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Is Austria's Economy Locked-in in the CESEE Region?

Austria's Competitiveness at the Micro-level

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Abstract

This paper analyses the competitiveness of Austrian manufacturing industries by comparing the performance of Austrian firms with the Western European firms using recent estimates of TFP across Wider Europe (EU-28 plus Western Balkans) during the period 2007-2015. According to the TFP estimates, Austrian firms with larger turnovers, and less employment, in regions with less regional-industrial concentration of labour have become more competitive in terms of TFP. Using firm's TFP and other characteristics aggregated by industries across Wider Europe, a gravity model for exports is estimated. Results show that larger trade across countries in the sample is driven by intra-firm trade, better efficiency of industries in terms of simple average of TFP growth of firms and more allocation of capital to more efficient firms. Comparing the actual values of exports from Austria to CESEE with the predicted values of the gravity model, I found that since 2012 excessive exports were directed to Western Europe rather than to CESEE. In a robustness check using unilateral exports value, these interesting findings also confirmed that a potential Austrian lock-in effect in the CESEE region reversed and trade diverged to the more competitive market of Western Europe.

Keywords: firm performance, total factor productivity (TFP), gravity model, exports performance, lock-in effect

JEL classification: D22, D24, F14, F15, F23, L25

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1. Introduction

Austria's economic competitiveness is of regular concern to the country's wider public. Fenz et al. (2015) found that the Austrian economy has lost some of its goods exports share to Germany over the last couple of years and that this was replaced by higher shares of exports from countries of Central, East and Southeast Europe (CESEE) to the German market. Overall this was seen as an indicator of a decline in Austrian competitiveness as markets in Germany and Western Europe are more competitive and demanding than Eastern Europe.

It is interesting to mention that between 1996 and 2015, the loss of about eight percentage points of Austrian goods exports share to Germany (which stood at more than 30% in 2015) was partly compensated by an increase in the share of exports to the economies in CESEE (which increased from 16% in 1996 to above 21% in 2015) (Holzner, 2015).

Taking export shares might not be a sufficient and suitable comparative tool for analysing competitiveness, as some other factors could be affecting the level of exports to a certain destination. By taking determining factors of exports into consideration, one can obtain a more comprehensive approach to find out how the competitiveness of a country has evolved. Here, this attempt is made using data on firms at the very micro level. By studying how their competitiveness evolved and how it affected export values, I analyse whether there has been excessive export behaviour of Austrian firms to the CESEE[1] region. The excessive exports will be calculated as the distance from the actual value of exports to a certain destination from its predicted value obtained from a gravity model.

In recent years, there has been a growing interest in assessing the competitiveness of heterogeneous firms at different levels of aggregation. While there is no consensus on a common definition of competitiveness, this study was motivated by the definition of '*foundational competitiveness'* as reiterated by the President of the European Central Bank (ECB), Mario Draghi in 2012: "*A competitive economy, in essence, is one in which institutional and macroeconomic conditions allow productive firms to thrive. In turn, the development of these firms supports the expansion of employment, investment and trade*."[2]

While economic policies are directed at aggregate outcomes, it is the firms at the micro level that are the economic agents affected and that can shape and change the patterns of sustainable growth through their competitiveness. From the aforementioned definition by Mario Draghi, the competitiveness at the micro level could be explained as the efficiency of firms in converting the factors and inputs of production into output. In fact, Total Factor Productivity (TFP) of firms is the essential indicator of micro competitiveness that is enhanced through innovation and technological advancements (Duguet, 2006; Aiello et al., 2015).

1 In this research, Central Eastern Member States of the EU (EU-CEE) plus Bosnia and Herzegovina, Macedonia, Montenegro, and Serbia are included in the sample of CESEE.

2 https://www.ecb.europa.eu/press/key/date/2012/html/sp121130.en.html

Aggregating firms' TFP to industry and country levels will help us to analyse the role of these micro-agents in the competitiveness at the more aggregated levels. As the first aim of this research, I will explore Austrian competitiveness by comparing the aggregate performance of Austrian firms with those in other Western European countries during the period 2007-2015 using the firms' TFP estimates from an earlier work (Fattorini et al., 2018). It is also important to find out how the allocation of factors of production (e.g. capital or total assets) to more efficient firms could affect the export performance of industries. Thus, the allocative efficiencies will be also measured and compared in the sample of Western Europe.

As the second aim, this research investigates to what extent firm performance is related to the aggregate industrial exports. The overarching research question of this study is whether the opening to the East by the expansion of the European Union actually supported Austrian competitiveness or whether it had a lock-in-effect in the CESEE region. The development of Austrian competitiveness measured in exports performance will also be compared to the development of competitiveness in its Western neighbours that were also (but to a lesser extent) engaged in intensifying economic ties with CESEE over the last decades.

While in the previous study (Fattorini et al., 2018) I analysed how macroeconomic conditions allow productive firms to thrive, in this paper I analyse the lock-in effect. To calculate the exports performance and compare it across all countries one needs to normalise exports with determining variables. The persistent Austrian export patterns to CESEE and stagnated penetration to other markets is studied following the strand of the literature on gravity models. Having a gravity model of manufacturing exports across EU-28 and Western Balkan including aggregate firm-level variables, the ratio of the actual exports value to specific destinations over the model-predicted exports value indicates the exports performance of countries normalised by the theoretical determining factors. By comparing such an indicator of exports performance of Austria to CESEE with other destinations, and with other exporters in Western Europe during the period 2007-2015, I will test whether there are excessive Austrian manufacturing exports to CESEE, namely the lock-in effect in CESEE.

One reason for the locked-in trade might be related to intra-industrial trade patterns due to vertical integration of multinational enterprises (MNEs). Austrian ownership structure remaining focused on the CESEE economies might be the cause of a persistent lock-in effect. Intra-firm trade may be the driving force behind the intra-industrial trade flows to CESEE. By setting up the gravity model at the industry level, I test how foreign-ownership and the materials of inputs used by the subsidiaries in the destination economy are related to trade flow patterns from the home to the host (destination market) of the MNE. Additionally, using the industry aggregates of TFP of firms, this study shows how the micro foundation of industrial performance is playing a role in exports. TFP level and growth, and distribution of capital to more efficient firms within the industries (i.e. allocative efficiency) can explain how the European industries perform in the neighbouring markets.

The rest of the paper is organised as follows. The second section reviews the related literature. The third section elaborates on the methodological approach and describes the data used in this study. The fourth section presents the results of the analysis. The final section provides a summary and conclusions.

2. Literature review

There is a general consensus on the broad definition of TFP which considers TFP as the efficiency of a firm to turn inputs of production like capital and labour into products (Hulten, 2001; Katayama et al., 2009; and van Beveren, 2012; Gal, 2013). According to this literature, productivity of an individual firm is measured relative to the average ability of all comparable firms within the industry (and/or within a region). The benchmark efficiency and technological level across firms are therefore corrected using econometric techniques.

At the firm-level, various econometric approaches have been suggested for examining productivity performance. The estimation of TFP needs to be dealt with carefully to arrive at unbiased and consistent estimates. Endogeneity bias is one important issue. For instance, Marschak and Andrews (1944) stated that the selection of inputs in the production is determined by firms' characteristics such as efficiency. De Loecker (2011) addressed this issue as a correlation between levels of inputs employed by the firm and unobserved productivity shocks. The positive correlation between the error term and inputs has been controlled in the approach proposed by Olley and Pakes (1996) by using investment as a proxy for unobserved TFP shocks. Levinsohn and Petrin (2003) and Wooldridge (2009) proposed intermediate inputs instead of investment for fixing the endogeneity problem considering a different technical approach. Other issues such as selection bias related to the exit of firms (Olley and Pakes, 1996; De Loecker, 2011), omitted price bias that refers to the lack of price information for inputs and outputs at the firm-level (Eslava et al., 2004; Ornaghi, 2006) and a multi-product issue that stems from the lack of information on the production of different products in the data (Bernard et al., 2009) have also been addressed in the literature and relevant technical methodologies have been proposed.

More recent approaches have developed semi-parametric estimators to overcome some of the methodological issues described above. The basic idea underlying Olley and Pakes (1996) to eliminate the endogeneity problem is to find an equation that makes the production shock observable to the researcher. Specifically, they use investment (when strictly positive) as a proxy variable. The Olley and Pakes (1996) procedure consists of two steps: first, consistent estimates of the labour and materials coefficients are computed, after eliminating the unobservable causing the endogeneity problem; second, exploiting information on firm dynamics, the coefficient on capital is estimated. Olley and Pakes (1996) also address the sample selection problem, considering that unproductive firms may exit the market, with the introduction of survival probabilities.

Levinsohn and Petrin (2003) advocate that firms with the same capital stock and investment may have different productivity levels. In practice, investment activity is lumpy, and investment is often zero. As an alternative, Levinsohn and Petrin (2003) propose to use a non-dynamic variable, i.e. intermediate inputs, as a proxy for the unobservable. Then, first and second stages follow from Olley and Pakes (1996). Hansen (2010) estimated TFP of Austrian and German firms applying the Levinsohn and Petrin (2003) technique and using the Amadeus firm-level data for the period 1994-2003. Merging the data with another analysis reporting exporting activities of firms, Hansen (2010) finds that exporting firms are around 40 percent more productive. Altomonte et al. (2013) also used this technique to estimate TFP of firms across Austria, France, Germany, Hungary, Italy, Spain and the United Kingdom. They find that internationalisation of firms is positively related with their innovation and productivity.

Wooldridge (2009) proposes estimating both stages simultaneously, i.e. a system of two equations, in a single GMM step, specifying lags of capital and inputs as instrumental variables for materials and labour. This improves the two-step estimation in terms of efficiency, and robust standard errors are easy to obtain.

In a more recent work, Ackerberg et al. (2015) extend the semi-parametric estimator of Olley and Pakes (1996) to overcome the issues related to the identification of the labour coefficient in the first stage. The critique arises from the fact that labour may be collinear to the non-parametric function in capital and labour used in the first stage. The solution that they propose is the identification of the labour coefficient in the second stage, assuming a conditional intermediate inputs demand function. In their approach, a firm is assumed to decide on investment in the period before, and the demand on intermediate inputs is strictly increasing with the unobserved productivity. Solving the maximisation problem of a firm using these assumptions allows identifying the productivity shock that is not observable by the researcher.

Emphasising the role of individual firm's decisions in driving the competitiveness and aggregate performance of an economy, macroeconomic shocks have significant but heterogeneous impact on the performance of firms. Depending on the firms' distribution in size and productivity, the response of the economy to external or internal macro imbalances such as relative prices, interest rates, and exchange rates is diverse. A recent study by the European Central Bank indicates that the member states with a larger share of low productive firms are more affected by exchange rate devaluations (Lopez-Garcia and Di Mauro, 2015).

In this research, the starting point is the individual firm performance as firms are seen as important agents affecting longer-term productivity growth. In an earlier study (Fattorini et al., 2018), we estimated TFP of more than 500,000 firms across the EU-28 and Western Balkan countries during the period 2007-2015. After deflating the nominal revenues and materials using appropriate producer price indices (PPIs) across industries and exchange rates across countries, TFPs were estimated by each NACE 2-digit industry across the whole Wider Europe. The semi-parametric estimator approach proposed by Ackerberg et al. (2015) was used. In this way, the simultaneity bias, briefly explained above, was carefully addressed. Furthermore, the TFP growth of firms was tested against some macroeconomic indicators. According to the results of the study, the TFP growth of a representative average firm in the European Union is positively affected by financial support from the European Regional Development Fund (ERDF) for Research, Technology and Development (RTD). The result is robust across different specifications controlling for the sample selection and endogeneity biases (Fattorini et al., 2018). Moreover, RTD funds enhance the growth of TFP at the bottom of the TFP distribution more than the top, which points at the stimulated innovativeness in the least efficient firms either through technological spillovers or through innovation processes. However, based on baseline results and several robustness checks controlling for the endogeneity of funds, ERDF on Business Support (BS) does not significantly relate to firms' TFP growth. Regional GDP and firm size in terms of employment are also positively related with the TFP growth of firms in the EU regions. However, firm size in terms of turnover is negatively related to TFP growth of firms across the EU.

