Agglomeration Economies, Globalization and Productivity: Firm level evidence for Slovenia*

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Abstract

This paper analyzes the impact of distinct types of regional agglomeration economies on firm level performance measured by total factor productivity for Slovenia. The main novelty of the paper lies in introducing agglomeration economies that are linked to globalization in addition to traditional Marshall–type and Jacobs–type of agglomeration effects. We also distinguish between knowledge spillovers related to domestic and foreign sources of agglomeration effects. We find positive effects of all types of agglomeration economies, whereby by far the largest effect is found for the agglomeration spillovers that are linked to globalization, followed by Marshall and Jacobs–type of agglomeration effects. Moreover, these agglomeration externalities are enhanced with foreign firm presence in regions or when interacted with regional exporters' externalities. We also show that firm heterogeneity impacts substantially at firms' ability to benefit from agglomeration effects. Micro and small firms are most likely to benefit from regional externalities of all types, while firms with higher absorptive capacity are more likely to benefit from the Jacobs–type of diversity of ideas and interactions across industries. Our research shows that properly accounting for agglomeration economies requires taking into account the internationalization of firms and firm heterogeneity.

JEL: R10, R15

Key words: total factor productivity, agglomeration economies, globalization

1. Introduction

The riddle of unequal spatial development both within countries and across the world has drawn increased attention from policy makers in recent years[1]. The economic geography literature attributes the regional concentration of economic activity to a delicate trade-off between agglomeration forces and dispersion forces[2]. Agglomeration forces emerge for a number of reasons. Firms want to locate in large markets, close to customers, to reduce trade costs. But by locating in a large market, they make the market larger because workers spend their wages locally, firms supply to each other, etc. In addition, positive knowledge spillovers can occur due to regional specialization when firms operating in the same sector locate close to each other. This is what is usually called Marshallian intra–industry externalities and is mostly measured by the size of labor pooling in a region or an industry within a region.

In contrast, Jacobs (1969) claims that diversity rather than specialization may serve as a mechanism promoting economic growth. More diverse regional industry structure in hand with close proximity stimulates opportunities to imitate, share and recombine ideas and practices across industries. The larger the diversity of firms across industries within a region the bigger is the scope for innovation and growth. Apart from these regional Marshallian externalities and Jacobs–type of externalities, there could also emerge agglomeration economies because of strong local or cross-the-border demand. Firms want to be close to customers, which results in higher demand. This in turn increases wages of local workers, which amplifies the effect of regional externalities (Krugman, 1991).

However, due to the lack of good data sets, the new economic geography literature has remained rather a theoretical concept, with only a small, but growing, number of papers that have attempted to measure the impact of agglomeration economies. For instance, Glaeser et al. (1992) analyze the growth of cities, Ciccone and Hall (1996) measure productivity premia by regressing regional value added on employment density for U.S. states, and Ciccone (2002) performs a similar exercise for the European NUTS2 regions. Combes (2000a) shows how local economic structure (specialization, diversity and degree of competition) influences regional employment growth. Cingano and Schivardi (2004) on the other hand, argue that using regional employment growth results in an identification problem, as the underlying assumption of exogeneity of changes in labor supply as a reaction to changes in local conditions is unlikely to hold. Therefore, the authors use regional TFP to avoid this issue. Also Combes, Duranton and Gobillon (2010) point out the econometric difficulty of identifying agglomeration economies and propose a number

[1] For instance, the World Development Report of 2009 was entirely devoted to the role of economic geography and the unequal spatial development within the European Union has been at the basis of the European Commission structural fund program.
[2] For an excellent overview of the theoretical models see Combes, Mayer and Thisse (2008).

of solutions. Brülhart and Mathys (2008), for instance, extend the work of Ciccone (2002) by introducing dynamics, which allows them to identify and estimate long-run effects. Most of these papers find evidence for positive agglomeration economies, in particular, a doubling of the agglomeration variables is associated with an increase in regional productivity or wages of between 1 to 13 percent.

Largely overlooked in this literature, however, has been the role of globalization in measuring agglomeration economies. For instance, the literature on foreign direct investment (FDI) has demonstrated important technological and knowledge spillovers to domestic firms from the presence of foreign firms (e.g. Javorcik, 2004; Aitken and Harrison, 1999; Damijan et al, 2003, 2013).

Trade liberalization and FDI can be shown to contribute to faster adjustment of relative regional production (and wages) in regions more heavily affected by trade liberalization shock. New economic geography literature represented by two workhorse models by Krugman (1991) and Krugman & Venables (1995) predicts that after a small country liberalizes trade international agglomeration forces reinforced by low trade cost will lead to shift the production from the small to a big country. Similarly, in order to optimize the production capacities according to the changed trade cost, within a country production facilities will move either to the central region or to the border region with a big country. This was empirically confirmed by Hanson (1997) for Mexico, who demonstrates that after the NAFTA Mexico city and maquiladoras at the US border gained in terms of production concentration. The Krugman (1991) model assumes perfect labor mobility, which lead to a monotonic shift of production away from the periphery. The Krugman & Venables (1995) model, however, assumes imperfect labor mobility leading to a kind of U-shaped evolution of regional production concentration. Specifically, after a certain point wages in periphery fall enough, which makes periphery more attractive for firms in the core region and eads to attracting back some of the production facilities. Damijan and Kostevc (2011) introduced the FDI flows into the debate. They demonstrate for five new EU member states that allowing for FDI inflows, which can be attracted to harmed poor regions due to low labor costs, can reverse the negative international agglomeration forces after the trade liberalization shock. Instead, FDI inflows can work towards regional convergence in terms of economic activity and relative regional wages. Thus the stronger the presence of foreign affiliates in a region, the stronger will be knowledge spillovers for firms clustered in a region. In a large region, a bigger presence of FDI amplifies the agglomeration effects, while in a smaller region this may work against the international agglomeration forces.

Likewise, recent work analyzing the effects of firm level trade on productivity suggests that there are learning effects, reflected in higher productivity premia from exporting (e.g. Bernard et al, 1999; De Loecker, 2007; ISGEP, 2007). Firms that are regionally clustered may therefore benefit more from such export externalities, which could be due to sharing of common infrastructure and due to common input-output linkages among firms sharing the same specialized suppliers' networks. Market access through exports does not only generate learning effects for firms participating in international trade, but also allows other firms to benefit from spillovers generated by regional clusters of exporters. This implies that regional agglomeration economies may be amplified through international market access. Two opposing effects can result. If export markets are important, the local market becomes less important, which would work against regional clustering. In contrast, strong export demand can also raise wages of workers locally, which in turn strengthens local demand and thus reinforces the agglomeration economies.

