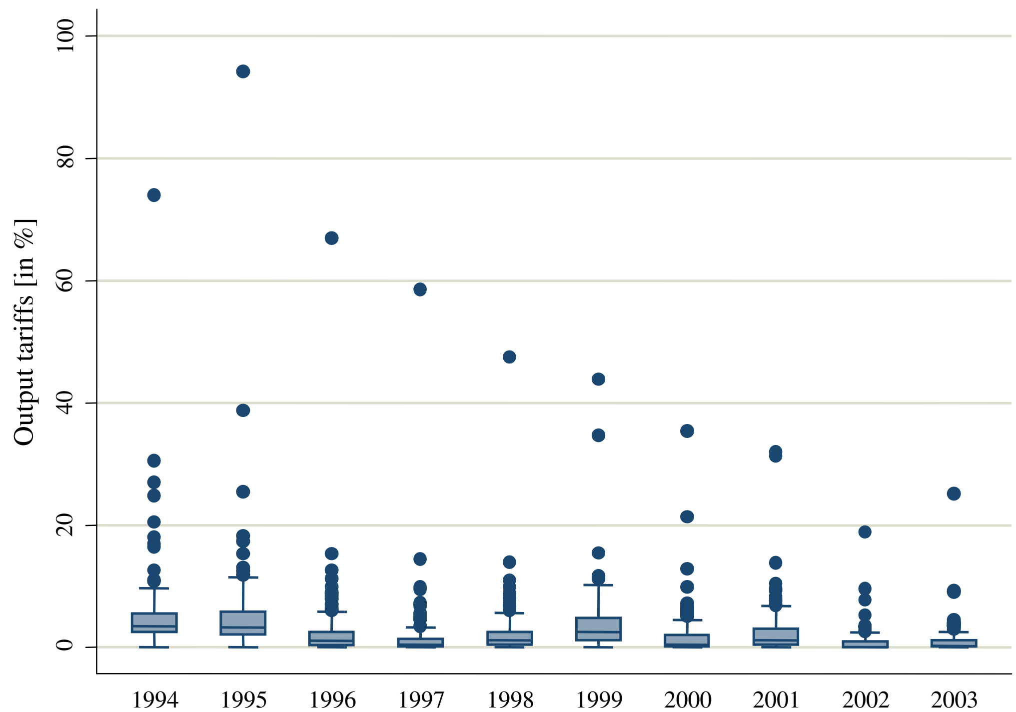
Notes: Values are maximum applied tariff rates (AHS) in percent, calculated as simple average of each three-digit affiliate level for a total of 70 industries.
Source: WITS database (World Bank and UNCTAD 2008).

Figure 1: Change in output tariffs (1994 - 2003)

This general finding also holds for an additional range of descriptive summaries. As presented in Figure 2, the median, the interquartile range, and the maximum values are also decreasing over time. The firms may respond to this variation over all products in terms of access to foreign technology and greater variety, and therefore a change in their productivity. Owing to liberalized trade, tariff variation is reduced over time.[26] In this case particularly, firms respond to these tariff cuts, when the parent industry imports from more than one affiliate industry. In the underlying data a parent indus-

[26] See also Luong (2008), p.16ff.

try at the three-digit classification imports on average from three different three-digit affiliate sectors.

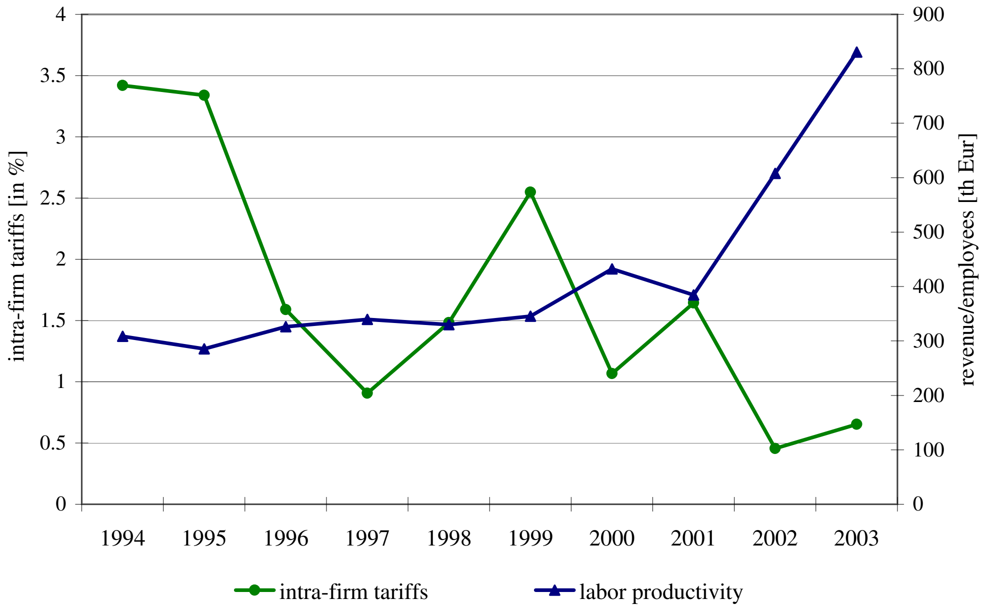


Source: WITS database (World Bank and UNCTAD 2008). Author's calculations.

Figure 2: Output tariff variation over time (1994 - 2003)

Tariff rates with the largest initial level in 1994 incur the greatest cut from trade liberalization compared with 2003. Figure F3.1 in the Appendix shows the graph on all existing three-digit industry levels. There is a significant negative correlation which affirms the large tariff reductions of initial tariff rates. Moreover, all tariffs are close to the 45-degree line. This confirms that almost all industries show considerable tariff cuts by at least 50 percent within the considered period.