By confining the sample to only Austrian firms, most of the explanatory variables in the earlier study become statistically insignificant (mostly due to lack of variations across only a few Austrian NUTS-2 regional variables) except for the size of firms in turnover and employment and agglomeration externalities. The size of Austrian firms in terms of employment is then negatively related to their TFP growth, while their size in terms of turnover is positively related to TFP growth. In fact, smaller Austrian firms in terms of employment and larger firms in terms of turnover had higher TFP growth during the period 2007-2015, a relationship opposite to that of an average EU firm presented in Fattorini et al (2018). Agglomeration externalities still remain negatively related to TFP growth, meaning that in a NUTS-2 region with smaller area where more employment is concentrated (density of regional-industrial employment), the TFP of firms would grow less.[3] Therefore, it could be argued that Austrian firms with larger turnover, and less employment, in regions with less density of labour have become more competitive in terms of TFP.

This study additionally uses gravity econometrics modelling to estimate bilateral exports flows. Bilateral trade flows were analysed in a seminal gravity model introduced by Tinbergen (1962). Similar to Newton's Law of Gravity, Jan Tinbergen illustrated that trade flows are increasing with the total income of two trading partners and decreasing with the distance between the two. Since then a large body of literature on the topic has emerged and added further statistical and theoretical details to the gravity models. Anderson (1979) established a theoretical framework to explain the gravity model using constant elasticity of substitution. An imperfect competition and product differentiation framework was then added to the model by Eaton and Kortum (2002) and Anderson and van Wincoop (2003) who also addressed the multilateral resistances (MLR), a necessary component in trade flows that need careful attention in the econometrics modelling of gravity. Head and Mayer (2014) offer a detailed discussion on issues related to gravity modelling.

Intra-firm trade contributing to the literature on both foreign direct investment (FDI) and global value chains (GVC) has been studied as one of the key drivers of global trade (Navaretti et al., 2006). In an imperfect competition and differentiated products framework, Antràs (2003) illustrated theoretically how a firm vertically integrates and expands its production in another location and how patterns of intra-firm trade develop between countries. Antràs and Helpman (2004) also develop a theoretical framework on how firms decide to choose strategies for supplying their intermediate inputs to their final products. Lanz and Miroudot (2011) highlights the importance of intra-firm trade in the explanation of trade collapse during 2008-2009, development of GVC and related trade policy implications.

This paper contributes to the existing literature by first analysing the competitiveness of Austrian firms in comparison to Western Europe during the period 2007-2015. Firm's TFP estimated in an earlier study (Fattorini et al., 2018) across Wider Europe (EU-28 plus Western Balkans) using the most recent semi-parametric technique are used in this study to indicate in which manufacturing sectors Austrian firms are most competitive. The updated more comprehensive firm-level data on European and Austrian firms using the recent TFP estimation technique add to previous studies in the literature such as that by Hansen (2010) and Altomonte et al. (2013) and Dhyne et al. (2014). The second contribution is the investigation of how firm-level characteristics aggregated at the industry level are associated with exports performance across Wider Europe[4]. The third contribution is a test on whether there is an Austrian lock-in effect in the CESEE region, i.e. excessive Austrian manufacturing exports to the CESEE during the period 2007-2015. This paper empirically contributes to several strands of the economic literature, such as New Trade Theory à la Melitz (2003), gravity modelling and intra-firm trade.

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3 These results are available upon request.

4 Dhyne et al. (2014) have done a similar exercise but across 11 European countries.

3. Methodology

3.1. TFP

For the calculation of firm-level TFP in the literature, it is common to assume that production in firm i in industry j located in country c at time t takes the following form of a Cobb-Douglas production function:

$$Y_{ijct} = A_{ijct}\, K_{ijct}{}^{\alpha_k} L_{ijct}{}^{\alpha_l} M_{ijct}{}^{\alpha_m} \qquad (1)$$

where Y denotes physical output; K, L, and M are respectively inputs of capital, labour and materials; and A is the traditional TFP measure. Assuming a homogeneous production function in each industry j across all countries, in order to be able to estimate (1), I consider the log transformation:

$$y_{ijct} = \alpha_{j0} + \alpha_k k_{ijct} + \alpha_l l_{ijct} + \alpha_m m_{ijct} + \varepsilon_{ijct} \qquad (2)$$

where lower case letters indicate natural logarithms and α_f $(, f = k, l, m)$ parameters refer to the share of the contribution of traditional inputs to output; and ε_{ijct} is the usual error term. Total factor productivity is then defined as

$$\ln(A_{ijct}) = \alpha_{j0} + \varepsilon_{ijct} \qquad (3)$$

In previous studies, equation (2) was estimated for each industry (firms across one country), where α_{j0} indicates the mean level of efficiency across firms within industry j over time, and ε_{ijct} is the deviation of time-producer specific efficiency from that mean in the country. The latter has an unobservable component μ_{ijct} that can be corrected by semi-parametric production function estimations in the literature (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Wooldridge, 2009; De Loecker, 2011; Ackerberg et al., 2015) and a predictable observable component ϑ_{ijct}. The former thus becomes an i.i.d. component including unobserved characteristics that can be correlated with the benchmark level efficiency at the country-industry level. Estimating equation (2) by industry, the measure of TFP then becomes

$$\ln(A_{ijct}) = \alpha_{j0} + \varepsilon_{ijct} = \alpha_{j0} + \mu_{ijct} + \vartheta_{ijct}$$

hence, $\varphi_{icjt} = \alpha_{j0} + \mu_{ijct}$ represents the firm's efficiency.

Therefore, after controlling for characteristics of the unobserved effects μ_{ijct} in regressions which show the deviation from the mean, the TFP measure at the firm-level will be calculated by the fitted parameters of the following equation:

$$\varphi_{ijct} = y_{ijct} - \left(\hat{\alpha}_k k_{ijct} + \hat{\alpha}_l l_{ijct} + \hat{\alpha}_m m_{icrt}\right) \qquad (4)$$

Equation (4) will provide for the fitted values of the estimates at the industry level across all regions. In this study, I use φ_{ijct} estimated by Fattorini et al. (2018) using the semi-parametric production function proposed by Ackerberg et al. (2015). The estimations are run across the sample of 28 EU members and Western Balkan countries within each NACE 2-digit industry.

In the earlier paper, in order to estimate TFP we calculated factor elasticities for each industry on a continental (Wider Europe) scale to be able to assess the competitiveness of firms horizontally across national borders. In the integrated framework of a Single Market, characterised by increasing economic integration, competitive pressure is usually thought to have diverse impacts on productivity as it is referred to in the literature of economic geography (Beaudry and Schiffauerova, 2009). Therefore, it was assumed that the functional form of the production was uniform across the industry in Wider Europe and the differences were due to the differences in TFP, which is the efficiency in choosing the best sets of inputs to produce the most of output in the industry. We compared those results with TFP estimated by each industry and country. We found some examples where the firm was very efficient with a very large estimated TFP by country, while the same firm was not that efficient when being estimated across Wider Europe. Thus, in order to compare the competitiveness of firms in a country with other countries' we opt for using the TFPs estimated by industry across the whole sample of countries.

The next section will provide descriptive statistics on the relevant firm's characteristics and the estimated TFP comparing Austrian firms with those from western EU countries.

3.2. EXPORT PERFORMANCE

There is a general consensus that more productive firms are better able to reach potential markets for exports (extensive margins) and also have higher export levels (intensive margins) (Melitz, 2003; Helpman et al., 2008; Melitz and Ottaviano, 2008). The productivity of firms therefore is strongly related to their exporting performance. Therefore, I will investigate the role of firms' dynamics in the Intra-EU export performance of industries. However, since there is a lack of coverage of firms' export information in the Amadeus database, I will combine exports at the industrial aggregates matching with the firm's variables.

3.2.1. Aggregate firms' efficiency

The first stage will be to have an aggregate indicator for the efficiency of firms within each country and each industry across the whole sample. This follows the method proposed by Olley and Pakes (1996) allowing one to calculate aggregate labour productivity using the simple average and the allocative efficiency term. In a similar manner and in line with Dhyne et al. (2014), I will measure aggregate TFP (the weighted average TFP of an industry, φ_{jct}) as the sum of the simple average TFP, $\overline{\varphi_{Jct}}$ and allocative efficiency at the industry level as follows:

$$\varphi_{jct} = \sum_{i\in j} \Pi_{ijct}\, \varphi_{ijct} = \overline{\varphi_{Jct}} + \sum_{i\in j}\left(\Pi_{ijct} - \overline{\Pi_{Jct}}\right)\left(\varphi_{ijct} - \overline{\varphi_{Jct}}\right) \quad (5)$$

where φ_{ijct} and Π_{ijct} respectively refer to the estimated TFP from equation (4) and size of firm i in sector j in country c at time t; $\overline{\varphi_{Jct}}$ and $\overline{\Pi_{Jct}}$ indicate the simple average of size and TFP of industry j in country c at time t. Firm's size can be measured as the number of firm's employee, or the amount of capital, or its turnover. The last term on the right hand side of equation (5) is a covariance measure which represents the allocative efficiency within sector j. Aggregate and average productivity coincide when this term is equal to zero – representing random allocation of resources across firms in the country-industry. In other words, a positive allocative efficiency measure indicates a larger productivity of the sector than randomly distributed resources across firms. Firms at the top of the productivity distribution tend to grow faster than other firms. This directs more allocation of resources to the more productive firms as they expand and grow. Therefore, the allocation of resources becomes more efficient – indicated with positive allocative efficiency – where the distribution of resources among firms diverges from the random distribution. Hence, it is argued that an industry with a long right-tail efficiency distribution has larger aggregate efficiency than the average efficiency.

These aggregate industry-specific TFPs and allocative efficiency measures will be described in the next section. Moreover, these aggregate indicators are used in the econometric analyses that are outlined below.

3.2.2. The lock-in effect

The lock-in effect can be defined as a situation in which Austria's economic performance is more dependent on the CESEE rather than on the rest of the EU or the rest of the world, which can be seen as a source of vulnerability. One of the major reasons could be that losing market share in a competitive market like that of Western Europe might indicate deterioration of competitiveness. Hence, here I analyse the exports of manufacturing industries by geographical destination and compare the new member states of the EU-CEE with the rest of the EU. In doing so, I use the aggregate indicator of firm-level efficiency as an important driver of export performance. I adopt the following gravity model using the bilateral exports of industries to European countries in the sample.

The gravity model to be estimated is as follows:

$$x_{jcdt} = \gamma_0 + \gamma_1 dp^k_{jcdt} + \gamma_2 m^o_{jcdt} + \gamma_3 \ln\left(1 + tariff_{jcdt}\right) + \gamma_4 EU_{cdt} + \gamma_5 \Delta\overline{\varphi_{jct}} + \gamma_6 \Delta\overline{\varphi_{jdt}}$$

$$+\gamma_7 p^k_{jct} + \gamma_8 p^k_{jdt} + \gamma_9 GDP_{ct} + \gamma_{10} GDP_{dt} + \gamma_{11} EU_{ct} + \gamma_{12} EU_{dt} + \Psi_{jcdt} + \epsilon_{jcdt} \quad (6)$$

where x_{jcdt} is the export value of industry j from country c to destination country d at time t in natural logarithms; dp^k_{jcdt} controls for the differences between the exporting industry's performance and that of other competitors in the destination market. In fact, dp^k_{jcdt} is the logarithmic share of the aggregate TFP of the exporting industry (φ_{jct} i.e. the capital weighted TFP average across firms in industry j in country c at time t) in the aggregate TFP of all other competitors weighted by their export share in the destination market d. Estimator γ_1 will then indicate whether the market shares are induced by the outperformance of the exporting firms.

$$dp^k_{jcdt} = \ln \frac{\varphi^k_{jct} X_{jcdt}}{\sum_{c' \neq c} \varphi^k_{jc't} X_{jc'dt}} \quad (7)$$

m^o_{jcdt} is the logarithm of share of material inputs used by the firms in industry j in the destination country d that are owned by the exporting country c relative to total materials used in that sector and country, which is a proxy for intra-firm trade; since there are some non-EU countries in the sample,

$\ln(1+tariff_{jcdt})$ controls for tariffs imposed against the imports in the sector to country d. Additionally, using the dummy variable EU_{cdt}, it is controlled if the two countries are EU members in year t.