This paper contributes to the emerging empirical literature that attempts to identify and measure agglomeration economies in a number of ways. First, we introduce agglomeration economies that are linked to globalization in addition to traditional Marshall–type and Jacobs–type of agglomeration effects. Second, we make a distinction between knowledge spillovers emerging from domestic firms versus those that emerge from foreign firms. It is often claimed that multinational companies (MNCs) have access to better technology and know-how and therefore knowledge spillovers are more likely to emerge when there are more MNCs in a region (e.g. Javorcik, 2004; Damijan et al., 2013). Third, we analyze how regions that are characterized by firms with more export market exposure may benefit more from export activity through learning spillovers. In this context we explore whether market access through regional clusters of exporters generates additional agglomeration economies at the firm level. We also study whether agglomeration economies that are linked to globalization aggravate the traditional (Marshall, Jacobs) sources of agglomeration effects. Fourth, we study the impact of agglomeration economies according to firm size and firm absorptive capacity to capture heterogeneous firm responses. A final contribution lies in the empirical methodology that we develop. In particular, we estimate total factor productivity using a control function approach, which allows us to control for the endogeneity of input choices and self-selection.

The rest of the paper is structured as follows. In the next section we discuss the empirical methodology, the agglomeration measures and describe the data. Section 3 provides the results. We conclude in section 4.

2. Empirical Approach and Data

2.1. Empirical approach and measurement

We will analyze the impact of agglomeration economies using a firm-level productivity approach. In a first stage, firm-level total factor productivity is estimated, while in a second stage we analyze how agglomeration economies may affect firm level total factor productivity.

Recent applications of estimating total factor productivity based on firm-level production functions have revealed significant problems of potential correlation between input levels and the unobserved firm-specific shocks. The key issue is that firms that experience a large positive productivity shock may respond by using more inputs, which violates the OLS assumption of strict exogeneity of inputs and the error term. This results in biased estimates of the coefficients on capital, which also leads to biased estimates of the total factor productivity (estimated as a residual term in regressing value added on firm capital and labor stocks). In order to account for this endogeneity between inputs and the output, several methods can be applied, such as Olley-Pakes (1996), Levinsohn-Petrin (2003) and General method of moments (GMM).

In this paper, we use as an estimation method the algorithm developed by Levinsohn and Petrin (2003), which builds further on Olley and Pakes (1996). While this approach allows us to control for the endogeneity of the input decisions of firms that are potentially affected by agglomeration economies, it does not capture potential selection effects in terms of initial location of firms. However, in the second stage of our analysis we control for firm fixed effects, which is one way to correct for initial location selection effects[3].

In the first stage of our approach we estimate production functions for each 2-digit NACE sector separately. This allows us to take into account that different sectors face different factor shares embedded in the technology they use. Total factor productivity of a firm is then defined as the estimated residual term in the production function, i.e. the variation in firm level output not explained by the variation in its input factors. We follow Levinsohn and Petrin (2003) and estimate a standard Cobb-Douglas value added production function:

$$y_{it} = \beta_0 + \beta_1 l_{it} + \beta_2 k_{it} + \omega_{it} + \varepsilon_{it} \quad (1)$$

where y stands for the log of (deflated) value added of firm i at time t, net of intermediate inputs (m), l represents the log of firm level employment, k is the log of (deflated) tangible fixed assets. The error has two components, the transmitted productivity component (ω) and ε representing the remaining white noise error

[3] Including firm level fixed effects is equivalent to including the inverse Mills ratio that results from a Heckman selection equation, since the probability of choosing a location for a particular firm is likely to stay constant during the sample period, which is relatively short.

that is uncorrelated with input choices. Employment (l) is considered as a freely variable input, while capital is a state variable and hence, just like the productivity shock (ω), it impacts on firms' decision rules. Demand for the intermediate input (m) is assumed to depend on the firm's state variables k and ω:

$$m_{it} = m_{it}(k_{it}, \omega_{it}) \tag{2}$$

Levinsohn and Petrin (2003) show that the demand function for intermediate inputs is monotonically increasing in ω, which allows inversion of (2) such that:

$$\omega_{it} = \omega_{it}(k_{it}, m_{it}) \tag{3}$$

Expression (3) shows that the unobservable productivity term is now a function of two observable inputs. A final assumption that is required for identificatuion of the input parameters is that the productivity term (ω) follows a first order Markov process. Substituting (3) into (1) and by proxying (3) by a third order polynomial in the observed input factors allows consistent estimation of the coefficient of the freely available labor input. Using the timing assumption governing ω, i.e. a first order Markov process, permits to obtain an estimate of ω. This results in a final step to come up with a consistent estimate of the capital coefficient. For further details of the implementation of the estimation algorithm we refer to Petrin, Levinsohn and Poi (2003). We apply this algorithm to all firms in each 2-digit NACE sector and we include year dummies to control for unobserved aggregate shocks. Using the estimates of the production coefficients, we define the log of measured TFP of firm i at time t in industry j, denoted by tfp_{ijt}, as:

$$tfp_{ijt} = y_{ijt} - \hat{\beta}_l l_{ijt} - \hat{\beta}_k k_{ijt} \tag{4}$$

In a second stage, we regress firm level total factor productivity on our agglomeration measures. As a robustness check, we will also report results using simple proxies for productivity, such as real value added per employee. We will focus on mainly three sources of externalities. The first are the Marshallian intra-industry knowledge spillovers, the second source are the Jacobs' knowledge spillovers that are external to the industry within which the firm operates, while the third source is the role of market access (Krugman, 1991).

Marshall (1890) argued that knowledge externalities were industry specific, since industries specialize geographically in order to benefit from proximity that favors the intra-industry transmission of knowledge, reduces transport costs of inputs and outputs, and allows firms to benefit from a larger labor pooling and specialized skilled labor. One of the two most frequently used proxies for the Marshallian agglomeration effects that have been used in the literature is regional own–industry employment, the other being the location quotient. The location quotient has been criticized as an indicator of local specialization as being very sensitive to the size of the region (Ejermo, 2005) and to the calculation method (Combes, 2000b). On the other hand, own-industry employment has been suggested to be a better proxy for agglomeration economies than the location quotient, as the localization economies arise from the absolute and not the relative size of the industry (see Beaudry and Schiffauerova, 2009) for a survey of the empirical literature). Our preference of the own-employment measure over the location quotient is thus clearly founded in the literature.