These findings suggest a relationship between tariff cuts and a productivity boost on the firm level. Figure 3 shows a negative link between tariffs and



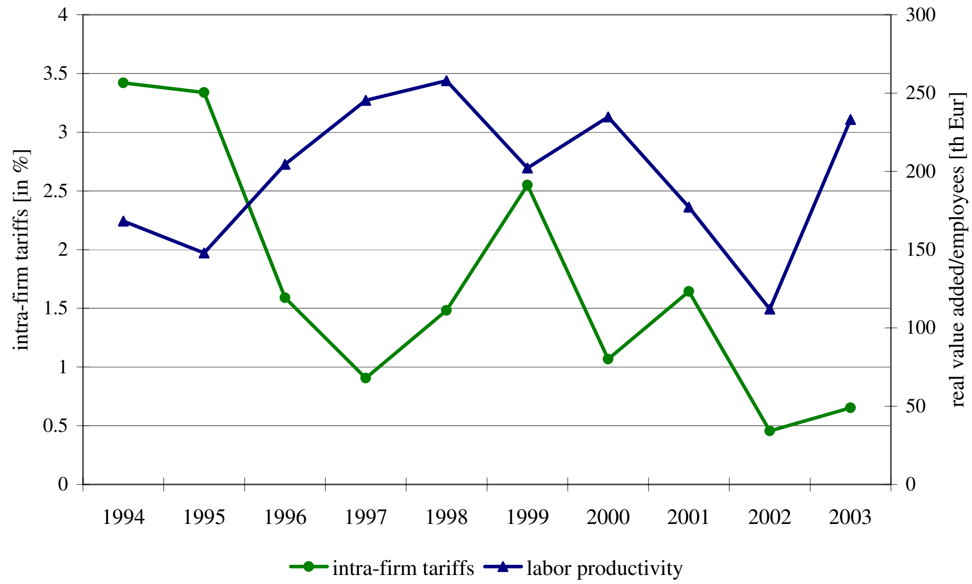
Notes: Values are given on a three-digit parent-industry level. Owing to large outliers the upper 5th percentile firms related to the revenue variable is excluded.
Sources: WITS database (World Bank and UNCTAD 2008), Amadeus database (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure 3: Tariff rates and labor productivity

productivity. In the sample period from 1994 to 2003 intra-firm tariff rates decreased while labor productivity of German and Austrian firms investing in Eastern Europe mainly increased during these phases. The same finding is obtained by considering tariff rates and productivity measured in real value added per employee. Figure 4 presents the outcome.[27]

Another aspect of the relationship between increasing productivity and decreasing input tariffs is documented in Figure 5. Firms are ranked by their labor productivity, whereby a low-level firm is in the lower 25th percentile, a medium firm ranges between 25 and 75th, and a high productivity is in the upper 25th percentile. The figure shows that more productive corporations

[27] The findings hold also for both countries Germany and Austria separately. Values are deflated by the corresponding producer price index provided by the German Federal Statistical Office (2008c) and Austrian National Bank (OeNB 2008), respectively.

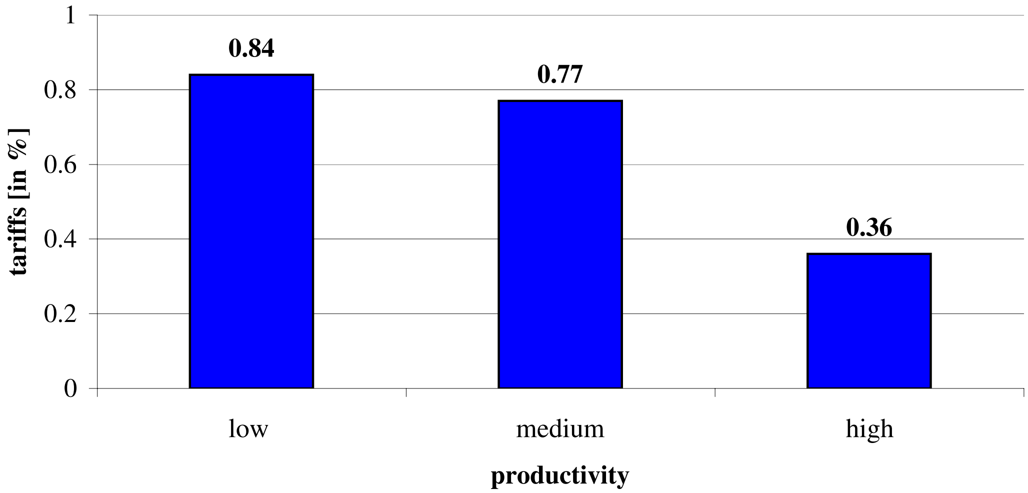


Notes: Values are given at a simple average over all parent firms on a three-digit industry level per year. Owing to large outliers the upper 5 percent quantile of the value added distribution is excluded.
Sources: WITS database (World Bank and UNCTAD 2008), Amadeus database (Bureau van Dijk 2005), and Chair for International Economics, University of Munich. Author's calculations.

Figure 4: Tariff rates and real value added

are confronted with, on average, lower input tariff rates. Hence, German and Austrian parent firms have liberalized access to foreign technology, greater variety and lower-priced intermediate inputs which in turn may boost their productivity.

Highly productive corporations are confronted with lower tariff rates compared with low-productive firms. Whether this in turn incentivizes intra-firm imports is shown in Figure 6. Low versus high productivity is determined by the firm's median labor productivity measured in real value added per employee. The figure suggests that less productive corporations have lower intra-firm imports in percent of parent sales compared with firms in the highly productive segment. It suggests that corporations practicing offshoring via significant tariff cuts play an important role in determining the impact of trade liberalization on productivity. Therefore, liberalized trade in terms



Notes: Productivity is measured by firms' revenue-employee ratio for all given parent firms in each three-digit industry. Low productivity means firms in the lower 25th percentile, high productivity firms in the upper 25th percentile. Tariffs on inputs are the weighted sum of the sectoral average tariff rates on imported inputs from all corresponding Eastern European industries affiliated to the parent industry (three-digit ISIC classification).
Sources: WITS database (World Bank and UNCTAD 2008), Amadeus database (Bureau van Dijk 2005) and Chair for International Economics, University of Munich. Author's calculations.

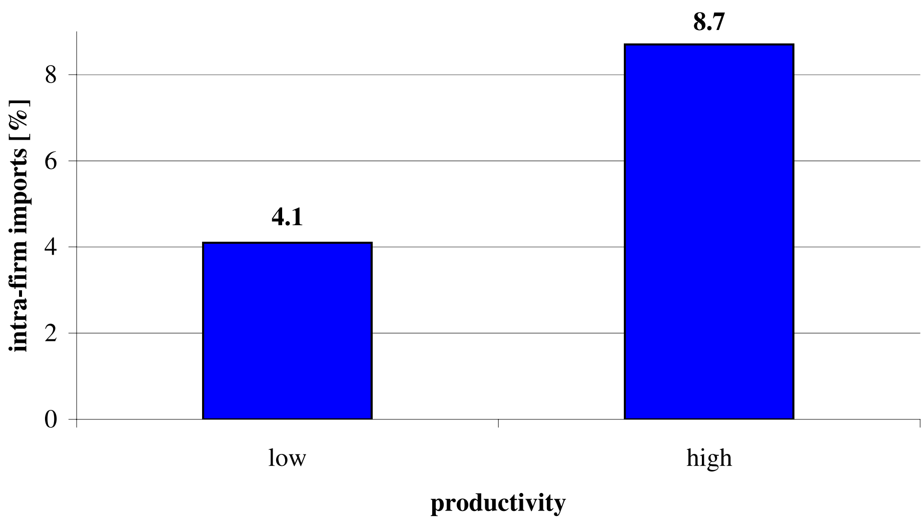
Figure 5: Input tariffs and labor productivity

of lower tariff rates lowers the price of offshoring and boosts productivity.[28] These effects take place outside the firm boundaries and within the firm.