$\Delta\overline{\varphi_{jct}}$ and $\Delta\overline{\varphi_{jdt}}$ are the growth of simple average TFP in the industry in the exporting country and the importing country respectively. p^k_{jct} and p^k_{jdt} are dummy variables indicating if there is a better allocation of capital to more productive firms in industry j in year t with respect to the previous year in the exporting and importing countries respectively. This means that the capital-weighted average TFP should be increased in the year the variable equals to 1.

GDP_{ct} and GDP_{dt} are the logarithms of GDP of the exporting and importing countries respectively. EU membership of each country is controlled including the dummies EU_{ct} and EU_{dt}. Ψ_{jcdt} collects a set of fixed effects, while ϵ_{jcdt} is the error term.

According to the state of the art of the gravity literature, it is important to control for the multilateral resistances. In other words, trade relations between two countries are also a function of the trade relations they have with third countries in a given sector. To control for that, I use country-sector-time fixed effects: ω_{jct} for the supply side and ω_{jdt} for the demand side of trade. However, the use of fixed effects excludes the variables that vary by country-times and country-sector-times. Therefore, while the specification including these multilateral resistance terms and bilateral-sector effects ω_{jcd} is the benchmark specification, two other specifications are also tested. First, I include country-time fixed effects ω_{ct} and ω_{dt} in addition to bilateral sector fixed effects ω_{jcd}. Then, I include only time fixed effects ω_t beside bilateral sector fixed effects ω_{jcd}. Finally, to control for possible shocks at bilateral tariff lines across years, the standard errors are clustered by bilateral sectors jcd. In this way, results are robust against heteroscedasticities in the error term.

The estimation covers a sample of 23 NACE 2-digit manufacturing industries located in 28 EU members and three Western Balkan countries considered as exporters and as destination markets during 2007-2015.

After estimating equation (6), I obtain the fitted values of log exports $\hat{x}_{jcdt}$ that is explained by explanatory variables. Larger (positive) differences between the actual values of exports and the fitted values of exports in equation (6) would suggest an excessive export behaviour of countries in a given sector to a destination. By aggregating the actual values of the exports from Austria to CESEE and dividing it by the aggregate fitted values of exports obtained from the estimated models, one can observe whether Austria is excessively exporting to these countries.

$$xp^{CESEE}_{ct} = \sum_{j}\sum_{d\epsilon CESEE} xp_{jcdt} \times 100 = \frac{\sum_j \sum_{d\epsilon CESEE} exp(x_{jcdt})}{\sum_j \sum_{d\epsilon CESEE} exp(\hat{x}_{jcdt})} \times 100 \qquad (8)$$

Furthermore, by comparing the aggregate export performance to CESEE across different exporters the lock-in effect of Austrian firms' exports in the CESEE region is tested.

3.3. DATA

This study uses the aggregates of firm-level TFP estimated by Fattorini et al. (2018) based on the Amadeus database provided by Bureau van Dijk Electronic Publishing. TFP estimates were computed based on the recent semi-parametric technique proposed by Ackerberg et al. (2015). As in equation (5), TFPs were then aggregated using firm's capital as weights. According to the data limitations, the period of the analysis is from 2007 to 2015.

Trade and data are gathered from the UN COMTRADE and tariffs from the TRAINS database provided by WITS. GDP is collected from the World Development Indicator of the World Bank.

4. Results

4.1. DESCRIPTIVE STATISTICS

Table 1 presents summary statistics of the firm-level aggregates across Western Europe in 2014. According to the simple average of TFP expressed (in logarithm), Austrian firms stand at the middle of the ranking as the 9th most productive country out of 18 Western European countries. According to the capital-weighted average TFP, Austrian firms ranked 8th. The latter shows that capital is allocated more efficiently than a normal distribution across Austrian firms. Firms in the Netherlands are the most productive firms with the highest simple average and capital-weighted average TFP estimates.

The average firm size in the Austrian sample for which TFP is calculated is 508 employees, ranked as the 6th country in terms of employment size, while only 794 Austrian firms are included in this sample covering all necessary information for the estimation of TFP. Austria is ranked 8th with average size of around 63 million EUR in total assets in 2014. In terms of turnover, 154 million EUR is the average Austrian firm's turnover which is ranked 6th in the sample of Western European countries.

Table 1 / Summary statistics of firm-level aggregates across Western Europe, 2014

Country	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
AT	8.62	3.07	508	63,011,798	154,323,557	794
BE	8.67	0.50	226	104,328,076	112,332,022	2697
CY	7.85	3.27	82	12,661,296	7,661,662	58
DE	8.91	0.30	1,131	206,658,839	350,997,360	5502
DK	9.46	5.26	697	126,165,424	218,561,239	570
ES	6.75	-1.21	30	4,105,189	8,881,020	51498
EE	5.56	-1.28	22	53,742	159,842	4042
FI	7.11	1.37	95	12,605,074	29,465,473	6540
FR	7.72	1.36	141	24,647,263	38,122,985	28177
GB	8.80	3.51	406	70,877,481	124,600,512	9795
GR	7.53	0.63	51	6,627,245	11,816,423	4340
IE	9.05	4.45	1,741	491,833,672	540,559,642	356
IT	9.33	-1.89	32	3,861,029	9,211,677	105514
LU	9.62	5.07	4,481	981,895,197	1,270,327,459	87
MT	8.26	4.85	186	10,591,842	19,544,966	42
NL	10.84	7.66	3,076	723,703,489	1,053,480,975	486
PT	6.25	-2.39	21	1,621,700	3,136,997	27013
SE	6.77	-1.17	93	16,365,140	27,970,991	13037

This information is from the sample of analysis and not from the entire population of firms
Source: Fattorini et al. (2018).

Table 5 in the appendix presents the summary statistics of the firm-level aggregates by industry in 2014. Based on the simple average TFP within each industry and country, Austria is the most competitive across Western Europe in two sectors of Manufacture of beverages and Manufacture of computer, electronic and optical products. Eleven firms are included in the sample of TFP estimation in the sector of beverages with an average of 429 employees, 98 million EUR total assets and 413 million EUR turnover in 2014. However, the capital weighted TFP in this sector of Austrian firms is ranked 4th after firms in Luxemburg, the Netherlands and Malta. In 2014, 49 Austrian firms with an average employment of 423 employees, with EUR 43 million total assets and EUR 77 million turnover operated in the Manufacture of computer, electronic and optical products. Their capital weighted TFP is ranked the second after 6 firms from Luxemburg indicating that the capital across these Austrian firms is allocated relatively close to its normal efficiency level.

Manufacture of coke and refined petroleum products in Austria has the largest capital-weighted TFP average in the sample of Western European countries. There is only one Austrian firm in this sector of the sample. Therefore, the simple and weighted average TFP in this sector is equal. This means that using the capital weights reduced the capital-weighted averages of firms' TFP in other countries in the sector. Therefore, in this sector larger capital is allocated to less efficient firms in other countries with lower TFP making the Austrian firm the most allocative efficient firm in the sector with 56 employees, EUR 1.7 million total assets and EUR 31.5 million turnover.

Capital is allocated most efficiently across the Western European countries for Austrian firms operating in the Repair and installation of machinery and equipment with their highest capital-weighted TFP. 12 Austrian firms are included in the sample of this sector with an average of 217 employees, and around EUR 6 million average total assets generating in average EUR 46 million in 2014.

In terms of average firm size, Austrian firms are relatively the largest firms in the Manufacture of wood and of products of wood and cork, except furniture, manufacture of articles of straw and plaiting materials. On average in 2014, 292 people were employed in these Austrian firms in this sector. However, in terms of capital, with average total assets of around EUR 31 million, Austrian firms in this sector are ranked second after Belgian firms with averages of EUR 44 million total assets and 83 employees.

4.2. ECONOMETRICS RESULTS

Table 2 presents the estimation results of the gravity model over bilateral exports flows of manufacturing industries across the EU-28 and Western Balkan countries during the period 2007-2015. Very large R-squares indicate high goodness of fit of the models. In all these specifications, bilateral sector specific effects ω_{jcd}, and time-specific effects ω_t, are controlled using related fixed effects. In model 2, importer-time ω_{dt} and exporter-time ω_{ct} are controlled as country-level multilateral resistances. Model 3 controls for sector-country multilateral resistances. In other words, in model 3, supply-side specific effects are controlled with exporter-sector-time fixed effects ω_{cjt}, and demand-side specific effects are controlled with importer-sector-time fixed effects ω_{djt}.

Firm-level performances measured by TFP are indeed related to larger exports. Based on Model 1, growth of simple average productivity in a given exporting industry $\Delta\overline{\varphi_{jct}}$ is positively related to larger exports value to a given destination. However, this becomes statistically insignificant in Model 2. In fact, including exporter-time fixed effects absorbs the variations of growth of simple average TFP in a given sector in a given country. Moreover, growth of simple average TFP in an industry in the destination market $\Delta\overline{\varphi_{jdt}}$ is not statistically related to the level of exports to that destination.

Coefficient of p_{jct} is statistically significant in Model 1 and Model 2. This suggests that improvement in aggregate TFP in an exporting industry has a statistically significant and positive relationship with the level of exports. Thus, when the capital is allocated to more efficient firms so that the capital-weighted average TFP is increased in a given year, the sector exports more. However, the coefficient of the variable in the destination p_{jdt} is not statistically significant, indicating that the exporting sector matters most.

In Model 2 and Model 3 controlling for multilateral resistances, the coefficient of m^o_{jcdt}, which is a proxy for the ownership of firms in destination country d owned by exporting country c in sector j, is statistically significantly positive. This indicates that intra-firm trade is positively related to the exports value of the industry. In fact, when more material inputs are used in a firm in the destination market that is owned by the exporting country the level of exports in the industry increases. This is in line with theoretical frameworks on vertical integration of MNEs. MNEs, who prefer choosing investment strategies rather than arm's length contracts, supply their materials and intermediate inputs across their integrated production stages, which is largely contributing to the higher exports values between countries. The coefficient of m^o_{jcdt} in model 3 shows that a one-percent larger share of material inputs of the MNE subsidiary in the destination market is related to a 0.25% larger exports value from home to the host country.

Moreover, in models 2 and 3, the outperformance of an exporting industry relative to other exporting industries in the destination market measured by dp^k_{jcdt} has a statistically significant and positive relation with the level of exports. In other words, when the market power is driven by higher efficiency of capital as measured by the capital-weighted aggregate TFP of the exporting industry relative to other competitors, the amount of exports to that destination is larger.