We construct such an intra-industry agglomeration measure (*IIS*) by taking the total number of regional employees in particular industry defined at the 2-digit NACE Rev. 1 level. Own firm employment is subtracted to avoid possible endogeneity and 1 is added to ensure that not every observation where the firm may potentially be the only regional representative of its industry is dropped[4]. Our measure is defined as (where *i* stands for firm *i*, in industry *j*, and region *r*) and varies over time *t*:

$$IIS_{ijrt} = \ln\left[\sum_{i \in j \cup r} E_{ijrt} - E_{ijrt} + 1\right] \tag{5}$$

A novel feature of our approach is that in defining *IIS* we make a further distinction between domestic and foreign firms. Domestic knowledge spillovers (*IIS*) refer to the total regional sectoral employment accounted for by domestic firms, while foreign knowledge spillovers (*IIS_For*) refer to total regional sectoral employment accounted for by foreign firms. We would expect the latter to have a bigger impact, given that multinational enterprises typically embody more technological know-how and that there exists ample evidence of positive externalities emerging from foreign direct investment (see Damijan et al., 2013).

Our second measure of agglomeration economies refers to the so-called Jacobs' knowledge spillovers that are external to the industry. Jacobs (1969) claims that the variety of industries within a geographic region promotes knowledge externalities leading to innovative activity and economic growth. Hence, more diverse regional

[4] Since the logarithm of zero is undefined.

industry structure in hand with close proximity stimulates opportunities to imitate, share and recombine ideas and practices across industries. Thus, diversity rather than specialization may serve as a mechanism promoting economic growth. Jacobs' externalities are often associated also to the Porter (1990) competition effects, which are more likely to promote growth. Stronger competition rather than monopoly is believed to serve as an incentive for firms to innovate, speed up technology adoption and to promote growth.

The most commonly used measure of Jacobs' externalities in empirical research is Herfindahl index[5]. This index indicating the degree of the diversity within region and industry usually shows positive or neutral effects. A less frequently used measure is the Gini diversity index, which also yields mostly positive effects. In accordance with the majority of the literature, we define the Jacobs' measure of diversity externalities as the inverse of regional Herfindahl index:[6]

$$invH_{rt} = 1 \Big/ \sum_{i \in j \cup r} s_{ijrt}^{2}, \tag{6}$$

whereby the index is calculated as the sum of the squared shares of firms' value added (s^2) in a given region and sector. The index varies over region and time. Note that according to the above specification, the inverse Herfindahl index measures the extent of diversity both within and between industries in a given region. High values of the inverse Herfindahl index indicate more pronounced diversity and a higher degree of competition within regions.

As a novelty in the literature, in this paper we introduce the third measure of agglomeration economies that are linked to globalization. In particular, we tune in on the importance of scale effects firms can reach from having access to export markets. In doing so, we assume there are two effects to capture. The first is a pure scale effect for the individual firm, the second is related to learning spillovers from export markets. To capture the former, we include the export share at the level of the firm (*Exsh*) for those firms that export and zero for those that do not. The idea of wider agglomeration effects from access to a larger foreign markets builds on the idea of Krugman (1991), Krugman and Venables (1995) and Damijan and Kostevc (2011) who argue that firms located closer to border with a large foreign country may benefit from additional agglomeration forces.

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[5] Usually it is also known as Hirschmann-Herfindahl index.

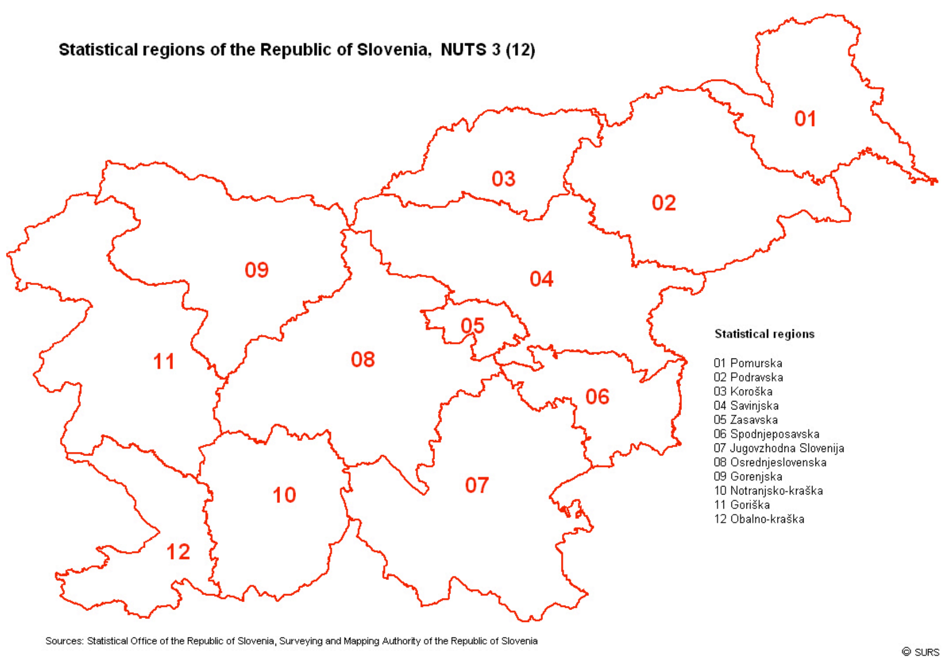
[6] See Beaudry and Schiffauerova (2009), Burger, Van Oort and Linders (2009), and de Groot, Poot and Smit (2009) for a survey of the empirical literature.

To capture wider learning effects from export markets we assume that firms operating in regions with more export exposure are more likely to benefit from the export activity from exporting firms. The learning effects that have been identified in the literature from exporting are therefore likely to spill over to the entire region. As argued above, this can be either due to a number of factors, like sharing common knowledge and expertise as well as sharing same specialized suppliers networks and export platforms. We therefore define our export externalities stemming from increased foreign market access (*MA*), as the share of regional exports (*X*) in total regional sales (*Y*), but we subtract own firm level exports and sales in this measure to avoid endogeneity issues.

$$MA_{ijrt} = \ln\left(\left(\sum_{i \in j \cup r} X_{ijrt} - X_{ijrt}\right) \Big/ \left(\sum_{i \in j \cup r} y_{ijrt} - y_{ijrt}\right)\right) \quad (7)$$

In addition to the three measures of various sources of agglomeration economies, we also control for possible cross–effects between them. In particular, we interact export market access with both the Marshall-type and the Jacobs-type of knowledge spillovers. This will allow us to account for possible magnification of within-industry and cross-industry agglomeration effects when regions and industries are more exposed to foreign market access.