5 Empirical Results

This section analyzes the impact of trade liberalization on firm-level productivity. The total factor productivity having been obtained, Equation 1 is estimated by simple OLS with fixed effects. The dependent variable is the natural log of TFP calculated by using the firm's real value added. In this first set of calculations the productivity estimations are not run for each sec-

[28] See Amiti and Konings (2007), p.1614ff.



Notes: Intra-firm imports are given at parent firm level as a percentage of parent sales. Productivity is low if the firm's real value added per worker is equal or below the median firm. Contrary, it is high if the firm's real value added per employee is equal or larger than the median corporation.
Sources: WITS database (World Bank and UNCTAD 2008) and Chair for International Economics, University of Munich. Author's calculations.

Figure 6: Tariff rates and offshoring

tor separately. That is, the coefficients for labor and capital are calculated using the set of 417 firms. To produce valid statistical inferences, the errors are corrected for heteroskedasticity.

Table 1 reports the results. Column (1) suggests that an increase in the output tariff reduces the firm productivity. The sign of the coefficient for tariffs is negative and significant. A decrease of ten percentage points in the tariff rate improves productivity by 0.54 percent. Column (2) additionally includes intra-firm tariffs. The coefficients for both tariff rates are negative and highly significant. The coefficient for output tariff falls, however, when the intra-firm tariff is included. It seems that the productivity effect through access to foreign technology has an important impact. Ignoring this variable would lead to a biased coefficient for the output tariff measure. The outcome suggests the existence of both effects: the competition effect described by Melitz (2003) as well as productivity-improving effects of foreign quality (Grossman and Helpman 1991), greater variety (Feenstra et al. 1992) and access to products at a reduced rate. The negative impact is larger for foreign-owned firms as reported in column (3). The largest negative effect on productivity is given by the coefficient for the input tariff rate. The positive impact of trade liberalization on productivity is smaller in the final market compared with intermediate inputs. The coefficient for input tariff is, however, not significant. Column (5) also reports an insignificant coefficient for input tariff rates but the impact of input tariff and the interaction with importing firms IM is as expected. In line with Amiti and Konings (2007), the effect is greatest for importing German and Austrian parent firms.

Table 2 uses the more reliable natural log of the productivity measure TFP calculated separately for each industry over 209,000 and 30,000 firms located in Germany and Austria, respectively. The set of the first four specifications shows an insignificant coefficient for the output tariff. This insignificant impact is in line with Amiti and Konings (2007) and can be explained by the framework described by Luong (2008). Inclusion of the intra-firm tariff rate, however, shows a negative and significant impact. A ten percentage point decline in the tariff rate raises productivity by 0.55 percent. Controlling for foreign-owned firms FO, column (4) suggests that having easier access to foreign products increases productivity. This impact is stronger for foreign-owned firms by 0.4 percent.[29] It indicates that a ten percentage point increase in the intra-firm tariff rate results in almost a 1 percent boost in the firm productivity. At this time inclusion of the input tariff rate shows a negative and significant coefficient. If input tariff rates are reduced by ten percentage points the access to foreign intermediates raises productivity by more than 1.2 percent. Column (7) reports a greater impact of reducing input tariff rates compared with intra-firm tariffs. Although the impact for importing firms is larger than for non-importing firms column (8) reports only insignificant results. That is, contrary to Amiti and Konings (2007),

[29] A ten percentage point increase in intra-firm tariff rate is assumed.

Table 1: Tariff rates and TFP

Dependent variable: tfp_{it} (real value added)	(1)	(2)	(3)	(4)	(5)
$tariffs_j$	-0.0540***	-0.0518***	-0.0513***	-0.0518***	-0.0544***
	[0.0051]	*[0.0050]*	*[0.0050]*	*[0.0050]*	*[0.0050]*
intra-firm $tariff_j$		-0.0537***	0.0418	-0.0535***	-0.0666***
		[0.0197]	*[0.0317]*	*[0.0198]*	*[0.0218]*
input $tariff_j$				-0.0587	0.0047
				[0.0744]	*[0.0880]*
FO			0.2460*		
			[0.1265]		
FO * intra-firm $tariff_j$			-0.0968***		
			[0.0299]		
IM					0.0066
					[0.0251]
IM * input $tariff_j$					-0.1244
					[0.1357]
fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*
Adj. R2	0.9	0.9	0.9	0.9	0.9
Observations	2083	2079	2079	2079	1745

Notes: A constant term as well as year, country, and firm fixed effects are included throughout all the specifications. Robust standard errors are in brackets. The dependent variable is the total factor productivity at the plant level i in industry j and year t. TFP is obtained by Levinsohn and Petrin (2003) with real value added as dependent variable. A constant technology for all industries is assumed. *Tariffs* are sectoral tariff rates at the parent industry level j. *Intra-firm tariff* is the sum of sectoral average tariffs weighted with imported goods from each related affiliate industry. *Input tariff* is the sum of the sectoral average tariff rates weighted with the industries' mean of imported inputs in percent of parents' sale. IM is a dummy equal to one if the value of imported goods between the parent firm and its affiliate is greater than zero. FO is a dummy equal to one if the global ultimate owner is a foreigner. The number of the corporate shareholders worldwide is included as control throughout all the specifications. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

there is unfortunately no single evidence of productivity gains from greater variety or learning effects controlled for by the interaction between importing firms IM and the intra-firm tariff rate. An F-test showing that all variables controlling for any type of tariff rates are different from zero is, however, significant.