Table 2 / Gravity estimation results on exports of manufacturing across EU-28 and Western Balkans, 2007-2015

	Model 1		Model 2		Model 3	
Dep. Var.: x_{jcdt}	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
$\boldsymbol{dp^k_{jcdt}}$	0.0034	(0.0025)	0.0070***	(0.0025)	0.95***	(0.061)
$\boldsymbol{m^o_{jcdt}}$	0.21	(0.13)	0.25**	(0.12)	0.27**	(0.13)
$\boldsymbol{EU_{cdt}}$	0.038	(0.082)	0.20**	(0.081)	0.24***	(0.079)
$\ln(1+\boldsymbol{tariff_{jcdt}})$	0.27	(0.35)	-0.23	(0.36)	-0.80*	(0.42)
$\boldsymbol{p^k_{jct}}$	0.012**	(0.0047)	0.013***	(0.0048)		
$\boldsymbol{p^k_{jdt}}$	-0.0042	(0.0048)	-0.0047	(0.0049)		
$\Delta\overline{\boldsymbol{\varphi}_{jct}}$	0.0047**	(0.0021)	0.0011	(0.0021)		
$\Delta\overline{\boldsymbol{\varphi}_{jdt}}$	0.0023	(0.0018)	0.0014	(0.0018)		
$\boldsymbol{GDP_{ct}}$	0.40***	(0.096)				
$\boldsymbol{GDP_{dt}}$	1.21***	(0.092)				
$\boldsymbol{EU_{ct}}$	0.21**	(0.088)				
$\boldsymbol{EU_{dt}}$	-0.12	(0.078)				
Fixed Effects	ω_{jcd}, ω_t		ω_{jcd}, ω_{ct}, ω_{dt}		ω_{jcd}, ω_{cjt}, ω_{djt}	
N	114211		114211		136844	
R-sq	0.952		0.953		0.953	
adj. R-sq	0.944		0.945		0.941	
AIC	234319.0		230216.0		290829.6	
BIC	234434.7		230293.2		290868.9	

Note: * p<0.1; ** p<0.05; *** p<0.01.
Robust standard errors (SE) are clustered by bilateral sectors jcd.

Regarding other variables, results are in line with expectations. For instance, EU exporters (i.e. indicated by EU_{ct} dummy variable) have larger exports. In fact, the coefficient in Model 1 tells us that when an exporter becomes a member of the EU, its bilateral exports to other countries in the sample is larger by about 23%[5]. However, being an importing EU country in the sample does not statistically significantly affect the amount of exports as EU_{dt} has a statistically insignificant coefficient. After controlling for multilateral resistances in Model 2 and Model 3, EU_{cdt} becomes statistically significant. The latter indicates that exports values between two EU members are relatively larger than if at least one of the countries is not an EU member. Controlling for the EU membership, these two models indicate that tariffs are negatively related with the exports values, while the coefficients are weakly significant.

Finally, the two traditional gravity variables that are GDP of the two countries are statistically significantly related to the large level of exports. When GDP of the exporting country GDP_{ct} increases by 1%, the bilateral exports in the sector increase by 0.4%. When the GDP of the importing country GDP_{dt} increases by 1%, the imports in the sector increase by 1.21%.

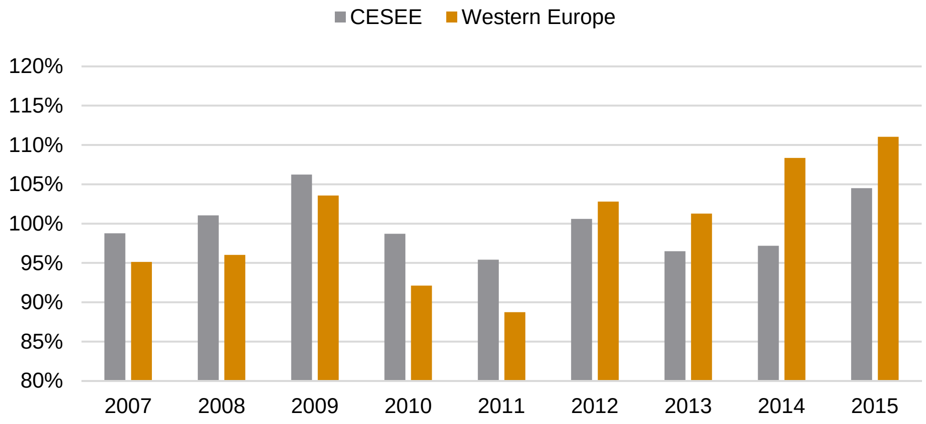
4.3. EXPORTS PERFORMANCE

Figure 1 presents the exports performance of Austria to the two destinations of CESEE and Western Europe based on Equation 8 in percentage points. Model 3 is chosen as a benchmark for this purpose. Each bar indicates how much the actual value of exports to the respective destinations (i.e. CESEE region or Western Europe) is far away from the fitted value of exports obtained from the model, as a percentage of the fitted value of exports. As the figure shows, Austrian excessive exports to CESEE were higher than the excessive exports to Western Europe from 2007 to 2011. This could be interpreted as the ‘lock-in effect’ of Austrian exports in CESEE during that period. However, since 2012, the situation reversed and Austrian exports to Western Europe increased over-proportionately compared to the exports to CESEE. The ‘excessive’ Austrian exports to Western Europe stood at around 111% of their predicted value in 2015, while to CESEE they stood at around 105%. One might argue that this might be because Western European GDP recovered less than CESEE’s GDP did while Austrian exports to Western Europe did not drop proportionately as it did to CESEE. However, these results are from Model 3 that do not include GDP. Therefore, this issue is because of many country-time varying variables beyond GDP that are controlled in the model using country-time fixed effects.

Figure 2 presents the exports performance to CESEE from different regions during the period 2007-2015. From 2007 to 2011, CESEE countries were generally outperforming Western Europe and Austria by having ‘excessive’ exports to other CESEE countries – above the predicted value. For instance, in 2010, ‘excessive’ intra-CESEE exports of manufacturing stood around 107% of model predicted values. Gradually this value decreased and in 2015, intra-CESEE exports stood at around only 88% of the model-predicted value of exports.

5 $23.37 = 100 \times (e^{0.21} - 1)$

Figure 1 / Austrian exports performance to CESEE and Western Europe, 2007-2015, in % of predicted value

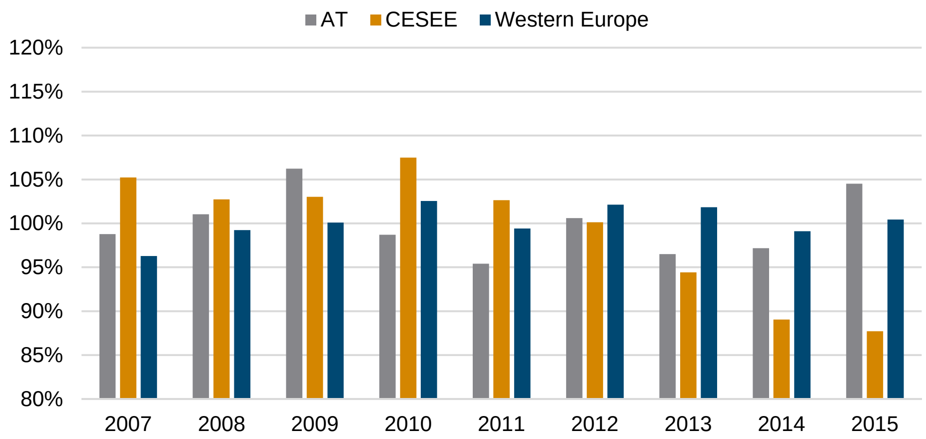


Source: Own calculation from Model 3 in Table 2.

Exports from Western European countries other than Austria had fluctuations. The 'excessive' exports from these countries to CESEE had been increasing since 2007 and reached its highest level of 103% of predicted value in 2010, then they dropped to 99% in 2011. Afterwards they rose again to stay above the model-predicted value with a short drop below the predicted value in 2014.

Austrian exports to the CESEE as a share of the predicted value were also fluctuating with its peak of 106% in 2009. After some ups and downs, in 2015 the 'excessive' Austrian exports of 105% of the predicted value over-performed other countries' exports to the CESEE.

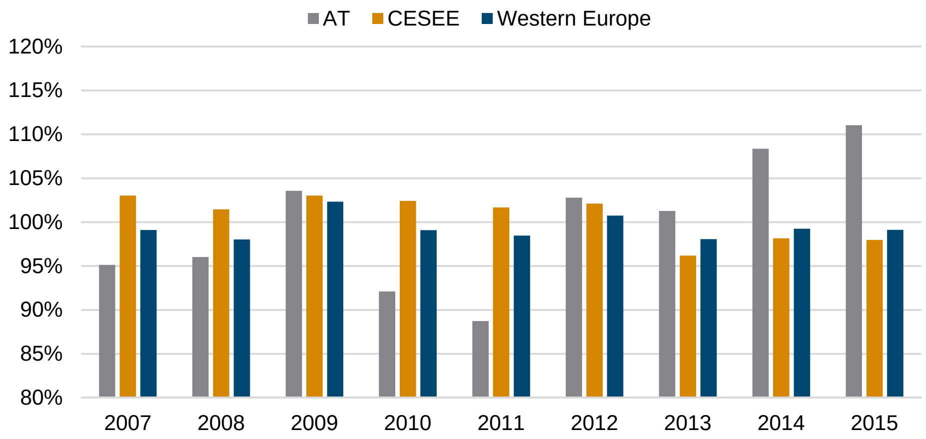
Figure 2 / Exports performance of Austria, the CESEE countries and Western Europe to CESEE by region/country of origin, 2007-2015, in % of predicted value



Source: Own calculation from Model 3 in Table 2.

Figure 3 presents the exports performance to Western Europe from different regions relative to the model-predicted values. Since 2007, the CESEE region was over-performing its predicted value generally better than other regions until 2011. From 2012 onwards, Austrian over-performance of exports to Western Europe relative to the model-predicted values outpaced other regions in the sample and reached 11% by 2015. This is larger than the over-performance of Austrian exports to the CESEE (only 5%; Figure 2), suggesting a 'lock-in-effect' of Austrian exports in Western Europe rather than in CESEE. This is also evident in 'excessive' Austrian exports to Western Europe in each individual industry.

Figure 3 / Exports performance of Austria, the CESEE countries and Western Europe to Western Europe by region/country of origin, 2007-2015, in % of predicted value



Source: Own calculation from Model 3 in Table 2.

4.4. ROBUSTNESS CHECK

To check the robustness of our results I adopt a separate approach using unilateral export values aggregated by destination countries. The exports model to be estimated is as follows

$$x_{jct}^{D} = \beta_0 + \beta_1 GDPpc_{ct} + \beta_2\, va_{jct} + \beta_3\, prod_{jct} + \beta_4 \Delta\overline{\varphi_{jct}} + \beta_5 p_{jct}^{k} + \beta_6 \overline{l_{jct}} + \omega_{jc} + \omega_t + \epsilon_{jct}$$

$$x_{jct}^{D} = \ln \sum_{d \in D} X_{jcdt} \quad , D \in \{World, Sample, CESEE, Western\ Europe\} \tag{9}$$

where X_{jcdt} is the total exports of industry j from country c to country d in year t; x_{jct}^{D} is the summation of all the exports in the given industry from country c to all destinations in the four sub-samples of world, EU-28 plus Western Balkan, CESEE and Western Europe. $GDPpc_{ct}$ is the logarithm of real GDP per capita in country c in year t; instead of GDP as the size of the exporting sector, the logarithm of value-added of the sector j in year t is used in va_{jct}; $prod_{jct}$ is the labour productivity in terms of total turnover of the exporting sector; $\Delta\overline{\varphi_{jct}}$ is the growth of simple average firm-level TFP in the exporting sector, p_{jct}^{k} is the dummy variable indicating if there is a better allocation of capital to more productive firms in the industry j in year t with respect to previous year in the exporting country as above; $\overline{l_{jct}}$ is the average firm employment in the exporting industry. ω_{jc} and ω_t are respectively exporting-sector-fixed-effects and year-fixed effects; and ϵ_{jct} is the error term that is clustered by exporting-sector to control for the shocks within each sector in each industry during years.

4.4.1. Results

Table 3 presents the estimation results of total manufacturing exports from the EU-28 and Western Balkan (WB) countries to four different destinations. GDP per capita has statistically significant coefficients in only two of the models, one that includes EU and WB and the other that includes only Western Europe (WE). In fact, it could be concluded that exports to the Western European region are determined by the larger GDP per capita of the exporting country. In all models, very large R-squares show the goodness of fits.