Figure 1: Statistical regions in Slovenia, NUTS-3



Source: Statistical office of Republic of Slovenia

So far we have assumed that most of the agglomeration effects firms are faced with stem from either within region (intra-industry or inter-industry) or from the export markets. There is, however, also a non-negligible source of potential agglomeration effects that arise from the demand from neighboring regions. We account for this by including the term *Neigh*, which is calculated as the sum of output, measured by the value added, of the bordering regions. Here, as it can be seen in Figure 1, some regions are highly isolated, while the others can benefit from many of the surrounding regions. For instance, region 1 can benefit only from region 2, while the central (capital) region 8 can benefit from demand stemming from as much as of seven surrounding regions. This is reflected also in the actual performance of regions, where region 1 is by far the poorest region in Slovenia (with GDP per capita index reaching 65 per cent of the country mean in 2008), while region 8 is the richest region (GDP per capita index 141).

Hence, our final empirical specification can be written as:

$$tfp_{ijrt} = \alpha + \beta_1 IIS_{jrt} + \beta_2 (IIS\_For)_{jrt} + \beta_3 MA_{jrt} + \beta_4 (IIS \times MA)_{jrt} + \beta_5 invH_{rt}\,, \quad (8)$$
$$+\beta_6 (invH \times MA)_{jrt} + \beta_7 Neigh_{rt} + \beta_8 Emp_{ijrt} + \beta_9 Emp^2_{ijrt} + \beta_{10} Exsh_{ijrt} + u_{ij} + \varepsilon_t\,,$$

where *tfp* is log total factor productivity. The right-hand-side (RHS) variables have been described above. Additionally, we include also firm own size and size squared, measured with number of employees, to account for the heterogeneity of firms in terms of size and for possible non-linearities in these size effects. With the exception of the inverse Herfindahl index, all of the RHS variables are specified in logs. Of the error term, u_{ij} controls for firm and industry fixed effects, while ε_t denotes the remaining white noise error.

The model is estimated using the fixed effects estimator. This means that we include firm fixed effects, which enables us to control for unobserved firm heterogeneity and selection effects. For instance, if firms select themselves into agglomerated regions there could be an identification problem. By including firm-level fixed effects, we control for such self-selection, provided that economically concentrated regions only change gradually over time. We will also report a number of robustness results that deal with this issue. Furthermore, we allow the standard errors to be clustered around regions.

In addition, we also include a full set of industry – year specific fixed effects, which control for industry- and time-specific shocks. Note that when performing standard fixed effects regressions at the firm level, industry dummies are by definition differenced out as they are time-invariant. To avoid this, we apply a useful trick that is commonly used in empirical literature. In order to account for time and industry fixed effects, we subtract time and industry mean values from firm-level data. This is done before the fixed effects regression. Thus, fixed effects regressions are done using the industry-year-demeaned firm-level data.

According to the previous discussion, we expect all of the RHS variables to have a positive impact on firm level TFP ($\beta_n > 0$). In particular, we expect that the three major sources of agglomeration effects in our model, Marshall, Jacobs and market access, will demonstrate the largest effects. We expect the Marshall intra-industry agglomeration effects to be further intensified in regions with more intensive presence of MNCs ($\beta_2 > \beta_1$), and stronger in regions with better access to exports markets ($\beta_4 > \beta_1$). Regarding the Jacobs inter-industry agglomeration effects, the outlooks are less clear as in half of the studies surveyed by Beaudry and Schiffauerova (2009) the coefficient for Herfindahl index has been proven positive and insignificant for the other half.

2.2. Data

We use micro data of companies active in manufacturing and services sectors in Slovenia between 2000 and 2008. The data are derived from annual income statements with financial and operational information, including the 3-digit NUTS region in which these firms are located. The data are retrieved from official published income statements and are from the Agency for Public Legal Records and Related Services (AJPES).

In principle, we use the total population of firms across manufacturing and business services sectors.[7] This implies that firms in the financial sector and in public sector (such as healthcare and education) and the whole government sector are excluded. A substantial fraction of firms is also excluded due to data trimming. We excluded all firms with zero employment and zero sales, as well as firms with negative value added. In addition, we also dropped potential outliers, i.e. firms in

[7] According to Nace Rev 1.1, data includes firms in sectors C, D, E, F, G, H, I, K, O.

the lowest and the top centile according to value added per employee. In both cases, those firms are excluded completely for the whole period.

We cover between 30,753 and 42,168 firms per year, which implies that we have 2,913 firms per region and per year on average. However, as shown by table 1, the distribution of firms across regions is highly skewed. The smallest region is represented with less than 500 firms per year (roughly 1.2 per cent of total sample), while the largest region hosts almost one half of the firms in the sample. Similarly, the largest region comprises more than half of the total value added of sampled firms, while the second largest region receives only some 11.8 per cent of total employment and 11.1 per cent of total value added. On the other hand, regions are quite similar in terms of the average number of employees per firm and value added per employee. On average, each firm employs 8.5 workers, with each worker contributing approximately 6,600 euro to value added on average. As indicated by the standard deviations, these figures hide a huge heterogeneity both between regions as well as within regions. The between-variation is mostly due to the exceptional variation in the largest two regions. The largest source of variation within regions seems to come from the size distribution of firms. Micro and small firms dominate the data. Micro firms (with 10 or less employees) and small firms (between 10 and 50 employees) account for 82 and 14 per cent of all firms, respectively. This heterogeneity of firms in terms size and productivity may affect our results on agglomeration externalities. We will therefore pay special attention to it and provide several refined tests to account for this firm heterogeneity.

[*Insert Table 1*]

In terms of exports there seem to be less variation among firms across regions. On average, each firm exports about 2.6 per cent of its total sales, whereby standard deviations reveal quite uniform distribution both between and within regions. Note that figures on average firm export share are low due to the fact that we use the whole universe of Slovenian firms including services firms. A large fraction of micro firms (with one employee only) and the vast majority of the services firms do not export.

