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The fall and rise of market power in Europe*

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Abstract

This paper presents an analysis of the recent developments of average market power in Europe by using a broad firm-level database for EU member states. To indicate competitive pressure at the firm-level, markups are estimated following De Loecker (2011), and De Loecker and Warzynski (2012). The analysis reveals a sharp drop in markups during the crisis, followed by a post-crisis increase. The European average has not yet reached its pre-crisis level, which is in contrast to results for the US, where average markups have climbed to pre-crisis levels already in 2011. There is significant heterogeneity among European economies and the pre-crisis levels do have been exceeded in some countries.

JEL Classification: E2, D2, D4, L1

Keywords: Market Power, Markups, Europe, Crisis

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1 Introduction

Recent empirical research, which is predominantly based on US data, suggests that there is an increasing concentration of economic activities and a declining competition intensity across industries. For example, Grullon et al. (2015) examined publicly traded companies in the United States and find that concentration increased in 75 percent of all industries (3-digit NAICS) since 2000 and that the number of publicly traded firms in the United States shrank by almost 50 percent during the last two decades. De Loecker and Eeckhout (2017) go beyond a market structure perspective and present evidence for increasing firm-level markups in the United States. Moreover, Stiglitz (2016) and The Economist (2016a and b) have prominently expressed concerns about recently increasing excess profits and global market power. The Council of Economic Advisors (CEA) (2016) of the Obama administration shared these concerns and suggested to re-think the actual US competition policy to address anti-competitive developments. A follow-up presidential order obliged the agencies in charge to propose steps to increase competition (Executive Order 13725 of April 15, 2016). However, whether or not the available studies are sufficient to indicate a real decline in competition is still the subject of discussion (e.g., Ohlhausen, 2016). So far, similar data and analysis for Europe is missing. This paper intends to fill this gap.

The potential reasons for an indicated inter-sectoral decline in competition intensity are not well identified. Some of the explanations that are currently under debate include an increasing role of scale economies against the background of a globalized world economy, crowding-out effects and increasing entry barriers through a selective technological progress (Andrews et al., 2015; Grullon et al., 2015), and external growth strategies of companies (CEA, 2016; Grullon et al., 2015) combined with an underenforcement of competition authorities (Motta, 2017).[1] Furthermore, the increasing importance of data and platform markets in a digital economy could also

[1] In the context of the United States merger regime, for example, Blonigen and Pierce (2016) find that mergers had a significantly more pronounced effect on market power then on efficiency and also Kwoka (2015) concludes that many mergers resulted in competitive harm in terms of both higher prices and non-price outcomes.

be responsible for an increasing role of "winner-takes-most-markets" (Autor et al., 2017; Monopolkommission, 2015). Moreover, an increasing number of indirect links between competitors via diversified institutional investors has also been discussed as a driver of anti-competitive behavior (Monopolkommission, 2016; OECD, 2017a).

None of these reasons consider trends that are exclusively prevalent in the United States. Nevertheless, especially for Europe, there is much less research available on recent developments of the inter-sectoral competition intensity and, to the best of the authors' knowledge, none that considers firm-level markups instead of market structure indicators.[2]

This study aims to fill this research gap by providing inter-sectoral evidence of the recent development of market power in EU countries that is based on estimated firm-level markups following the approach by De Loecker and Eeckhout (2017). A crucial advantage of our study is that we do not only consider publicly traded firms, as is the case in the study by De Loecker and Eeckhout (2017) for the United States, and that we perform our analysis also on a more disaggregated geographical level of individual European member states. A special focus of our analysis lies in the description of the development of market power during and in the aftermath of the 2008 financial and economic crisis. The dramatic cyclical drop, which started in 2008, particularly hit European economies and may have been the reason for a process of restructuring, both at the firm and industry level (cf. e.g., Foster et al., 2016; Duval et al., 2017). Therefore, it is likely that the crisis years had a significant impact on the competitive environment in European economies, raising the question of whether or not competition has worsened after the crisis.

The analysis of the development of estimated firm-level markups across EU28 countries reveals that there has been a sharp drop in average market power during the crisis years of 2008 and 2009, which has been followed by a post-crisis increase. The upward trend in average markups since 2012/2013 is not solely driven by industry

[2] Autor et al. (2017) find an increasing industry concentration also for non-US economies. Also Valletti (2017) recently presented evidence on concentration (C4 and HHI4) and accounting profit trends in EU5 countries between 2010 and 2015. He concluded that there is no average concentration increase after the crisis and that profit margins increased less than in the United States.

restructuring but also by a within firm increase of markups. However, the pre-crisis level of average market power was not reached in 2015. This is in contrast to results for the United States, where average markups climbed to pre-crisis levels as soon as in 2011, followed by a sharp increase in 2013 and 2014 (De Loecker and Eeckhout, 2017). The post-crisis increase of markups in Europe can be observed along the entire upper half of the markup distribution. In other words, not only do firms with already high markups increase their markups further but the median markup has also increased in recent years. This is again in contrast to the findings for the United States, where the increase in average markups is entirely driven by firms with markups in the top half of the markup distribution and the 90^{th} percentile is increasing clearly disproportionately (De Loecker and Eeckhout, 2017). The analysis of particular EU member states reveals a significant heterogeneity. In some countries, the average post-crisis markup is higher than before the crisis and in some countries the average markups are decreasing.