Larger productivity is positively and statistically significantly related to exports to any destination. However, larger size of the industry in terms of value-added is only positively and statistically significantly related to exports to CESEE, the whole sample of countries, and to the whole world. But it does not statistically significantly affect exports to Western Europe.

Growth of simple average firm-level TFP of the exporting sectors is also positively related to the aggregate exports values in a given sector. However, this relationship becomes more statistically significant when the total exports are to the Western European countries. Therefore, in order to export a larger amount of manufacturing to Western Europe, firms in a given sector need to be more competitive and more productive. Moreover, allocation of capital to more efficient firms increases the exports statistically significantly to many destinations, except to CESEE. Larger firm-size in the exporting industry is also statistically significantly related to export values to any destination.

Table 3 / Estimation results of manufacturing exports from EU-28 and Western Balkans to different destinations, 2007-2015

Dep. Variable:	x_{jct}^{World}	x_{jct}^{EU+WB}	x_{jct}^{CESEE}	x_{jct}^{WE}
$GDPpc_{ct}$	0.0000075	0.000012***	0.00000034	0.000014***
	(0.0000061)	(0.0000046)	(0.0000088)	(0.0000051)
$prod_{jct}$	0.31***	0.36***	0.22***	0.34***
	(0.074)	(0.079)	(0.082)	(0.093)
va_{jct}	0.062*	0.080**	0.10**	0.067
	(0.034)	(0.038)	(0.048)	(0.043)
$\Delta\overline{\varphi_{jct}}$	0.0049**	0.0067**	0.0057*	0.0073***
	(0.0023)	(0.0027)	(0.0030)	(0.0025)
p_{jct}^{k}	0.013**	0.012**	0.0049	0.016**
	(0.0059)	(0.0061)	(0.011)	(0.0075)
$\overline{l_{jct}}$	0.17***	0.22***	0.33***	0.27***
	(0.063)	(0.062)	(0.12)	(0.087)
Fixed Effects	ω_{jc}, ω_t	ω_{jc}, ω_t	ω_{jc}, ω_t	ω_{jc}, ω_t
N	4312	4312	4312	4312
R-sq	0.991	0.989	0.981	0.988
adj. R-sq	0.990	0.988	0.978	0.987
AIC	-1185.6	-442.2	2465.4	664.2
BIC	-1147.4	-404.0	2503.6	702.4

Note: * p<0.1; ** p<0.05; *** p<0.01.
Robust standard errors in parentheses, which are clustered by bilateral sectors jc.

By dividing actual values of exports to the fitted values of exports obtained from the models, one can calculate exports performance of countries by destination as follows:

$$xp_{ct}^{D} = \frac{\sum_j exp\left(x_{jct}^{D}\right)}{\sum_j exp\left(\widehat{x_{jct}^{D}}\right)} \times 100 \tag{10}$$

Table 4 / Manufacturing exports performance to four regions, 2007-2014

Exporter (c)	Year	xp_{ct}^{World}	xp_{ct}^{EU+WB}	xp_{ct}^{CESEE}	xp_{ct}^{WE}
AT	2008	111.0%	112.5%	119.7%	112.1%
AT	2009	107.8%	107.7%	116.0%	107.6%
AT	2010	104.4%	104.3%	108.0%	104.1%
AT	2011	100.1%	98.8%	99.9%	98.9%
AT	2012	96.2%	96.2%	96.4%	96.1%
AT	2013	95.1%	96.3%	92.7%	96.5%
AT	2014	95.0%	95.2%	90.5%	95.4%
AT	2015	95.2%	94.4%	90.1%	94.5%
CESEE	2008	99.5%	98.6%	98.6%	100.0%
CESEE	2009	99.6%	99.7%	101.9%	100.7%
CESEE	2010	99.9%	99.2%	102.2%	99.6%
CESEE	2011	100.8%	99.7%	100.6%	100.0%
CESEE	2012	100.2%	100.4%	103.1%	100.0%
CESEE	2013	100.7%	101.0%	103.1%	99.7%
CESEE	2014	101.4%	102.2%	99.2%	102.0%
CESEE	2015	103.5%	104.2%	99.5%	104.4%
WE	2008	106.9%	110.3%	108.0%	112.4%
WE	2009	104.5%	106.2%	102.6%	106.8%
WE	2010	102.9%	102.7%	103.0%	102.5%
WE	2011	100.9%	100.7%	101.3%	100.8%
WE	2012	99.5%	98.9%	98.3%	99.1%
WE	2013	99.2%	98.2%	97.9%	97.7%
WE	2014	95.5%	95.0%	96.9%	94.5%
WE	2015	96.1%	93.5%	97.1%	92.8%

Source: Own calculations based on results of estimations presented in Table 3.

Table 4 presents the statistics on aggregate exports performance to different regional destinations. Austrian and Western European exports performances to all destinations had deteriorated over the years. Total exports from the CESEE to regions other than the CESEE hadn't been generally exceeding the model-fitted exports over the years. This indicates that CESEE had become gradually more competitive, increasing their extra-regional exports during recent years.

Austrian exports performance to the CESEE has deteriorated from 120% in 2008 to 90% in 2015. This worsening performance is much larger than the exports performance of Austria to other regions. In fact, actual exports of Austria to Western Europe deteriorated from 112% of its model-fitted values to 95%, which is relatively lower than that to the CESEE region. Furthermore, deterioration in exports performance of Western Europe to CESEE was from 108% in 2008 to 97% in 2015, which is relatively smaller than that from Western Europe to Western Europe. In other words, based on these results one can observe that in the past years, Western Europe experienced more of a lock-in effect in CESEE than Austria.

5. Conclusions

This contribution analyses the competitiveness of Austrian manufacturing industry by comparing the performance of Austrian firms with Western European firms using the recent estimation of total factor productivity (TFP) across Wider-Europe. TFP estimates from earlier work (by Fattorini et al., 2018) were used in this study. According to their TFP estimates, Austrian firms with larger turnover, and lower employment and in regions with less concentration of regional-industrial employment have become more competitive in terms of productivity during the period 2007-2015.

Among 18 Western European countries, the simple average TFP across Austrian firms in 2014 ranks Austria the 9th most competitive country. Using capital (total assets) of firms as weights for averaging TFP would rank Austria as the 8th most competitive country in the sample of 18 Western European countries. This indicates that in Austria larger capital is allocated to slightly more efficient firms than a normal distribution of capital across firms.

According to the simple average TFP, in 2014 Austria was the most competitive across Western Europe in two sectors, namely Manufacture of beverages and Manufacture of computer, electronic and optical products. According to the capital-weighted average TFP, Manufacture of coke and refined petroleum products and the Repair and installation of machinery and equipment were the most competitive firms across Western Europe in 2014. This indicates that capital in these Austrian sectors was allocated to the most efficient firms increasing their aggregate productivity to the first rank.

The gravity estimation results follow the strand of the New Trade Theory indicating that firm-level performance matters for larger exports in the industry. Growth of simple average TFP and larger allocation of capital to more productive firms in an exporting industry are positively associated with bilateral exports in the sample of the EU-28 and Western Balkans. Moreover, larger aggregate firm-level TFP of an exporting industry that enjoys a large share in the destination market relative to other exporters in that destination is positively associated to the exports values. Besides, the results affirm the intra-firm trade relations as the larger intermediate inputs share in a destination market used by the subsidiaries owned by the exporting country are positively associated with the larger amount of exports in the same sector of activity, an indication of vertical integration of multinational enterprises (MNEs) and intra-industry trade.

The gravity model was then used to construct the exports performance measure as a ratio of the actual exports values to predicted values obtained from the model. The calculated measure indicates that Austrian manufacturing exports to Western Europe have outperformed the Austrian exports to CESEE since 2012. In 2015 excessive manufacturing exports from Austria to CESEE is 105% of the predicted value. Excessive exports from other European countries to CESEE is estimated to be only 100% of their predicted values obtained from the model in the same year. Therefore, normalising the two sources of exports shows that Austrian exports performed 5% over the exports from other Western European countries to CESEE in 2015. Nevertheless, this is also the case for the Austrian exports to Western Europe hovering 11% above the predicted values from the gravity model, while the exports from other

Western European countries to Western Europe is about 1% below the predicted values obtained from the model. This shows that Austrian exports over-perform other Western European countries' exports not only in the CESEE market but also in the Western European market.

The results of the gravity model were challenged by a robustness estimation over total unilateral exports and similar results were obtained. In particular, I found that growth of simple average TFP of an exporting sector and a better allocation of capital to more efficient firms, two main indicators of firm competitiveness, are positively associated with larger exports, which is not significant for the exports to CESEE, but statistically significant for total exports to Western Europe. This could suggest that to gain access to Western European markets, firms need to be more competitive than they need to be to access CESEE markets. Calculated exports performance from these total exports models also show that Austrian exports to CESEE decreased more than to Western European destinations, which in relative terms is not a sign of the lock-in effect in CESEE. Overall, based on the total exports analysis (Table 4), I found that exports originated from CESEE to Western Europe over-performed the predicted values of these models during the past few years, while those originated from Western Europe and Austria deteriorated. This finding indicates that CESEE exporting industries have gained competitiveness over recent years, as also Fenz et al. (2015) previously noted.

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Appendix

Table 5 / Summary statistics of firm-level aggregates across Western Europe, by NACE rev. 2 industry, 2014

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
AT	food products	10.85	8.08	311	38,887,499	124,132,885	82
BE	food products	10.36	5.21	118	27,105,366	77,696,617	431
CY	food products	9.27	6.73	74	6,845,178	12,686,340	14
DE	food products	11.30	6.90	440	48,548,755	205,102,005	416
DK	food products	11.13	8.85	515	101,051,735	285,207,685	106
ES	food products	8.60	2.72	30	3,839,544	9,805,262	7,389
EE	food products	7.05	3.06	33	98,266	256,963	339
FI	food products	9.59	6.54	137	11,432,568	35,124,826	515
FR	food products	8.94	5.25	65	7,674,303	16,260,563	7,214
GB	food products	11.06	7.91	905	84,881,897	184,744,295	992
GR	food products	8.84	3.55	52	5,108,099	9,538,683	1,121
IE	food products	11.46	10.14	1,471	246,887,223	426,156,929	29
IT	food products	8.85	2.87	29	4,356,928	11,878,875	8,787
LU	food products	12.13	11.20	6,947	321,422,975	472,037,368	7
MT	food products	9.59	7.80	113	8,061,809	18,752,929	11
NL	food products	12.45	10.95	5,054	1,130,291,415	1,706,925,258	75
PT	food products	7.91	1.93	19	965,749	2,598,110	3,982
SE	food products	9.07	4.80	37	4,926,863	14,651,870	1,183
AT	beverages	4.08	1.85	429	98,435,352	413,662,147	11
BE	beverages	3.43	-1.02	2,958	2,149,477,364	795,285,576	55
CY	beverages	2.71	1.12	148	46,629,511	22,672,838	4
DE	beverages	3.92	-0.18	309	49,238,983	127,730,951	102
DK	beverages	2.92	0.39	4,714	1,556,056,435	964,996,628	11
ES	beverages	3.03	-4.23	26	7,078,605	9,277,760	1,644
EE	beverages	2.41	-1.18	52	507,555	704,874	31
FI	beverages	3.38	0.50	141	21,201,285	44,102,080	43
FR	beverages	3.40	-3.18	92	54,049,969	50,091,282	548
GB	beverages	3.06	-1.94	931	306,108,776	266,476,018	150
GR	beverages	2.71	-2.09	44	5,961,250	9,461,320	169
IE	beverages	3.01	1.76	5,839	4,058,082,356	3,642,762,215	5
IT	beverages	3.28	-3.83	25	8,270,483	12,801,578	1,156
LU	beverages	3.57	2.94	72	10,572,225	36,330,444	2
MT	beverages	2.61	1.91	498	69,333,022	52,725,404	2
NL	beverages	3.31	2.32	16,249	5,970,880,483	4,438,536,728	5
PT	beverages	3.41	-3.40	25	4,634,206	4,629,507	580
SE	beverages	3.38	-0.61	61	36,215,340	27,080,594	72
AT	tobacco products	8.95	8.95	365	117,189,040	113,474,352	1
BE	tobacco products	11.99	9.73	112	153,333,589	409,766,267	11
DE	tobacco products	13.16	7.66	674	78,301,702	785,241,354	12
DK	tobacco products	8.81	6.46	3,128	468,003,895	322,743,069	3
ES	tobacco products	9.94	6.15	186	284,739,168	83,453,432	16
FI	tobacco products	9.77	9.77	2	277,000	214,000	1
FR	tobacco products	9.71	8.59	388	82,411,244	366,128,692	3
GB	tobacco products	11.83	5.63	14,081	4,639,275,018	5,895,491,237	9