In addition, we also provide some insights about the potential agglomeration externalities across regions. Table 2 summarizes four main sources of regional agglomeration spillovers: (*i*) Marshall–type (domestic and foreign intra–industry externalities), (*ii*) Jacobs–type (knowledge spillovers due to inter–industry diversity), (*iii*) global externalities (market access) and (*iv*) cross-regional spillovers from neighboring regions. According to the theory, the largest Marshallian regional externalities are to be expected in the largest regions with largest industries. This is confirmed by Table 2 showing that two largest regions have the above the average potential for intra–industry spillovers. These disadvantages of smaller regions could be counter–vented by larger penetration of foreign firms, but the data suggest that the largest region receives disproportionally more foreign productive capacities than other regions and hence builds even higher potential for Marshall-type of regional externalities.

[*Insert Table 2*]

In terms of the Jacobs–type of knowledge spillovers, the largest region seems to be less favored. Mid-sized regions reveal relatively higher figures of inverse Herfindahl index indicating larger inter–industry diversity and hence more potential for positive knowledge spillovers. The smallest regions, again, seem to be in disadvantage also in terms of cross–industry diversity. In contrast, as shown by table 2, smaller region may benefit in larger extent from the globally–induced knowledge spillovers due to larger shares of exporters. Similarly, as shown by the *Neighbor* indicator, regions bordering to larger regions, in particular those bordering to the capital region, may benefit disproportionally from the demand effects spilling over from larger regions. The largest two regions reveal significant smaller potential for these cross–regional neighbor effects.

Finally, it remains to be verified by estimating model (8), how these four sources of agglomeration externalities impact at the total productivity growth of firms. Results are presented in the next section.

3. Results

This Section presents results obtained from estimating the empirical model (8). We first present the main results, and proceed with results obtained by estimating model (8) by broad industries (manufacturing vs. services), by firm size classes and by productivity quintiles, to check how firm heterogeneity (in terms of firm size and productivity) may matter for understanding agglomeration economies.

3.1. Main results

Table 3 gives our base line results. In column (1) we report the results from estimating model (8). The first row shows the Marshall–type of intra–industry domestic regional externalities. We can note that Marshallian domestic regional externalities have a positive impact on firm level total factor productivity. A doubling of agglomeration externalities would, on average, increase TFP by 3.2 %[8]. Furthermore, these domestic spillovers are amplified by the presence of foreign regional intra–industry agglomeration externalities as reported in the second row of Table 3. Hence, a doubling of regional foreign presence would imply an increase in TFP in Slovenian firms by an additional 0.6 percentage points or 3.8 % in total. This is consistent with the view that foreign firms generate stronger horizontal positive externalities for domestic firms and the internationalization of the production process can be interpreted as beneficial for local firms.

[*Insert Table 3*]

The Jacobs–type of inter–industry externalities due to regional diversity of economic activities, as measured with the inverse Herfindahl index (see row 5), also play an important role. Increasing the regional diversity by 100 %, which is equivalent to increasing the regional diversity in region 5 at par to the one in region 6, would imply an increase in firms' TFP by 1.1 %. Furthermore, if region 5, which is plagued with the highest regional concentration of economic activities, would succeed in increasing the diversity of economic activity to the national level, this would increase the productivity of its firms by 4%.

The evidence so far points towards stronger productivity effects of Marshallian than the Jacobs–type of agglomeration externalities. Both, however, seem to be of lesser importance when compared to the effects of globalization for firm performance. Regional exposure to international markets, measured by what we call market access (MA), defined in equation (7), seem to play much larger role. We find a strong and statistically significant positive effect of international market access on total factor productivity. In particular, a doubling of market access, such

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[8] Since knowledge spillovers are expressed in logarithms, referring to equation (3), a doubling of these spillovers would imply an increase in total factor productivity of $(2^{\beta_1}-1)\times 100\%$.

as increasing the market access in the second largest region to the national level, would imply an increase in TFP of 43 %. Market access and knowledge spillovers arising from the cluster of regional exporters, however, does not only affect firms' TFP directly, but also through interaction effects with the Marshall–type of regional spillovers. A doubling of market access in interaction with the intra–industry agglomeration externalities would imply an increase in firms' TFP by additional 6.2 %. On the other side, Jacobs–type of agglomeration externalities do not seem to be aggravated by the market access forces. In some specifications these interaction terms return significant negative spillovers.

Moreover, in addition to the within–regional externalities firms are shown to benefit also from cross–regional agglomeration effects stemming from the neighboring regions. The '*neighbor effect*' seems to be modest, but highly significant in all specifications. In any case, a doubling of economic size of the neighboring regions would imply an increase in firms' TFP by an additional 0.9 %.

Apart from the regional export spillovers, firms that export also have a better performance. We find that on average a 10 percentage points increase in firm level export shares are associated with an increase in firm level total factor productivity of 0.6 %.

A potential concern that arises is self–selection of firms. The most productive firms locate in the regions where agglomeration effects are strongest, which in turn can strengthen already existing agglomeration economies. Such endogeneity of our agglomeration measures, however, is less likely as we include firm fixed effects in all specifications and hence we control for such self–selection, provided it takes time for regions to build up agglomeration economies. Nevertheless, we also ran the same specification, but with lagged values of our agglomeration measures. The idea is that if self-selection is driving our results, the lagged values of our agglomeration measures should not have an impact on current productivity and hence any positive effect can then be attributed to the actual impact of agglomeration, rather than self-selection. We report these results in the second and third column. The second column includes the RHS variables lagged by one period, while third column includes second lags of the explanatory variables. The point estimates related to knowledge spillovers remain very robust. While the effect of market access goes up in the second column, the effects of Marshallian and Jacobs externalities go down. Using two lags, however, the effects of both become insignificant, while the effects of market access and neighbor externalities remain strong and significant. All in all, the results remain relatively robust, which suggests that self–selection cannot explain the positive effects of agglomeration on measured total factor productivity.

While it seems natural to analyze the impact on total factor productivity, we do rely on the correct estimation of TFP. To check whether our results are robust to alternative measures of productivity, we replace in the fourth column TFP with labor productivity measured by (deflated) value added per worker. Hence, we include as an additional regressor the capital labor ratio to capture the effect that capital–intensive firms typically will have a higher value added per worker. Again, our results remain fairly robust and closely resemble the results obtained with TFP in the first column. The coefficients on Marshallian domestic and foreign agglomeration effects, on Jacobs–type externalities and on market access spillovers are almost identical to the ones obtained using the TFP measure of productivity. This confirms that the results are very robust with regard to the measure of productivity.