Table 2: Tariff rates and sectoral TFP

Dependent variable: sectoral *tfp* $_{it}$ (real value added)								
	basic estimations				input estimations			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$tariffs_j$	-0.0213		0.0381	0.0371		-0.0211	0.0376	0.0859***
	[0.0143]		*[0.0272]*	*[0.0279]*		*[0.0143]*	*[0.0272]*	*[0.0302]*
intra-firm $tariff_j$		-0.0389**	-0.0552***	-0.0552***			-0.0545***	-0.0754***
		[0.0154]	*[0.0207]*	*[0.0207]*			*[0.0208]*	*[0.0223]*
input $tariff_j$					-0.1593**	-0.1626**	-0.1234*	-0.0906
					[0.0678]	*[0.0822]*	*[0.0717]*	*[0.1036]*
FO				2.9744***				
				[0.0477]				
FO * intra-firm $tariff_j$				-0.0391**				
				[0.0190]				
IM								0.0091
								[0.0941]
IM * intra-firm $tariff_j$								-0.0126
								[0.0162]
fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Adj. R2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Observations	1364	1364	1352	1352	1364	1352	1327	1090

Notes: A constant term as well as year, country, and firm fixed effects are included throughout all the specifications. Robust standard errors are in brackets. The dependent variable is the total factor productivity at the plant level i in industry j and year t. TFP is obtained by Levinsohn and Petrin (2003) for each 2-digit ISIC classification with firms' real value added as dependent variable for Germany and Austria, respectively. *Tariffs* are the simple average of sectoral tariff rates in all corresponding affiliates' industries on a three-digit level for each parent industry. *Intra-firm tariff* is the sum of the weighted average of tariffs aggregated up to the three-digit parent industry level. IM is a dummy equal to one if the firm's intra-firm imports are greater than zero. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

Owing to the fact that the data consist of German and Austrian firms, Table 3 reports the results for the country differences. The country dummy is equal to one if the firm is located in Germany and zero if the observation relates to Austria. All three specifications show that productivity gains from liberalized trade are greater for Austria than for Germany. This holds for all three types of tariff rates. Again, the impact of reducing intra-firm tariff rates is greater compared with the output tariff coefficients.

Amiti and Konings (2007) give an additional interpretation for trade liberalization. They argue that reduced tariff rates "lower the price of international outsourcing" (Amiti and Konings 2007, p.1614, fn 11). In this context, lower tariffs increase offshoring and this in turn boosts firm productivity. Görg et al. (2008) also study the impact of international outsourcing on productivity.[30] In order to investigate the effect the results obtained stepwise for the offshoring channel are reported in Table 4.

In columns (1) to (3) offshoring measured as intra-firm imports in percent of parent sales is regressed on tariffs. Including controls, column (3) of Table 4 shows that a falling output tariff rate raises the offshoring activities. Column (4) suggests that offshoring in turn is positively linked with firm productivity. Increasing intra-firm imports significantly raises the firm's real value added. If increasing firm-level productivity is explained by greater offshoring and therefore by greater variety of and easier access to foreign goods, the coefficient for tariff rates is expected to be insignificant or equal to zero. Column (5) suggests that both offshoring and trade liberalization have a significant impact. The sign of the coefficient for intra-firm imports is positive, as expected. The impact, however, is reduced. That is, trade liberalization incentivizes offshoring and this in turn raises productivity. Besides that, a positive effect of reduced output tariffs on productivity remains. This is also

[30] For a detailed discussion on the existence of further empirical studies, see Görg et al. (2008), p.671ff.

Table 3: Country differences

Dependent variable: sectoral tfp_{it} (real value added)			
	(1)	(2)	(3)
tariffs_j	-0.2183***	-0.0837**	-0.0838**
	[0.0397]	*[0.0364]*	*[0.0366]*
tariffs_j * country	0.1831***	0.0800**	0.0803**
	[0.0298]	*[0.0379]*	*[0.0380]*
intra-firm tariff_j		-0.1603***	-0.1602***
		[0.0388]	*[0.0389]*
intra-firm tariff_j * country		0.1210***	0.1215***
		[0.0434]	*[0.0436]*
input tariff_j			-0.1432
			[0.1153]
input tariff_j * country			0.0682
			[0.1226]
country	0.3156***	0.1349	0.2219**
	[0.0680]	*[0.0902]*	*[0.0971]*
fixed effects	*yes*	*yes*	*yes*
Adj. R2	0.8	0.8	0.8
Observations	1669	1665	1665

Notes: A constant term as well as year, industry, and firm fixed effects is included throughout all specifications. Robust standard errors are in brackets. The dependent variable is the sectoral total factor productivity at the plant level i in industry j and year t. TFP is obtained by Levinsohn and Petrin (2003) for each sector separately with real value added as dependent variable. *Tariffs* are sectoral tariff rates at the parent industry level. *Intra-firm tariff* is the sum of sectoral average tariff rates weighted with imported goods from one affiliate industry over all imported goods. *Input-tariff* is the sum of the sectoral average tariff rates weighted with the intermediate inputs ratio imported from one Eastern European affiliate industry over all corresponding intermediates. *Country* is a dummy equal to one if the parent firm is German and, contrary, equal to zero if the parent firm is Austrian. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 4: Channel of tariff rates and offshoring on productivity

	dependent variable: intra-firm imports			dependent variable: ln (real value added)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intra-firm imports	-	-	-	0.0035***	0.0030**	0.0031**	0.0031**	0.0030***
				[0.0011]	*[0.0012]*	*[0.0013]*	*[0.0012]*	*[0.0011]*
tariffs$_j$	-0.1183	-0.1730**	-0.1644*		-0.0152**	-0.0127*	-0.0127*	-0.0116
	[0.0865]	*[0.0868]*	*[0.1023]*		*[0.0071]*	*[0.0074]*	*[0.0075]*	*[0.0083]*
intra-firm tariff$_j$						-0.0119	-0.0118	-0.0141
						[0.0147]	*[0.0210]*	*[0.0177]*
ln (L)		-1.6533***	-1.5245***				-0.0109	-0.0028
		[0.4596]	*[0.5140]*				*[0.0150]*	*[0.0259]*
ln (K)			0.2654					0.0123
			[0.3237]					*[0.0167]*
industry fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Adj. R2	0.02	0.03	0.04	0.02	0.02	0.03	0.03	0.01
Observations	783	743	481	1262	586	561	529	331