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
GR	tobacco products	9.60	7.02	189	41,493,889	107,820,823	11
IE	tobacco products	11.71	11.45	67	158,332,500	341,858,500	2
IT	tobacco products	10.79	8.08	60	23,146,481	91,024,152	16
NL	tobacco products	14.15	13.35	363	180,044,195	474,730,976	4
PT	tobacco products	9.72	8.19	247	54,868,015	56,659,636	2
SE	tobacco products	9.56	6.41	563	133,742,074	255,206,674	10
AT	textiles	4.77	1.88	267	17,811,566	59,042,731	18
BE	textiles	5.27	-0.15	133	10,482,881	29,553,226	128
DE	textiles	4.84	0.12	316	15,260,117	72,365,747	106
DK	textiles	4.43	2.19	412	40,693,819	85,490,131	10
ES	textiles	4.73	-2.84	18	928,579	2,689,556	1,767
EE	textiles	3.47	-1.80	23	32,555	95,382	159
FI	textiles	4.79	-0.05	29	2,089,014	7,364,740	128
FR	textiles	5.05	-0.75	38	2,252,351	9,028,967	510
GB	textiles	4.50	-0.96	147	4,382,752	24,047,879	214
GR	textiles	4.10	-0.91	39	4,431,016	3,883,856	123
IE	textiles	4.81	3.07	62	2,890,908	11,093,124	5
IT	textiles	5.20	-3.32	24	1,864,414	5,257,806	3,875
LU	textiles	4.61	3.84	353	134,650,909	139,326,144	2
NL	textiles	4.73	2.07	773	81,954,569	202,970,510	11
PT	textiles	4.85	-2.82	26	834,356	2,171,512	1,385
SE	textiles	4.80	-1.04	15	1,843,376	3,125,768	247
AT	wearing apparel	5.28	4.19	794	36,260,631	91,390,087	3
BE	wearing apparel	5.60	2.09	101	6,184,627	52,409,984	40
DE	wearing apparel	5.59	1.08	779	38,664,205	151,461,852	69
DK	wearing apparel	5.00	3.77	876	26,024,763	152,163,865	4
ES	wearing apparel	5.28	-2.14	122	7,017,381	16,758,135	1,285
EE	wearing apparel	3.77	-2.13	25	11,342	52,055	290
FI	wearing apparel	5.29	0.74	47	2,110,332	7,636,064	97
FR	wearing apparel	6.06	-0.86	586	167,853,605	144,726,893	506
GB	wearing apparel	5.31	0.03	564	17,505,269	68,886,869	172
GR	wearing apparel	4.84	-0.55	27	1,571,373	3,666,580	224
IE	wearing apparel	5.28	2.68	141	8,220,108	29,111,138	8
IT	wearing apparel	5.76	-2.13	24	1,497,129	5,108,664	5,173
MT	wearing apparel	4.15	4.15	166	810,082	5,228,028	1
NL	wearing apparel	5.21	5.21	435	1,577,000	53,760,000	1
PT	wearing apparel	5.80	-2.84	24	190,294	1,091,411	2,945
SE	wearing apparel	5.46	0.92	37	3,544,250	9,990,326	72
AT	leather and related products	5.72	3.39	315	9,350,193	86,186,563	8
BE	leather and related products	5.39	4.51	63	11,560,797	35,289,102	3
CY	leather and related products	4.70	4.70	20	88,186	1,439,925	1
DE	leather and related products	5.44	2.30	2,860	227,511,225	709,142,428	24
DK	leather and related products	5.00	4.55	72	6,128,104	48,357,792	2
ES	leather and related products	5.21	-1.01	17	451,849	2,624,096	1,261
EE	leather and related products	3.67	-0.25	24	9,985	43,847	44
FI	leather and related products	5.15	1.67	29	928,176	4,766,345	43

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
FR	leather and related products	5.82	0.72	74	2,167,272	20,541,730	236
GB	leather and related products	5.52	1.53	260	6,073,139	46,155,279	35
GR	leather and related products	4.77	0.75	24	1,403,873	1,924,574	41
IT	leather and related products	5.74	-2.68	29	1,844,417	7,080,433	4,101
LU	leather and related products	5.37	5.37	8,900	1,067,488,128	1,936,171,520	1
NL	leather and related products	5.47	4.27	108	4,509,592	40,838,091	3
PT	leather and related products	5.51	-2.28	28	263,941	1,718,880	1,543
SE	leather and related products	5.30	1.36	12	276,485	2,836,005	44
AT	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.89	-0.68	292	30,801,926	98,035,716	34
BE	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	3.15	-1.65	82	43,722,648	26,281,397	79
CY	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.17	1.38	39	7,994,476	3,960,274	2
DE	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	3.11	-1.14	250	24,863,319	81,437,304	89
DK	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.66	0.14	289	18,421,610	79,201,707	11
ES	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.96	-4.21	11	735,564	1,733,335	2,651
EE	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.09	-4.46	18	44,694	129,891	620
FI	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	3.27	-3.31	32	3,232,978	10,525,919	487

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
FR	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	3.32	-4.06	26	1,249,091	4,933,698	1,107
GB	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.58	-2.70	141	8,092,499	30,194,194	186
GR	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.33	-2.19	19	3,900,167	2,359,718	91
IE	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.99	0.64	53	6,856,243	23,608,022	7
IT	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	3.21	-5.12	14	1,486,415	2,692,961	3,573
LU	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.99	1.81	68	2,756,962	52,503,961	3
NL	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.78	1.13	198	22,100,000	86,706,798	5
PT	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	2.79	-4.84	17	1,330,792	2,445,591	1,765
SE	wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	3.18	-4.14	27	2,611,713	8,780,347	1,046
AT	paper and paper products	3.66	0.16	567	83,196,458	174,216,840	29
BE	paper and paper products	4.24	-0.39	150	32,390,644	85,865,905	68
CY	paper and paper products	2.99	1.42	44	1,679,135	3,866,697	5
DE	paper and paper products	4.29	-1.33	349	54,938,179	125,587,566	137
DK	paper and paper products	3.35	0.96	563	89,823,786	222,419,503	12
ES	paper and paper products	3.71	-3.03	45	10,437,737	15,458,382	825

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\overline{L}$	Average firm-size in capital, $\overline{K}$	Average firm-size in turnover, $\overline{Y}$	Number of firms, n_c
EE	paper and paper products	2.84	-0.83	35	368,512	397,597	33
FI	paper and paper products	3.86	-0.20	687	246,062,050	311,682,657	90
FR	paper and paper products	3.86	-2.32	129	12,851,192	41,295,092	409
GB	paper and paper products	3.85	-2.20	447	57,895,842	116,953,779	274
GR	paper and paper products	3.24	-1.81	109	4,618,824	8,218,603	140
IE	paper and paper products	3.46	1.50	7,113	996,751,511	1,379,876,532	6
IT	paper and paper products	3.88	-3.67	35	4,746,673	12,652,279	1,819
LU	paper and paper products	4.01	4.01	389	34,294,476	45,845,280	1
MT	paper and paper products	3.42	3.42	21	646,920	7,711,713	1
NL	paper and paper products	3.54	0.42	920	138,386,894	476,265,874	20
PT	paper and paper products	3.45	-1.74	45	16,657,079	20,994,670	298
SE	paper and paper products	3.74	-1.76	404	131,056,530	150,475,465	196
AT	Printing and reproduction of recorded media	1.53	-2.07	153	22,595,443	46,891,560	23
BE	Printing and reproduction of recorded media	2.36	-2.29	74	6,450,303	19,156,308	113
CY	Printing and reproduction of recorded media	0.64	-0.04	26	1,360,200	3,303,177	2
DE	Printing and reproduction of recorded media	5.80	-2.43	450	61,422,002	97,235,930	108
DK	Printing and reproduction of recorded media	1.22	-2.18	130	10,802,681	28,267,417	18
ES	Printing and reproduction of recorded media	3.19	-5.70	14	1,235,907	1,716,500	3,667
EE	Printing and reproduction of recorded media	1.46	-5.08	16	47,222	82,204	202
FI	Printing and reproduction of recorded media	2.88	-4.68	57	10,799,445	11,354,055	321
FR	Printing and reproduction of recorded media	3.81	-5.17	21	816,477	3,483,067	1,353
GB	Printing and reproduction of recorded media	0.72	-5.23	228	20,001,647	35,589,785	333

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
GR	Printing and reproduction of recorded media	1.09	-4.68	28	2,611,899	3,565,288	171
IE	Printing and reproduction of recorded media	1.33	-2.29	131	16,436,850	46,070,094	14
IT	Printing and reproduction of recorded media	3.96	-6.13	25	3,758,504	4,438,265	3,588
LU	Printing and reproduction of recorded media	2.19	2.19	368	3,717,254	63,845,504	1
MT	Printing and reproduction of recorded media	1.07	-0.10	15	358,155	874,093	2
NL	Printing and reproduction of recorded media	1.06	-1.46	893	110,892,769	157,885,565	12
PT	Printing and reproduction of recorded media	2.36	-5.83	10	557,824	731,155	1,251
SE	Printing and reproduction of recorded media	2.41	-5.33	19	1,952,779	3,836,699	618
AT	coke and refined petroleum products	4.78	4.78	56	1,722,729	31,478,808	1
BE	coke and refined petroleum products	5.68	2.63	397	3,053,277,620	4,877,660,298	13
DE	coke and refined petroleum products	5.50	2.61	608	334,284,816	2,893,651,839	31
DK	coke and refined petroleum products	5.33	4.59	399	150,672,826	2,932,538,859	2
ES	coke and refined petroleum products	4.99	1.63	904	920,061,327	3,086,684,288	18
EE	coke and refined petroleum products	3.06	2.43	510	15,590,676	8,435,997	2
FI	coke and refined petroleum products	5.17	3.03	572	640,849,012	1,853,117,248	9
FR	coke and refined petroleum products	5.40	2.74	159	48,645,144	201,625,981	14
GB	coke and refined petroleum products	4.53	0.47	2,396	3,980,435,269	7,411,640,282	38
GR	coke and refined petroleum products	4.28	1.27	102	47,498,140	344,745,163	29
IE	coke and refined petroleum products	5.67	4.12	83	21,788,866	1,417,924,832	5
IT	coke and refined petroleum products	4.95	-0.05	74	59,203,630	250,750,311	214
NL	coke and refined petroleum products	5.92	3.36	136	164,621,540	1,672,959,644	8
PT	coke and refined petroleum products	4.96	2.66	233	488,361,215	1,204,571,550	8
SE	coke and refined petroleum products	4.50	2.27	195	156,788,053	1,030,021,787	12
AT	chemicals and chemical products	-0.61	-3.66	365	86,617,683	139,858,964	41