The results in Table 3 provide average effects for both manufacturing and services firms, controlling for firm fixed effects as well as sector-year effects. In Table 4 we show separate results for manufacturing and services firms. The results are fairly intuitive. One can see that agglomeration effects stemming from domestic regional agglomeration effects are substantially stronger for service firms. The same applies for agglomeration effects stemming from foreign presence in regions, where these effects become even insignificant for manufacturing firms. One reason for this could be that the embedded knowledge is arguably less tangible in service sectors than in manufacturing firms.

Manufacturing firms, however, seem to gain relatively more from knowledge spillovers due to regional diversity than service firms. On the other side, though service firms are less exposed to international knowledge spillovers they seem to benefit from regional exporter clusters' spillovers in roughly the same extent than manufacturing firms. In contrast, the effects of individual firms' learning in foreign markets, proxied by the firm–level export share, are by some 50% larger for service relative to manufacturing firms. This is probably due to the fact that service firms export less, but those who do experience larger extra learning effects than manufacturing firms that are in general more export oriented. In any case, global knowledge spillovers are shown to provide the single most important source of agglomeration economies as well as to additionally strengthen the regional Marshall–type of agglomeration effects for service firms.

[*Insert Table 4*]

One concern is that the results in tables 3 and 4 do not take into account firm heterogeneity. Both tables provide results for the average firm while controlling for narrow and broad sectors. However, typically, within narrowly defined regions and within sectors there exists a lot of firm heterogeneity. The Slovenian economy in particular is characterized by a large group of micro firms that co-exist with medium and large sized enterprises. Our empirical model (8) controls for firm size by including employment and employment squared. Results in Table 3 demonstrate that size has an important positive and non-linear impact on productivity growth. However, this does not allow for sensing how firm size may affect its ability to gain from the various sources of agglomeration economies.

In addition, previous work shows that firms' absorptive capacity proxied by productivity plays an important role for the ability of firms both to learn from innovation and to benefit from intra-industry spillovers provided by foreign presence (see Damijan et al., 2012; Damijan et al., 2013). In what follows, we therefore analyze how our agglomeration measures may have a differential impact depending on firm size and firm individual absorptive capacity. Arguably, micro firms may benefit more from local knowledge spillovers than large firms given they have less resources to invest in own R&D or on-the-job training. Similarly, more productive firms are more likely to be able to benefit from the agglomeration externalities. We report the results in the next sub-sections.

3.2 Accounting for firm size

Table 5 repeats the results of Table 3, but in addition we report results for five different size classes. They refer to micro firms when the firm employs between 1-9 workers; small firms when the firm has between 10-49 workers; our third size class refers to firms with 50-249 workers, and the final two size classes refer to firms with 250 to 499, and the largest with more than 500 employees.[9]

It is interesting to note that both Marshallian and the Jacobs–type of agglomeration externalities are strong and positive for micro and small firms, but they vanish for the larger ones. This pattern also emerges for our measure of

[9] Note that there is no switching of firms between different size classes as we classify firms to different size classes based on firms' median number of employees in the analyzed period.

market access (or regional export exposure), with stronger results for micro firms, while for the larger ones the effects become small and insignificant. It is only the neighbor effects that remain positive and significant up to the midsize class of firms.

Larger firms, however, are shown to benefit mostly from their individual exposure to export markets. The coefficient for firm export share is of magnitude 4 to 5 times bigger for the class of the largest firms as compared to micro and small firms.

[*Insert Table 5*]

These results are quite telling. Agglomeration effects mainly benefit micro and small firms. There could be due to a number of reasons why especially the smallest firms benefit from agglomeration economies. Typically small firms have less resources to invest in R&D than large firms and by locating in regions with important agglomeration economies in terms of knowledge spillovers they can learn from the larger firms in the region, without having to incur the R&D sunk costs. Also in terms of export exposure small firms can benefit from the regional expertise of international firms and by using or being part of the same specialized regional suppliers networks. This is in line with Chetty and Blankenburg Holm (2000), who find for New Zealand's exporting firms that networks can help firms expose themselves to new opportunities, obtain knowledge, learn from experiences, and benefit from the synergistic effect of pooled resources. Small firms are more flexible than large ones and hence they can adjust their production process faster when there are different shocks in terms of agglomeration rents to benefit from. Finally, small firms have more potential for growth and therefore are more likely to be able to engage in a process of 'catching up' compared to large firms.

3.3 Accounting for firm absorptive capacity

As argued above, firm's absorptive capacity proxied by productivity may be another factor affecting firm ability to benefit from agglomeration economies that are around in the region. We estimate model (8) by subsamples of firms according to their total factor productivity. Firms are allocated into five quintiles according to their initial TFP in 2000 (or the first year a firm enters the sample). The quintiles are held constant throughout the period. This allows us to check how firms' initial absorptive capacity impacts at their ability to learn in different ways from other firms in the same or neighboring regions.

[*Insert Table 6*]

Table 6 shows that firms' absorptive capacity significantly affects the magnitude of how firms can benefit from the Jacobs–type of diversity externalities and the neighbor effects. In both cases, the top quintile of firms (top 20 %) according to productivity levels benefits by as much as three-times more than the lowest quintile (bottom 20 %) of firms. In contrast, absorptive capacity does not seem to differently impact firms' ability to gain from Marshall–type of intra–industry agglomeration effects. The effects are only marginally differently distributed across productivity quintiles. This is true both for domestic and foreign externalities. In terms of market access (i.e. regional exporters' externalities) the results are less clear as the coefficients are significant for the second and fourth quintile only. On the other side, more productive firms seem to benefit the most from their individual export exposure. Firms in the top 20 % quintile gain more than twice that much as firms in the lowest two quintiles.

One of the reasons why firms with higher absorptive capacity may benefit more from the Jacobs–type but not from the Marshall–type of agglomeration externalities as compared to their less productive peers probably lies in the nature of these regional externalities. While Marshallian externalities rely on regional industry size and the corresponding labor pooling and other effects within the industry, the Jacobs–type of externalities relies on knowledge spillovers across industries and in particular on diversity of ideas, practices and innovations. The source of spillovers in the Marshall setup are the benefits of a larger pool of suppliers and larger pool of specialized labor. No special absorptive capacity is needed to benefit from these general sectoral externalities. In contrast, the source of knowledge spillovers in the Jacobs setup is diversity of ideas and interactions across industries facilitating experimentation and innovation. Only more productive firms have the absorptive capacity to take active part in the processes of imitation, sharing and recombination of ideas and practices across industries.