Notes: A constant term as well as a country dummy and firm fixed effects is included throughout all the OLS specifications. Robust standard errors are in brackets. The dependent variable in the first set is intra-firm imports in percent of parent sales. The dependent variable in the second set is the real value added at plant level i in industry j. The data are on project level for the year 1999. Therefore the number of observations can be larger than 417 firms. *Tariffs* and *Intra-firm tariff* are the average and weighted average tariff rate, respectively, for each parent-affiliate relationship on the Eastern European investment level. *Ln(L)* is the natural log of the number of parent employees. *Ln(K)* is the log of the parent firm's capital stock. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 5: Contribution of trade liberalization (in percent)

tariff rate	$\widehat{\beta}$	$\widehat{\beta}_{Austria}$	$\widehat{\beta}_{Germany}$
output tariff	0.3 - 0.4	0.3 - 0.8	0.03 - 0.4
intra-firm tariff	0.5 - 0.7	0.6 - 1.6	0.4 - 0.6
input tariff	0.6 - 1.6	1.4 - 2.1	0.8 - 1.2

Notes: The table summarizes the average effect of a ten percentage point reduction of each mentioned tariff rate on firm-level productivity. Author's calculations.

affirmed by the following specifications (6) to (8). Inclusion of the intra-firm tariff variable suggests that a reduced tariff rate incentivizes offshoring and raises productivity. The impact of the intra-firm tariff itself is insignificant. The coefficient for offshoring is positive and significant whereas the impact of tariffs is reduced.

A summary of all findings for a ten percentage point reduction in the studied types of tariffs is provided by Table 5. First, the contribution of trade liberalization to productivity is smaller for Germany than for Austria for all tariff types. Second, in both countries, Germany and Austria, the contribution of a reduction in intra-firm and input tariffs is larger compared with lowering output tariffs. This means that lowering the intra-firm tariff rate by ten percentage points increases German productivity on average by 0.5 percent and Austrian productivity by more than 1 percent. Finally, the effect is greater for multinationals in both countries.

6 Robustness

Owing to robustness concerns of the empirical findings, several measurement and specification issues can be presented in this section. The results reported in Table 6 are estimated by use of the real value added per employee as measurement for the firm's productivity. Beside the impact of output tariffs all coefficients for trade liberalization have the expected influence. Again, the impact of input tariffs is greater compared with lowering intra-firm tariff rates. Multinationals benefit more from lowering tariff rates than domestic firms. However, inserting the input tariff rate to the specification including output and intra-firm tariffs, show a statistically insignificant coefficient on the input variable.

Changing the dependent variable through the firm's operating revenue suggests that lower tariff rates increase the firm's revenue. Throughout all specifications the capital-to-labor ratio, the firm size, and intermediate materials are included to analyze the impact on an alternative productivity measure. The results suggest that trade liberalization has a positive impact. The effect is largest for the input tariff rate, followed by intra-firm rates and the output tariffs. Again, the coefficient for the input tariff rate itself is insignificant. Table 7 presents the estimates.

Tables 8 and 9 affirm the finding that there are significant differences between Germany and Austria. It holds for both measures real value added per employee and real revenue per employee, respectively, that generally the effect for Austria is larger. The exception in both tables, however, is given by a larger impact of lower input tariffs in Germany than in Austria. The F-test on all included tariff variables in both columns (3) suggests that the impacts are significantly different from zero. Moreover, Table 9 reports that the difference in lower intra-firm tariff rates is not as large as shown before. Nevertheless, reducing the tariff rates increases labor productivity. In general

Table 6: Tariff rates and labor productivity

Dependent variable: *real value added per employee*								
	basic estimations				input estimations			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
tariffs_j	0.0069	0.0132**	0.0132**	0.0134**		0.0071	0.0132**	0.0132**
	[0.0062]	*[0.0066]*	*[0.0066]*	*[0.0066]*		*[0.0063]*	*[0.0066]*	*[0.0066]*
intra-firm tariff_j		-0.0692***	-0.0692***	-0.0237			-0.0685***	-0.0683***
		[0.0176]	*[0.0176]*	*[0.0492]*			*[0.0177]*	*[0.0177]*
input tariff_j					-0.1797**	-0.1771**	-0.1196	-0.0179
					[0.0720]	*[0.0721]*	*[0.0738]*	*[0.1048]*
FO			0.8122***	0.8360***				0.8128***
			[0.0731]	*[0.0768]*				*[0.0732]*
FO * intra-firm tariff_j				-0.0456				
				[0.0435]				
FO * input tariff_j								-0.1958
								[0.1341]
fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Adj. R2	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Observations	1852	1848	1848	1848	1866	1848	1848	1848

Notes: A constant term as well as year, country, and firm fixed effects is included throughout all the specifications. Robust standard errors are in brackets. The dependent variable is the firms' real value added per employee for Germany and Austria, respectively. *Tariffs* are the simple average of sectoral tariff rates in all corresponding affiliates' industries on a three-digit level for each parent industry. *Intra-firm tariff* is the sum of the weighted average of tariffs aggregated up to the three-digit parent industry level. *Input tariff* is the aggregated sum of the input weighted average of the output tariffs. *FO* is a dummy equal to one if the firm's owner is a foreigner. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

Table 7: Robustness: Trade liberalization and operating revenue

	Dependent variable: *ln (revenue)* $_{it}$			
	(1)	(2)	(3)	(4)
tariffs_j	-0.0379***	-0.0359***	-0.0378***	-0.0359***
	[0.0053]	*[0.0052]*	*[0.0053]*	*[0.0052]*
intra-firm tariff_j		-0.0677***		-0.0674***
		[0.0218]		*[0.0220]*
input tariff_j			-0.1054	-0.0647
			[0.0763]	*[0.0794]*
ln $(K/L)_i$	0.4020***	0.3914***	0.4027***	0.3920***
	[0.0536]	*[0.0537]*	*[0.0536]*	*[0.0537]*
ln $(L)_i$	0.6345***	0.6307***	0.6357***	0.6315***
	[0.0530]	*[0.0526]*	*[0.0531]*	*[0.0527]*
ln $(\text{materials})_i$	0.1723***	0.1686***	0.1712***	0.1680***
	[0.0340]	*[0.0344]*	*[0.0341]*	*[0.0345]*
fixed effects	*yes*	*yes*	*yes*	*yes*
Adj. R2	0.9	0.9	0.9	0.9
Observations	1527	1523	1523	1523

Notes: A constant term as well as year, country, and firm fixed effects are included throughout all the specifications. Robust standard errors in brackets. The dependent variable is the natural log of real revenue at the plant level i in industry j and year t. *Tariffs* are sectoral tariff rates at the three-digit ISIC parent industry classification. *Intra-firm tariff* is the sum of sectoral average tariff rates weighted with imported goods from one affiliate industry over all imported goods. *Input tariff* is the sum of the sectoral average tariff rates weighted with intermediate inputs imported from one Eastern European affiliate industry over all corresponding intermediates. *Ln(K/L)* is the log of capital over employees. *Ln(L)* is the natural log of the number of employees in the parent firm, and *Ln(materials)* is the log of imported goods in th euros. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

the effect is lower compared with the results of Table 3.