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
BE	chemicals and chemical products	3.53	-4.03	176	144,641,710	139,359,613	221
CY	chemicals and chemical products	-0.79	-2.96	36	7,305,887	4,297,423	7
DE	chemicals and chemical products	3.79	-4.79	1,250	373,402,028	584,260,546	354
DK	chemicals and chemical products	-1.25	-4.52	422	49,872,457	145,926,931	22
ES	chemicals and chemical products	0.93	-7.43	41	7,982,094	21,862,342	1,848
EE	chemicals and chemical products	0.60	-4.09	38	100,957	576,366	52
FI	chemicals and chemical products	0.52	-5.64	112	34,891,162	52,443,540	136
FR	chemicals and chemical products	8.70	-0.56	309	94,351,957	124,093,284	809
GB	chemicals and chemical products	-0.27	-5.48	309	75,747,999	118,350,805	582
GR	chemicals and chemical products	0.90	-5.81	45	4,437,125	9,446,708	232
IE	chemicals and chemical products	-0.62	-4.00	227	7,379,767	70,254,449	22
IT	chemicals and chemical products	1.75	-7.76	39	6,650,825	17,243,071	2,837
LU	chemicals and chemical products	-0.87	-2.84	1,985	326,264,833	1,151,549,326	6
MT	chemicals and chemical products	-0.88	-2.29	34	4,393,952	4,369,011	3
NL	chemicals and chemical products	-1.28	-5.85	1,152	528,413,869	449,549,005	60
PT	chemicals and chemical products	0.94	-6.65	23	4,348,888	8,643,075	448
SE	chemicals and chemical products	0.21	-6.35	68	18,292,308	35,115,749	280
AT	basic pharmaceutical products and pharmaceutical preparations	3.41	0.29	436	68,024,258	190,694,426	22
BE	basic pharmaceutical products and pharmaceutical preparations	4.99	0.17	1,276	672,247,744	607,489,476	47
CY	basic pharmaceutical products and pharmaceutical preparations	2.56	1.74	80	3,460,055	3,955,290	2
DE	basic pharmaceutical products and pharmaceutical preparations	4.04	-1.44	2,338	657,963,198	805,146,691	142
DK	basic pharmaceutical products and pharmaceutical preparations	3.73	0.53	3,026	829,260,458	880,362,318	21

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
ES	basic pharmaceutical products and pharmaceutical preparations	4.16	-1.60	236	62,463,952	78,632,089	234
EE	basic pharmaceutical products and pharmaceutical preparations	2.60	0.78	50	167,792	612,138	5
FI	basic pharmaceutical products and pharmaceutical preparations	3.65	0.76	313	28,844,435	114,161,875	19
FR	basic pharmaceutical products and pharmaceutical preparations	4.45	-1.54	1,088	493,451,057	404,337,485	175
GB	basic pharmaceutical products and pharmaceutical preparations	3.55	-1.52	1,073	394,214,691	368,517,323	199
GR	basic pharmaceutical products and pharmaceutical preparations	3.16	-1.18	161	13,422,214	37,419,109	71
IE	basic pharmaceutical products and pharmaceutical preparations	3.85	-0.45	1,098	1,470,779,784	411,491,166	41
IT	basic pharmaceutical products and pharmaceutical preparations	4.34	-2.38	219	35,636,752	83,317,952	435
LU	basic pharmaceutical products and pharmaceutical preparations	4.33	4.33	178	154,912,000	79,644,000	1
MT	basic pharmaceutical products and pharmaceutical preparations	2.81	1.40	182	19,169,949	42,134,313	4
NL	basic pharmaceutical products and pharmaceutical preparations	3.46	0.16	4,203	1,072,860,430	1,350,306,450	19
PT	basic pharmaceutical products and pharmaceutical preparations	3.82	-0.51	80	12,971,669	14,581,789	68
SE	basic pharmaceutical products and pharmaceutical preparations	3.81	-0.77	244	449,465,715	152,727,873	72
AT	rubber and plastic products	3.66	-0.27	429	32,998,666	92,648,648	46
BE	rubber and plastic products	3.71	-1.45	164	19,602,993	49,495,159	163

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
CY	rubber and plastic products	3.01	1.67	23	1,023,538	2,628,064	4
DE	rubber and plastic products	3.77	-2.43	910	74,881,044	190,844,389	376
DK	rubber and plastic products	3.41	0.17	207	25,178,261	58,410,133	25
ES	rubber and plastic products	3.94	-3.87	33	2,535,656	7,086,490	2,114
EE	rubber and plastic products	2.71	-2.33	24	56,223	147,145	128
FI	rubber and plastic products	3.69	-2.18	80	7,172,883	21,746,840	311
FR	rubber and plastic products	3.93	-3.50	232	21,818,651	47,245,783	1,095
GB	rubber and plastic products	3.34	-3.05	191	12,943,633	37,187,738	613
GR	rubber and plastic products	3.12	-2.34	44	4,982,154	8,253,767	251
IE	rubber and plastic products	3.47	0.50	128	10,775,909	34,068,905	16
IT	rubber and plastic products	4.87	-4.64	42	4,561,554	10,368,040	4,928
LU	rubber and plastic products	3.62	1.16	2,037	162,572,812	602,154,336	10
MT	rubber and plastic products	2.48	2.27	321	476,377	2,848,474	2
NL	rubber and plastic products	3.58	0.30	255	26,218,393	76,323,115	25
PT	rubber and plastic products	3.53	-3.05	30	1,915,934	4,989,509	725
SE	rubber and plastic products	3.87	-2.78	41	2,140,945	8,781,833	625
AT	other non-metallic mineral products	3.68	-0.53	673	104,924,407	151,786,683	53
BE	other non-metallic mineral products	3.80	-1.44	131	50,194,194	46,894,082	185
CY	other non-metallic mineral products	2.83	1.23	59	4,337,264	3,942,011	5
DE	other non-metallic mineral products	4.01	-1.74	730	155,446,322	159,496,974	224
DK	other non-metallic mineral products	3.40	0.02	1,158	135,576,998	251,075,537	30
ES	other non-metallic mineral products	3.55	-4.38	22	5,397,939	4,374,927	3,001
EE	other non-metallic mineral products	2.70	-2.49	24	74,467	169,200	144
FI	other non-metallic mineral products	3.81	-2.09	52	5,221,253	11,338,309	258
FR	other non-metallic mineral products	4.15	-3.47	233	41,111,673	58,113,635	1,054
GB	other non-metallic mineral products	3.36	-2.46	261	40,311,924	48,920,440	229
GR	other non-metallic mineral products	3.08	-2.74	39	11,545,664	7,480,884	360
IE	other non-metallic mineral products	3.44	1.27	9,904	1,842,374,288	2,569,560,978	8

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
IT	other non-metallic mineral products	4.05	-4.88	32	6,985,307	7,255,914	5,586
LU	other non-metallic mineral products	3.69	2.12	162	17,725,206	41,276,105	5
MT	other non-metallic mineral products	2.92	2.12	145	28,295,444	8,792,868	2
NL	other non-metallic mineral products	3.75	0.87	168	48,206,996	82,146,470	11
PT	other non-metallic mineral products	3.55	-3.72	29	6,597,564	4,854,171	1,654
SE	other non-metallic mineral products	4.13	-2.32	44	5,368,465	12,903,287	357
AT	basic metals	7.03	2.56	1,420	243,854,388	469,782,035	50
BE	basic metals	7.73	2.32	450	55,671,495	170,539,420	102
DE	basic metals	7.23	1.40	1,567	139,475,598	432,196,843	240
DK	basic metals	6.82	4.38	233	26,229,173	77,906,890	12
ES	basic metals	6.88	0.13	57	12,147,074	28,864,767	1,089
EE	basic metals	4.78	1.89	16	35,412	124,933	19
FI	basic metals	7.06	2.59	545	121,922,919	252,210,013	68
FR	basic metals	7.19	0.88	316	46,220,493	104,111,012	352
GB	basic metals	7.23	0.82	711	138,637,302	143,149,261	256
GR	basic metals	6.66	2.21	221	62,128,472	76,746,712	79
IE	basic metals	7.08	5.21	86	2,638,903	24,747,395	6
IT	basic metals	7.33	-0.24	73	11,569,469	37,304,389	1,662
LU	basic metals	6.95	3.77	28,049	7,611,069,124	8,773,939,982	10
NL	basic metals	7.30	3.66	2,109	381,056,063	401,786,846	10
PT	basic metals	6.74	1.58	41	3,328,063	13,650,913	184
SE	basic metals	7.15	1.23	184	50,249,163	72,701,181	215
AT	fabricated metal products, except machinery and equipment	-10.53	-15.91	180	26,133,318	56,029,600	87
BE	fabricated metal products, except machinery and equipment	-8.47	-16.18	97	7,250,867	24,105,868	351
CY	fabricated metal products, except machinery and equipment	-12.08	-12.78	28	1,388,665	1,981,711	3
DE	fabricated metal products, except machinery and equipment	-0.56	-13.19	411	22,838,271	89,084,567	653
DK	fabricated metal products, except machinery and equipment	-13.35	-16.83	198	18,634,333	51,358,332	47
ES	fabricated metal products, except machinery and equipment	3.57	-6.63	17	1,324,433	2,630,418	9,332
EE	fabricated metal products, except machinery and equipment	6.71	-2.29	14	24,921	82,691	736

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
FI	fabricated metal products, except machinery and equipment	2.25	-6.09	24	1,425,761	4,230,876	1,649
FR	fabricated metal products, except machinery and equipment	4.85	-4.49	43	2,519,571	7,988,296	4,289
GB	fabricated metal products, except machinery and equipment	-12.95	-18.50	149	10,608,591	29,165,545	1,218
GR	fabricated metal products, except machinery and equipment	-6.08	-14.65	27	3,732,336	5,228,064	443
IE	fabricated metal products, except machinery and equipment	-13.40	-14.75	346	46,647,730	98,180,446	25
IT	fabricated metal products, except machinery and equipment	10.82	-0.28	19	1,301,036	3,642,986	22,438
LU	fabricated metal products, except machinery and equipment	-11.76	-13.15	621	51,020,701	102,992,996	10
MT	fabricated metal products, except machinery and equipment	-12.73	-12.73	230	369,248	14,350,946	1
NL	fabricated metal products, except machinery and equipment	-13.34	-14.56	381	50,471,190	107,574,344	24
PT	fabricated metal products, except machinery and equipment	5.26	-2.95	14	507,986	1,119,726	4,718
SE	fabricated metal products, except machinery and equipment	-0.43	-10.99	51	5,340,769	9,283,484	3,342
AT	computer, electronic and optical products	7.20	4.21	423	42,654,376	76,673,037	49
BE	computer, electronic and optical products	5.64	0.78	256	30,923,073	74,090,702	102
CY	computer, electronic and optical products	3.94	3.94	6	1,037,000	116,000	1
DE	computer, electronic and optical products	5.72	-1.11	1,826	215,275,817	349,813,087	458
DK	computer, electronic and optical products	5.22	1.54	375	44,247,081	84,740,200	41
ES	computer, electronic and optical products	5.44	-1.25	29	1,958,818	5,248,039	752