4. Conclusions

The paper studies the impact of various sources of regional agglomeration economies on firm level performance measured by total factor productivity in Slovenia. The main contribution of the paper lies in introducing agglomeration economies that are linked to globalization in addition to well-known Marshall–type and Jacobs–type of agglomeration effects. We call this additional source of regional externalities market access and measure it with regional pool of exporters. In addition, we also introduce cross–regional externalities stemming from the neighboring regions. In estimating the impact of agglomeration on total factor productivity we take into account potential endogeneity of the input choices and selection effects. Furthermore, we distinguish between domestic and foreign Marshall–type of regional agglomeration effects and allow for interaction with the agglomeration economies that are linked to globalization measured with regional exporters' externalities.

We find positive effects of all four types of agglomeration economies, whereby by far the largest effect is found for the agglomeration spillovers that are linked to globalization, followed by Marshall–type and Jacobs–type of agglomeration effects and the least effect is found for the neighbor effects. Moreover, these agglomeration effects are enhanced with foreign firm presence in regions or when interacted with regional exporters' externalities. We show that firm heterogeneity impacts substantially at firms' ability to benefit from agglomeration effects. Micro and small firms are most likely to benefit from regional externalities of all types, while firms with higher absorptive capacity, i.e. most productive firms, are more likely to benefit from the Jacobs–type of diversity of ideas and interactions across industries.

Our research shows that properly accounting for agglomeration economies requires to take into account the internationalization of firms and firm heterogeneity.

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Tables to be included in text

Table 1: Summary Statistics for 2008

Region	N	Region share in value added	Total employ-ment	Employees per firm		VA/emp per firm (EUR)		Firm export share	
				mean	s.d.	mean	s.d.	mean	s.d.
1	1,048	0.024	12,610	12.0	40.6	6,246	14,420	0.036	0.140
2	4,966	0.111	49,707	10.0	98.6	5,920	121,080	0.024	0.109
3	792	0.015	8,030	10.1	51.4	8,074	42,708	0.025	0.107
4	3,872	0.097	39,703	10.3	71.1	6,970	22,815	0.030	0.124
5	488	0.010	4,037	8.3	22.5	5,102	43,066	0.018	0.083
6	771	0.021	5,872	7.6	25.2	7,356	31,258	0.039	0.147
7	1,741	0.031	14,742	8.5	29.0	6,357	11,022	0.032	0.135
8	19,276	0.511	160,518	8.3	115.0	6,886	74,536	0.024	0.109
9	3,885	0.064	24,324	6.3	50.1	6,753	14,115	0.025	0.111
10	665	0.009	4,370	6.6	19.7	5,512	12,229	0.030	0.119
11	2,046	0.049	17,186	8.4	56.9	4,414	86,834	0.026	0.115
12	2,618	0.058	18,587	7.1	34.8	8,020	35,351	0.025	0.111
Total	42,168	1.000	359,686	8.5	90.9	6,657	69,706	0.026	0.114

Source: AJPES; own calculations.

Table 2: Sources of agglomeration externalities in 2008 (mean and standard deviations)

Region	Marshall domestic (IIS)	Marshall foreign (IIS_For)	Jacobs (inverse Herf. index)	Global (Market access)	Neighbor
1	5.94	1.58	23.60	0.138	0.111
2	7.55	4.68	36.50	0.051	0.136
3	5.40	1.02	17.50	0.044	0.208
4	7.37	2.08	26.80	0.065	0.667
5	5.17	0.21	6.80	0.128	0.629
6	5.27	2.04	12.90	0.060	0.138
7	6.38	1.28	18.10	0.109	0.541
8	8.88	6.76	28.10	0.121	0.260
9	6.87	2.11	21.40	0.174	0.569
10	4.98	0.64	11.10	0.153	0.649
11	6.46	2.65	18.70	0.064	0.642
12	6.58	3.77	36.80	0.082	0.058
Total	7.73	4.55	26.90	0.105	0.332
(s.d.)	1.77	3.03	26.40	0.036	0.196

Source: AJPES; own calculations.

Table 3: Agglomeration effects in Slovenia, base results

	(1)	(2)	(3)	(4)
	TFP	TFP	TFP	VA/emp
Number of lags (*s*)	*s*=0	*s*=1	*s*=2	*s*=0
IIS_{t-s}	0.045***	0.017**	-0.002	0.043***
	[6.38]	[2.54]	[-0.30]	[6.23]
IIS_For_{t-s}	0.008***	0.009***	0.008***	0.006***
	[3.63]	[4.02]	[3.40]	[2.63]
MA_{t-s}	0.517***	0.721***	0.333**	0.510***
	[3.82]	[5.46]	[2.53]	[3.82]
$IIS * MA_{t-s}$	0.087*	0.124***	0.065	0.149***
	[1.79]	[2.73]	[1.43]	[3.14]
$Inv.HERF_{t-s}$	0.016***	0.008**	0.001	0.017***
	[4.54]	[2.35]	[0.21]	[4.77]
$Inv.HERF * MA_{t-s}$	-0.048	-0.206***	-0.068	0.011
	[-0.60]	[-2.65]	[-0.68]	[0.13]
$Neighbor_{t-s}$	0.013***	0.018***	0.017***	0.007***
	[7.00]	[8.60]	[6.80]	[3.83]
Emp_{t-s}	0.362***	0.167***	-0.104*	-0.358***
	[7.35]	[3.44]	[-1.85]	[-7.55]
$Emp\text{-}sq_{t-s}$	-0.144***	-0.065**	0.080**	0.059*
	[-4.51]	[-2.04]	[2.16]	[1.94]
$Exsh_{t-s}$	0.059***	0.015***	0.018***	0.060***
	[10.90]	[2.73]	[3.21]	[11.13]
K/emp_{t}				0.111***
				[53.21]
Constant	0.007***	0.026***	0.037***	0.036***
	[3.17]	[12.70]	[15.20]	[17.83]
Firm level fixed effects	Yes	Yes	Yes	Yes
Year-industry effects	Yes	Yes	Yes	Yes
Observations	205,357	170,636	140,519	205,357
R-squared	0.149	0.075	0.0044	0.090
Number of firms	35,564	32,335	29,377	35,564