Table 8: Robustness: Country differences and value added

Dependent variable: *ln(real value added/L)* $_{it}$			
	(1)	(2)	(3)
tariffs_j	-0.1267**	-0.0361	-0.0361
	[0.0529]	*[0.0540]*	*[0.0540]*
tariffs_j * country	0.1078**	0.0222	0.0222
	[0.0514]	*[0.0525]*	*[0.0526]*
intra-firm tariff_j		-0.1560**	-0.1561**
		[0.0629]	*[0.0630]*
intra-firm tariff_j * country		0.1008*	0.1025*
		[0.0598]	*[0.0598]*
input tariff_j			-0.2109*
			[0.1133]
input tariff_j * country			-0.0247
			[0.1567]
country	-0.2237***	-0.3692**	-0.3698**
	[0.0765]	*[0.1660]*	*[0.1661]*
fixed effects	*yes*	*yes*	*yes*
Adj. R2	0.8	0.8	0.8
Observations	1851	1847	1847

Notes: A constant term as well as year, industry, and firm fixed effects are included throughout all the specifications. Robust standard errors are in brackets. The dependent variable is the firm's real value added per employee. *Tariffs* are sectoral tariff rates at the parent industry level. *Intra-firm tariff* is the sum of sectoral average tariff rates weighted with imported goods from one affiliate industry over all imported goods. *Input tariff* is the sum of the sectoral average tariff rates weighted with intermediate inputs imported from one Eastern European affiliate industry over all corresponding intermediates. *Country* is a dummy equal to one if the parent firm is German and equal to zero if the parent firm is Austrian. Additionally, the natural log of turnover is included as a control variable in each specification. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

The findings also hold when the data are separated into a manufacturing and services classification. The results reported in Table T3.5 in the Appendix show a significant and positive impact of falling tariffs on productivity in the manufacturing sector. A ten percentage point decrease raises

Table 9: Robustness: Country differences and operating revenue

Dependent variable: *ln(real revenue/L)* $_{it}$	(1)	(2)	(3)
$tariffs_j$	-0.1063***	-0.1019***	-0.1027***
	[0.0223]	*[0.0304]*	*[0.0303]*
$tariffs_j$ * country	0.0738***	0.0719**	0.0727**
	[0.0219]	*[0.0305]*	*[0.0304]*
intra-firm $tariff_j$		-0.0635*	-0.0636*
		[0.0363]	*[0.0363]*
intra-firm $tariff_j$ * country		0.0001	0.0007
		[0.0397]	*[0.0398]*
input $tariff_j$			-0.109
			[0.0739]
input $tariff_j$ * country			-0.0286
			[0.1317]
ln (K/L)	0.2954***	0.2907***	0.2911***
	[0.0432]	*[0.0432]*	*[0.0432]*
ln (L)	-0.2664***	-0.2661***	-0.2655***
	[0.0378]	*[0.0378]*	*[0.0378]*
country	-0.6329***	-0.0243	-0.0285
	[0.1503]	*[0.1820]*	*[0.1811]*
fixed effects	*yes*	*yes*	*yes*
Adj. R2	0.8	0.8	0.8
Observations	2083	2079	2079

Notes: A constant term as well as year, industry and firm fixed effects are included throughout all the specifications. Robust standard errors are in brackets. The dependent variable is the natural log of real revenue over employees. *Tariffs* are sectoral tariff rates at the parent industry level. *Intra-firm-tariff* is the sum of sectoral average tariff rates weighted with imported goods from one affiliate industry over all imported goods. *Input-tariff* is the sum of the sectoral average tariff rates weighted with intermediate inputs imported from one Eastern European affiliate industry over all corresponding intermediates. *Country* is a dummy equal to one if the parent firm is German and, contrary, equal to zero if the parent firm is Austrian. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.

productivity by 0.34 percent. As shown before, the impact is greater for intra-firm tariff rates. Trade liberalization increases firm productivity by more than 0.6 percent. The coefficient for the input tariff is not significant. Moreover, column (4) presents a negative link between the number of shareholders and the firm's productivity. Column (5) suggests that multinationals benefit more from trade liberalization than purely domestic firms. This also holds for the service sectors. The output tariff rate, however, is no longer significant. The coefficients for the intra-firm tariff variable suggest that tariffs falling by ten percentage points raise productivity by more than 2 percent. Unfortunately, in the service sector subsample the number of observations drops significantly.

7 Conclusion

Even though there is a huge amount of literature on trade liberalization, empirical studies on liberalized trade in terms of both output and input tariffs in firm productivity are rare. Moreover, there is no detailed study on the relationship between intra-firm tariffs and productivity in Germany and Austria which considers the directly preceding periods of the Eastern European enlargement. This paper argues, however, that it is important, especially for Germany and Austria as two of the countries most affected by the eastern enlargement. Therefore, the underlying analysis tries to say to what extent tariff reductions for Central and Eastern Europe lead to a boost in German and Austrian firm-level productivity. More precisely, following Amiti and Konings (2007), the paper considers the determinants of firm-level total factor productivity. Obtaining productivity by using the Levinsohn and Petrin technique (2003) that corrects for unobserved productivity shocks, a unique matching of intra-firm import data finds that tariff reductions significantly increase total factor productivity. The size of the coefficient depends strongly in both countries on the type of tariffs: input tariff rates show the largest effects, followed by intra-firm and output tariff rates. The impact of a ten percentage point tariff cut ranges between 0.3 and 2 percent. The effect for Austria is larger than for Germany. The results also suggest that trade liberalization makes offshoring cheaper and this in turn increases productivity. This channel, among others, is hypothesized by Amiti and Konings (2007) for Indonesian firms. This study is the only one using data relating to Germany, Austria and Eastern Europe. Moreover, it is the only one which distinguishes between tariffs on intra-firm imports and tariffs on intermediate inputs. The results are in line with findings for other country studies and robust to a wide range of tests varying the dependent variable and the underlying estimation specifications.