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\overline{L}$	Average firm-size in capital, $\overline{K}$	Average firm-size in turnover, $\overline{Y}$	Number of firms, n_c
EE	computer, electronic and optical products	4.01	0.02	69	76,227	1,689,898	66
FI	computer, electronic and optical products	5.74	-0.28	504	37,449,034	117,957,104	247
FR	computer, electronic and optical products	6.55	-0.91	308	36,514,432	60,903,242	729
GB	computer, electronic and optical products	5.35	-1.09	355	41,894,816	72,945,275	612
GR	computer, electronic and optical products	5.09	0.67	186	21,828,805	45,612,122	70
IE	computer, electronic and optical products	5.99	1.73	3,234	591,890,467	1,288,066,810	47
IT	computer, electronic and optical products	6.01	-2.78	67	5,965,881	12,326,900	3,512
LU	computer, electronic and optical products	6.44	4.31	230	24,581,657	91,940,595	6
MT	computer, electronic and optical products	4.59	3.17	402	1,357,165	8,250,093	5
NL	computer, electronic and optical products	5.60	1.20	2,790	497,906,409	613,515,038	49
PT	computer, electronic and optical products	5.09	0.35	65	2,487,237	12,486,316	123
SE	computer, electronic and optical products	5.81	-0.60	374	39,262,504	104,295,856	447
AT	electrical equipment	0.57	-2.96	623	95,152,489	181,615,464	35
BE	electrical equipment	2.63	-3.67	126	12,182,659	39,945,190	84
DE	electrical equipment	2.00	-4.71	831	61,302,363	195,807,097	344
DK	electrical equipment	0.03	-2.36	726	57,735,659	181,834,616	22
ES	electrical equipment	3.56	-3.10	57	5,771,897	12,945,971	963
EE	electrical equipment	0.87	-3.36	77	151,985	518,438	71
FI	electrical equipment	0.52	-4.59	71	4,367,326	25,348,325	184
FR	electrical equipment	2.95	-4.95	501	105,903,822	90,895,271	587
GB	electrical equipment	0.63	-5.79	164	10,595,938	40,071,575	482
GR	electrical equipment	-0.13	-5.18	40	3,937,243	7,280,343	139
IE	electrical equipment	0.08	-2.00	5,823	987,632,861	1,021,876,690	28
IT	electrical equipment	4.19	-5.37	41	3,573,838	9,700,190	4,146
LU	electrical equipment	0.46	-0.74	435	27,426,329	95,648,456	3
MT	electrical equipment	-0.65	-0.65	43	653,880	20,443,634	1
NL	electrical equipment	0.31	-1.15	11,163	1,416,849,378	2,084,592,712	14
PT	electrical equipment	1.42	-5.18	42	2,067,758	6,839,908	379
SE	electrical equipment	2.16	-5.08	255	20,848,722	61,533,718	362
AT	machinery and equipment n.e.c.	5.48	0.56	637	44,416,159	176,462,703	121
BE	machinery and equipment n.e.c.	5.42	-0.07	136	44,276,665	39,396,212	238
CY	machinery and equipment n.e.c.	4.27	4.27	30	168,458	939,552	1
DE	machinery and equipment n.e.c.	5.80	-1.51	854	84,822,837	191,572,440	1,034
DK	machinery and equipment n.e.c.	5.14	0.52	534	68,719,963	172,060,197	106
ES	machinery and equipment n.e.c.	5.16	-2.89	28	1,991,492	4,949,442	3,169
EE	machinery and equipment n.e.c.	3.74	-0.88	26	37,184	153,090	100

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
FI	machinery and equipment n.e.c.	5.38	-1.11	163	14,842,641	45,069,243	669
FR	machinery and equipment n.e.c.	5.82	-1.08	90	5,815,244	24,335,323	1,467
GB	machinery and equipment n.e.c.	5.13	-1.68	306	35,126,840	75,386,522	852
GR	machinery and equipment n.e.c.	4.78	-0.54	54	2,924,100	5,288,065	199
IE	machinery and equipment n.e.c.	5.20	1.69	1,124	227,942,958	234,492,034	29
IT	machinery and equipment n.e.c.	5.59	-3.85	38	3,339,417	9,814,708	12,071
LU	machinery and equipment n.e.c.	5.45	2.77	255	47,233,982	47,065,351	13
MT	machinery and equipment n.e.c.	4.58	4.58	61	810,218	4,054,408	1
NL	machinery and equipment n.e.c.	5.40	0.95	1,529	258,074,853	526,574,351	70
PT	machinery and equipment n.e.c.	5.10	-1.42	24	953,132	3,062,218	850
SE	machinery and equipment n.e.c.	5.34	-1.99	158	17,876,578	39,316,840	1,255
AT	motor vehicles, trailers and semi-trailers	1.41	-2.26	851	62,371,925	285,108,053	35
BE	motor vehicles, trailers and semi-trailers	2.25	-2.82	416	20,314,041	230,320,660	59
CY	motor vehicles, trailers and semi-trailers	0.85	0.12	823	161,496,818	27,582,891	2
DE	motor vehicles, trailers and semi-trailers	1.67	-4.59	6,757	2,418,976,583	2,837,925,663	198
DK	motor vehicles, trailers and semi-trailers	1.15	-1.07	248	16,240,852	64,203,452	9
ES	motor vehicles, trailers and semi-trailers	2.84	-5.42	163	19,041,194	68,776,611	879
EE	motor vehicles, trailers and semi-trailers	1.36	-2.84	64	33,809	404,508	43
FI	motor vehicles, trailers and semi-trailers	1.80	-3.31	73	3,082,748	16,481,529	104
FR	motor vehicles, trailers and semi-trailers	3.14	-5.56	1,182	179,416,678	387,935,099	556
GB	motor vehicles, trailers and semi-trailers	1.19	-4.58	1,319	127,134,829	372,659,966	262
GR	motor vehicles, trailers and semi-trailers	1.39	-2.36	38	5,317,748	7,644,244	33
IE	motor vehicles, trailers and semi-trailers	1.38	-0.48	104	6,581,090	36,138,567	6
IT	motor vehicles, trailers and semi-trailers	3.79	-4.98	127	18,529,897	47,710,116	1,301
LU	motor vehicles, trailers and semi-trailers	0.88	0.14	2,054	204,673,004	531,591,992	2
MT	motor vehicles, trailers and semi-trailers	0.82	0.82	1,107	26,917,260	154,309,712	1
NL	motor vehicles, trailers and semi-trailers	1.03	-1.72	24,177	5,879,773,510	10,613,501,092	10
PT	motor vehicles, trailers and semi-trailers	3.19	-4.01	102	5,229,825	22,653,171	298

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SE	motor vehicles, trailers and semi-trailers	1.68	-5.14	570	125,854,633	203,487,841	359
AT	other transport equipment	4.38	2.12	1,014	112,442,264	310,742,686	7
BE	other transport equipment	5.12	2.09	413	58,684,280	123,485,353	16
DE	other transport equipment	5.50	0.87	1,133	151,050,391	403,535,448	79
DK	other transport equipment	4.36	2.55	142	7,816,245	36,788,920	5
ES	other transport equipment	5.34	-1.46	225	50,235,504	55,647,924	255
EE	other transport equipment	3.61	-0.36	10	28,318	97,399	38
FI	other transport equipment	5.40	-0.12	58	1,934,764	13,806,779	111
FR	other transport equipment	5.79	-1.19	1,418	242,136,450	378,766,448	207
GB	other transport equipment	4.39	-1.34	1,184	208,479,934	302,561,466	173
GR	other transport equipment	4.13	0.08	65	9,168,250	4,341,147	22
IE	other transport equipment	4.57	2.75	95	18,092,600	22,652,600	5
IT	other transport equipment	5.51	-2.93	117	22,921,625	30,005,009	1,340
LU	other transport equipment	5.15	5.15	5	373,206	3,935,991	1
MT	other transport equipment	4.92	3.35	34	9,939,850	14,235,122	3
NL	other transport equipment	4.60	1.06	12,036	4,060,351,894	5,342,700,059	12
PT	other transport equipment	5.39	-0.32	33	3,214,702	3,030,364	90
SE	other transport equipment	5.01	-1.33	129	13,173,923	28,629,987	186
AT	furniture	3.15	0.68	294	9,746,148	46,770,750	12
BE	furniture	3.08	-1.53	69	3,564,123	14,057,894	86
CY	furniture	2.53	1.77	33	254,101	1,827,230	2
DE	furniture	3.15	-0.74	325	15,700,971	59,179,091	72
DK	furniture	2.77	-0.26	244	17,438,395	73,343,245	21
ES	furniture	2.86	-5.17	11	689,419	1,147,350	2,783
EE	furniture	2.13	-3.97	15	14,984	54,696	397
FI	furniture	3.07	-2.49	24	667,046	3,995,717	226
FR	furniture	3.32	-3.40	27	888,848	4,454,586	641
GB	furniture	2.72	-2.72	215	5,078,702	31,249,750	233
GR	furniture	2.42	-2.42	20	1,751,708	1,450,503	131
IE	furniture	2.81	0.94	607	12,458,657	162,881,697	6
IT	furniture	3.46	-5.19	21	1,337,293	3,829,227	4,405
NL	furniture	2.88	1.54	714	20,155,500	120,642,748	4
PT	furniture	2.85	-4.66	15	391,391	846,457	1,589
SE	furniture	3.05	-3.39	78	11,208,509	16,162,908	493
AT	Other manufacturing	1.53	-1.86	277	43,273,110	59,912,630	14
BE	Other manufacturing	2.75	-3.32	71	9,172,812	34,143,183	62
CY	Other manufacturing	0.49	0.49	20	5,234,887	1,818,331	1
DE	Other manufacturing	2.36	-5.21	1,856	223,129,534	254,553,557	153

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DK	Other manufacturing	0.88	-2.23	2,276	293,270,310	524,135,027	17
ES	Other manufacturing	2.16	-5.94	16	985,724	2,423,353	1,391
EE	Other manufacturing	1.33	-4.51	13	18,299	53,327	164
FI	Other manufacturing	2.48	-3.40	75	6,270,444	15,820,279	276
FR	Other manufacturing	3.10	-4.63	35	2,821,166	7,448,205	1,337
GB	Other manufacturing	0.96	-6.92	154	9,582,691	31,775,997	1,322
GR	Other manufacturing	2.36	-3.54	29	1,793,398	3,183,213	121
IE	Other manufacturing	1.18	-3.04	228	56,467,271	148,194,874	36
IT	Other manufacturing	2.80	-6.63	25	1,533,535	4,890,620	3,680
LU	Other manufacturing	0.84	-0.48	129	23,140,341	51,929,290	3
MT	Other manufacturing	0.82	-0.22	19	1,288,421	6,213,067	2
NL	Other manufacturing	1.07	-1.78	913	91,945,755	182,967,394	16
PT	Other manufacturing	2.30	-5.50	11	291,720	1,029,679	888
SE	Other manufacturing	1.71	-5.50	21	1,857,714	6,225,372	501
AT	Repair and installation of machinery and equipment	2.47	-0.28	217	6,357,200	45,759,392	12
BE	Repair and installation of machinery and equipment	2.12	-2.65	65	2,154,770	15,509,617	40
CY	Repair and installation of machinery and equipment	0.35	-0.38	34	3,430,737	2,460,941	2
DE	Repair and installation of machinery and equipment	6.38	-2.67	536	47,759,894	128,604,666	81
DK	Repair and installation of machinery and equipment	0.61	-2.20	83	5,991,513	25,051,407	13
ES	Repair and installation of machinery and equipment	2.73	-5.44	10	400,968	1,048,272	3,165
EE	Repair and installation of machinery and equipment	2.40	-4.93	13	12,920	64,416	359
FI	Repair and installation of machinery and equipment	2.97	-3.95	17	471,250	3,185,904	548
FR	Repair and installation of machinery and equipment	5.29	-4.36	33	1,919,853	6,834,079	2,979
GB	Repair and installation of machinery and equipment	0.87	-5.56	169	30,389,603	51,699,681	359
GR	Repair and installation of machinery and equipment	1.35	-3.78	49	5,220,457	4,094,954	69
IT	Repair and installation of machinery and equipment	4.07	-5.67	15	2,015,419	2,794,745	4,871
NL	Repair and installation of machinery and equipment	0.90	-2.76	95	14,549,312	23,907,880	18
PT	Repair and installation of machinery and equipment	3.86	-3.64	14	285,283	1,031,623	1,240

country	Industry	Simple average TFP, $\overline{\varphi_c}$	Capital-weighted average TFP, φ_c^k	Average firm-size in employment, $\bar{L}$	Average firm-size in capital, $\bar{K}$	Average firm-size in turnover, $\bar{Y}$	Number of firms, n_c
SE	Repair and installation of machinery and equipment	1.96	-5.58	12	323,361	2,411,439	1,043

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