Note: Fixed effects regression. Robust t-statistics in brackets; *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Agglomeration effects in Slovenia, accounting for difference between manufacturing and services firms

	(1) Manufacturing	(2) Services
IIS	0.023**	0.060***
	[2.19]	[5.71]
IIS_For	-0.003	0.013***
	[-0.63]	[4.63]
MA	0.651***	0.610***
	[2.82]	[3.79]
*IIS * MA*	0.104	0.117**
	[1.00]	[2.08]
Inv.HERF	0.026***	0.016***
	[2.84]	[4.01]
*Inv.HERF * MA*	-0.589***	0.033
	[-3.33]	[0.38]
Neighbor	0.012***	0.014***
	[3.10]	[6.77]
Emp	0.553***	0.358***
	[3.87]	[6.87]
Emp-sq	-0.261***	-0.143***
	[-2.84]	[-4.27]
Exsh	0.048***	0.062***
	[5.02]	[9.51]
Constant	0.006	0.006***
	[1.16]	[2.80]
Firm level fixed effects	Yes	Yes
Year-industry effects	Yes	Yes
Observations	31,814	170,969
R-squared	0.208	0.117
Number of firms	5,872	30,205

Note: Fixed effects regression. Robust t-statistics in brackets; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Agglomeration effects in Slovenia, by size classes

	(1) Pooled	(2) SC1	(3) SC2	(4) SC3	(5) SC4	(6) SC5
IIS	0.038***	0.043***	0.043**	0.005	-0.082**	-0.021
	[5.35]	[4.96]	[2.54]	[0.25]	[-2.07]	[-0.35]
IIS_For	0.006**	0.006**	0.004	0.005	0.024	0.013
	[2.43]	[2.17]	[0.94]	[0.63]	[1.50]	[0.56]
MA	0.508***	0.604***	0.136	0.194	0.803	-1.241
	[3.72]	[3.79]	[0.45]	[0.40]	[0.56]	[-0.83]
*IIS * MA*	0.097**	0.153***	-0.179*	-0.107	0.056	-0.492
	[2.01]	[2.77]	[-1.78]	[-0.59]	[0.13]	[-0.64]
Inv.HERF	0.015***	0.019***	0.002	-0.028	0.090	-0.001
	[4.19]	[4.60]	[0.27]	[-1.51]	[1.15]	[-0.02]
*Inv.HERF * MA*	-0.063	-0.045	-0.193	-0.033	0.488	-1.197
	[-0.78]	[-0.51]	[-0.99]	[-0.06]	[0.67]	[-1.02]
Neighbor	0.010***	0.010***	0.010**	0.014**	0.009	0.005
	[5.38]	[4.59]	[2.40]	[1.99]	[0.52]	[0.20]
Exsh	0.067***	0.074***	0.046***	0.003	-0.056	0.283**
	[12.28]	[11.71]	[4.23]	[0.09]	[-0.66]	[2.34]
Constant	0.004***	-0.124***	0.530***	0.803***	1.282***	1.286***
	[6.08]	[-145.51]	[325.79]	[171.66]	[48.20]	[28.25]
Firm level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	209,027	171,980	29,326	6,526	750	445
R-squared	0.015	0.010	0.028	0.0001	0.028	0.0005
Number of firms	35,955	30,507	4,281	993	112	62

Notes: SC1 refers to micro firms (1-9 workers), SC2 – small firms (10-49 workers), SC3 – midsize firms (50-249 workers), and SC4 (250 to 499) and SC5 (more than 500 employees) refer to the largest firms. Fixed effects regression. Robust t-statistics in brackets; *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Agglomeration effects in Slovenia, by productivity quintiles

	(1) Pooled	(2) Quint.1	(3) Quint.2	(4) Quint.3	(5) Quint.4	(6) Quint.5
IIS	0.045***	0.065***	0.038***	0.023	0.049***	0.047***
	[6.38]	[3.96]	[2.92]	[1.47]	[2.86]	[2.64]
IIS_For	0.008***	0.007	0.008*	0.012**	0.008*	0.005
	[3.63]	[1.22]	[1.67]	[2.35]	[1.64]	[0.90]
MA	0.517***	0.263	0.985***	0.163	0.915***	0.105
	[3.82]	[0.81]	[3.46]	[0.53]	[3.37]	[0.35]
*IIS * MA*	0.087*	0.109	0.217**	0.010	0.164*	-0.065
	[1.79]	[0.74]	[2.20]	[0.11]	[1.84]	[-0.74]
Inv.HERF	0.016***	0.033**	0.025***	0.013	0.010	0.012*
	[4.54]	[2.51]	[2.60]	[1.62]	[1.57]	[1.76]
*Inv.HERF * MA*	-0.048	-0.413	-0.104	0.036	0.193	-0.180
	[-0.60]	[-1.57]	[-0.48]	[0.21]	[1.30]	[-1.23]
Neighbor	0.013***	0.022***	0.015***	0.020***	0.003	0.007*
	[7.00]	[3.94]	[3.72]	[5.20]	[0.75]	[1.93]
Emp	0.362***	0.618***	0.262***	0.280***	0.449***	0.618***
	[7.35]	[4.85]	[2.84]	[2.89]	[4.96]	[3.61]
Emp-sq	-0.144***	-0.226***	-0.052	-0.103	-0.220***	-0.398***
	[-4.51]	[-2.85]	[-0.90]	[-1.64]	[-3.77]	[-3.37]
Exsh	0.059***	0.105***	0.058***	0.078***	0.040***	0.039***
	[10.90]	[5.72]	[4.60]	[6.68]	[3.79]	[3.97]
Constant	0.007***	-0.662***	-0.236***	-0.080***	0.167***	0.734***
	[3.17]	[-58.60]	[-50.48]	[-19.21]	[37.38]	[56.32]
Firm level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	205,357	34,327	40,645	42,135	43,901	44,349
R-squared	0.149	0.039	0.072	0.061	0.042	0.055
Number of firms	35,564	8,110	7,140	6,909	6,690	6,715

Notes: Quintile 1 consists of top 20 % and quintile 5 consists of the bottom 20 % of firms according to initial TFP in 2000. Fixed effects regression. Robust t-statistics in brackets; *** p<0.01, ** p<0.05, * p<0.1.