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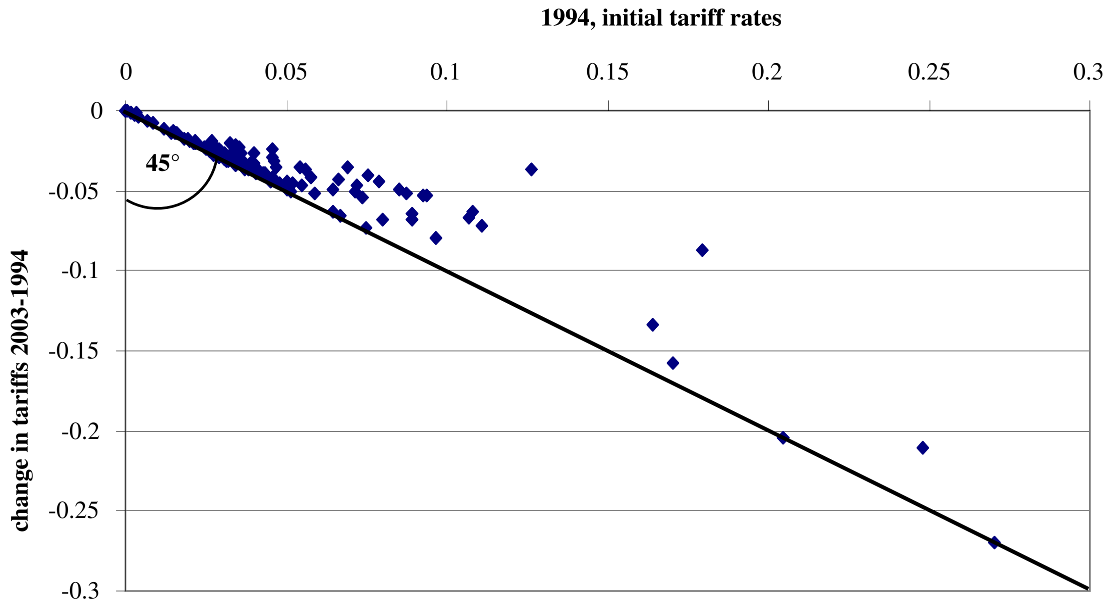
Appendix - Figures and Tables



Source: WITS database (World Bank and UNCTAD 2008). Author's calculations.

Figure F3.1: Change in initial tariff levels

Table T3.1: Overview of empirical literature on trade liberalization and productivity

literature	countries	period	observations	estimation method	productivity measures	**results** of	
Amiti and Konings (2007)	Indonesia	1991 - 2001	plant-level	Olley-Pakes (1996)	total factor productivity	*10%-points decrease in*	
						output tariffs	[1%;6%]
						input tariffs	[2%;12%]
De Locker (2007)	Belgium	1994 - 2002	firm-level	Olley-Pakes (1996), enhanced by ommited price variable bias	total factor productivity	*relaxing*	
						avg. quota restriction	4%
Fernandes (2003)	Colombia	1977 - 1991	plant-level	Levinsohn-Petrin (2003)	total factor productivity	*10%-points decrease in*	
						nominal tariffs	[0.7%; 2.9%]
Goldberg et al (2008)	India	1989 - 2003	firm-level	Topalova (2004)	amongst others: total factor productivity	*10%-points decrease in*	
						input tariffs	4.5%
Head and Ries (1999)	Canada	1987 - 1994	industry-level, plant-level	semi-log OLS, fixed effects	output per plant	*tariff cuts*	
						Canadian tariffs	-8.5%
						US tariffs	9.8%
Krishna and Mitra (1998)	India	1986 - 1993	firm-level	Harrison (1994), extended	total factor productivity	*liberalized trade*	
						trade reform (1991)	[3%;6%]
Luong (2008)	Mexico	1984 - 1990	plant-level	factor share method, OLS, Olley-Pakes (1996)	total factor productivity	*10%-points decrease in*	
						output tariffs	[−1.6%; −3.9%]
						input tariffs	[−1.4%; 9.7%]
						output tariffs*rank	[0.4%; 0.6%]
						input tariffs*rank	[−0.4%; −0.7%]
Halpern, Koren and Szeidl (2005)	Hungarian	1992 - 2001	product-level	Olley-Pakes (1996)	total factor productivity	*10%-points increase in*	
						import share	1.8%

Table T3.1 (continued): Overview of empirical literature on trade liberalization and productivity

literature	countries	period	observations	estimation method	productivity measures	**results** of
Muendler (2004)	Brazilia	1986 - 1998	firm-level	Olley-Pakes (1996), extended	total factor productivity	*10%-points decrease in* nominal tariffs [1.3%; 6.1%]
Pavcnik (2002)	Chile	1979 - 1986	industry-level, plant-level	Olley-Pakes (1996)	total factor productivity	*trade orientation* sectoral (aggregated) 19% plant level difference between traders and non traders [3%;10%]
Schor (2004)	Brazilia	1986 - 1998	plant-level	Olley-Pakes (1996)	total factor productivity	*10%-points decrease in* nominal tariffs [0.4%;1.3%] input tariffs [1.5%; 2.7%]
Topalova (2004)	India	1986 - 1993	industry-level, plant-level	Levinsohn-Petrin (2003)	total factor productivity	*10%-points decrease in* nominal tariffs [0.2%;1.6%]
Trefler (2004)	US, Canada	1980 - 1996	industry-level, plant-level	differences-in-differences	employment growth labor productivity	*change in FTA-mandated tariff concessions* CA: [−12%; −24%] US: [−3%; 9%] CA: [8%;15%] US: [4%;14%]

Table T3.2: German productivity estimations (industry level)

Dependent variable: *real added value* $_{it}$				
	OLS		Levpet	
industry	capital	employees	capital	employees
14: Other mining and quarrying	0.242	0.766	0.591	0.201
15: Manufacturing - food products and beverages	0.281	0.709	0.275	0.608
17: Manufacturing - textiles	0.158	0.709	0.49	0.588
20: Manufacturing - wood and products of wood	0.095	0.931	0.056	0.591
21: Manufacturing - pulp, paper and paper products	0.232	0.72	0.469	0.41
22: Publishing, printing, reproduction of rec. media	0.182	0.734	0.179	0.701
24: Manufacturing - chemicals and chemical products	0.114	0.886	0.028	0.607
25: Manufacturing - rubber and plastic products	0.321	0.554	0.069	0.542
26: Manufacturing - non-metallic mineral products	0.248	0.625	0.281	0.596
27: Manufacturing - basic metals	0.27	0.685	0.342	0.527
28: Manufacturing - fabricated metal products	0.212	0.71	0.1	0.534
29: Manufacturing - machinery and equipment n.e.c.	0.161	0.776	0.382	0.695
31: Manufacturing - electrical machinery	0.151	0.815	0.402	0.685
32: Manufacturing - radio, television, communication	0.4	0.6	0.257	0.706
33: Manufacturing - medical, precision, optical instruments	0.204	0.758	0.065	0.733
34: Manufacturing - motor vehicles, trailers, semi-trailers	0.286	0.668	0.381	0.648
35: Manufacturing - transport equipment	0.188	0.745	0.404	0.593
36: Manufacturing - furniture, n.e.c.	0.182	0.753	0.242	0.751
40: Electricity, gas and water supply	0.308	0.571	0.395	0.367
45: Construction	0.223	0.733	0.186	0.738
50: Sale, repair of motor vehicles and motorcycles	0.256	0.633	0.28	0.43
51: Wholesale trade and commission trade	0.155	0.672	0.165	0.669
52: Retail trade	0.201	0.731	0.068	0.705
60: Land transport, transport via pipelines	0.423	0.395	0.311	0.585
62: Air transport	0.09	0.973	0.444	0.011
64: Post and telecommunications	0.186	0.818	0.387	0.921
67: Activities auxiliary to financial intermediation	0.267	0.369	0.587	0.192
72: Computer and related activities	0.23	0.744	0.196	0.784
74: Other business activities	0.23	0.424	0.135	0.608
90: Sewage and refuse disposal	0.175	0.54	0.004	0.6

Note: The dependent variable is the firm's real added value at plant level i in industry j and year t. All variables are given in natural logs. A constant term as well as year dummies are included throughout all the specifications. The coefficients for each industry are obtained from simple OLS estimations and Levinsohn-Petrin estimations (2003), respectively. Calculations run at a two-digit ISIC industry level. *Source:* Amadeus (Bureau van Dijk 2005). Author's calculations.

Table T3.3: Austrian productivity estimations (industry level)

Dependent variable: *real added value* $_{it}$				
	OLS		Levpet	
industry	capital	employees	capital	employees
15: Manufacturing - food products and beverages	0.438	0.638	0.215	0.702
17: Manufacturing - textiles	0.093	0.924	0.619	0.691
20: Manufacturing - wood and products of wood	0.01	0.393	0.456	0.609
26: Manufacturing - non-metallic mineral products	0.152	0.864	0.559	0.654
27: Manufacturing - basic metals	0.333	0.647	0.711	0.631
28: Manufacturing - fabricated metal products	0.116	0.903	0.51	0.724
29: Manufacturing - machinery and equipment n.e.c.	0.049	0.893	0.376	0.813
32: Manufacturing - radio, television, communication	0.236	0.665	0.585	0.809
36: Manufacturing - furniture, n.e.c.	0.19	0.864	0.657	0.322
40: Electricity, gas and water supply	0.688	0.268	0.49	0.597
45: Construction	0.26	0.699	0.206	0.502
50: Sale, repair of motor vehicles and motorcycles	0.26	0.614	0.419	0.36
51: Wholesale trade and commission trade	0.179	0.671	0.423	0.113
52: Retail trade	0.15	0.806	0.309	0.886
60: Land transport, transport via pipelines	0.181	0.921	0.398	0.663
63: Supporting and auxiliary transport activities	0.146	0.797	0.607	0.028
67: Activities auxiliary to financial intermediation	0.442	0.27	0.502	0.123
74: Other business activities	0.165	0.476	0.504	0.425

Note: The dependent variable is the firm's real added value at plant level i in industry j and year t. All variables are given in natural logs. A constant term as well as year dummies are included throughout all the specifications. The coefficients for each industry are obtained from simple OLS estimations and Levinsohn-Petrin estimations (2003), respectively. Calculations run at a two-digit ISIC industry level.
Source: Amadeus (Bureau van Dijk 2005). Author's calculations.

Table T3.4: Baltic, Central and Eastern European countries

Albania	Latvia
Armenia	Lithuania
Azerbaijan	Macedonia, FYR
Belarus	Moldova
Bosnia and Herzigovina	Poland
Bulgaria	Romania
Croatia	Russian Federation
Czech Republic	Serbia and Montenegro
Estonia	Slovak Republic
Georgia	Slovenia
Hungary	Tajikistan
Kazakhstan	Ukraine
Kyrgyz Republic	Uzbekistan
Latvia	

Source: University of Munich, Chair for International Economics.

Table T3.5: Robustness: Manufacturing vs. services

	Dependent variable: *tfp* $_{it}$ (revenue)									
	Manufacturing					Services				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
tariffs_j	-0.0353***	-0.0342***	-0.0342***	-0.0342***	-0.0339***	-0.1896*	-0.001	0.0047	-0.001	0.0692
	[0.0044]	*[0.0043]*	*[0.0043]*	*[0.0043]*	*[0.0043]*	*[0.1082]*	*[0.0689]*	*[0.0706]*	*[0.0689]*	*[0.0749]*
intra-firm tariff_j		-0.0642***	-0.0642***	-0.0642***	-0.012		-0.2380**	-0.2417**	-0.2380**	-0.0605
		[0.0210]	*[0.0210]*	*[0.0210]*	*[0.0319]*		*[0.1114]*	*[0.1125]*	*[0.1114]*	*[0.0734]*
input tariff_j			-0.0320					-0.1509		
			[0.1123]					*[0.1409]*		
FO				0.7044***	0.8462***				1.6788***	2.3142***
				[0.0845]	*[0.0918]*				*[0.3041]*	*[0.4236]*
FO * intra-firm tariff_j					-0.0525*					-0.2275**
					[0.0316]					*[0.0907]*
#(SH)				-0.0223***	-0.0222***				0.0428***	0.0581***
				[0.0012]	*[0.0012]*				*[0.0082]*	*[0.0107]*
fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Adj. R2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Observations	1136	1136	1136	1136	1136	391	387	387	387	387

Notes: A constant term as well as year, country, and firm fixed effects is included throughout all the specifications. Robust standard errors are in brackets. The dependent variable is the sectoral total factor productivity at the plant level i in industry j and year t. TFP is obtained by the Levinsohn-Petrin-technique (2003) with revenue as dependent variable. *Tariffs* are sectoral tariff rates at the parent industry level. *Intra-firm tariff* is the sum of sectoral average tariff rates weighted with imported goods from one affiliate industry over all imported goods. *Input tariff* is the sum of the sectoral average tariff rates weighted with intermediate inputs imported from one Eastern European affiliate industry over all corresponding intermediates. *FO* is a dummy equal to one if the global ultimate owner is a foreigner. $\#(SH)$ is the number of the firms' shareholders worldwide. *, **, *** indicate significance at the 10, 5, and 1 percent level, respectively.