These results matter for both researchers as well as policy makers. First and foremost, an intersectoral rise in market power may significantly affect overall resource allocation and thus may have significant macroeconomic consequences. For example, De Loecker and Eeckhout (2017) argue that several secular trends in the United States may be caused by a rising average market power—such as declining labor and capital shares, declining wages for low skill workers, a declining labor force participation, and declining labor market flows. Barkai (2016) and Autor et al. (2017) also link a declining labor share to an increasing market power. If there is indeed a causal link between market power and decreasing labor shares, then market power may in turn be a determinant of an increasing income inequality, which can be observed in many OECD economies (Bourguignon, 2017). Another macroeconomic trend that may be related to an increasing market power—and which has (also) recently attracted a lot of attention from both policy makers and researchers—is the slowdown in aggregate productivity growth, which can be observed in recent decades among OECD countries (OECD, 2017b; Gordon, 2016). Many complementary reasons are discussed for the productivity growth slowdown (e.g., OECD, 2017b; Gordon, 2016; Andrews et al., 2015; Duval et al., 2017; Ahmad et al., 2017), but competition intensity has only recently entered this debate (e.g., Decker et al, 2017; Bartelsman et al., 2013; De Loecker and Eeckhout, 2017). This is surprising, since, for example, many studies find support for productivity enhancements due to pro-competitive policies (e.g., Nicoletti and Scarpetta, 2003; Griffith et al., 2010; Aghion et al., 2004).

The paper is structured as follows: In Section 2, the strategy to measure competitive pressure at the firm-level is introduced according to De Loecker (2011), and De Loecker and Warzynski (2012). The data on European firms is described in Section 3 and the results on the development of average markups are presented and discussed in Section 4. Finally, in Section 5 we discuss potential implications of this study.

2 Measuring market power

Measuring the degree of competition intensity in markets or the market power of individual firms is a challenging issue. This is especially true for broad inter-industry studies in which an appropriate definition of markets and data on prices or quantities are not available. Performance oriented measures, which are based on the idea to measure excess profits over marginal cost, are generally preferred over structural measures. They are less susceptible to the market definition and consider that competition may be intense, even in highly concentrated markets.[3] De Loecker (2011), and De Loecker and Warzynski (2012) have proposed an approach to approximate individual firms' market power by estimating firm-level markups from production data. This approach is followed in the subsequent analysis and explained in the following.

The authors' strategy is based on the idea that market power manifests itself in prices P above marginal costs λ ($\frac{P}{\lambda} > 1$) and, hence, markups μ above unity ($\mu = \frac{P}{\lambda}$). They identify markups as the ratio of an input's output elasticity and the revenue share of its costs. This builds on the insight that under perfect competition the output elasticity of a variable input factor without adjustment costs equals its revenue share. Individual firm-level output elasticities can be derived from production

[3] For a comprehensive discussion of empirical strategies to measure market power, see Perloff et al. (2007).

function estimates using the control function approach, according to Olley and Pakes (1996), and Levinsohn and Petrin (2003).

The definition of markups as a function of output elasticities is briefly derived formally in the following:[4] Suppose a firm i produces an output Q in period t with productivity ω_{it} and labor L_{it} as a variable input factor without adjustment costs as well as capital stock K_{it} as an input factor with adjustment costs:[5]

$$Q_{it} = Q_{it}(L_{it}, K_{it}, \omega_{it}). \tag{1}$$

Provided that firms are minimizing costs, they face an optimization problem which can be formulated in the form of the Lagrangian function

$$(L_{it}, K_{it}, \lambda_{it}) = w_{it}L_{it} + r_{it}K_{it} + \lambda_{it}(Q_{it} - Q_{it}(\cdot)), \tag{2}$$

with w_{it} and r_{it} denoting the factor prices of the inputs labor and capital respectively. The first-order condition with respect to the labor input is hence given as

$$\frac{\partial_{it}}{\partial L_{it}} = w_{it} - \lambda_{it}\frac{\partial Q_{it}(\cdot)}{\partial L_{it}} \stackrel{!}{=} 0. \tag{3}$$

Rearranging the first-order condition of the variable input, considering the output elasticity θ^L_{it} as $\frac{\partial Q_{it}(\cdot)}{\partial L_{it}}\frac{L_{it}}{Q_{it}}$, and the markup μ_{it} as $\frac{P_{it}}{\lambda_{it}}$, gives the following expression for the markup:

$$\mu_{it} = \theta^L_{it}\left(\frac{w_{it}L_{it}}{P_{it}Q_{it}}\right)^{-1}. \tag{4}$$

Firms' expenditures on intermediate inputs $(w_{it}L_{it})$ and their revenues $(P_{it}Q_{it})$ are available from balance sheets and only the respective input factor's output elasticity (θ^L_{it}) has to be obtained through the estimation of a production function.[6]

[4] According to De Loecker and Warzynski (2012).

[5] Input factor adjustment costs restrict a firm's reaction to changes in output demand and thus the variation regarding the respective factor. For example, Hall (2004) shows empirically that the adjustment costs of both capital and labor are relatively small. As an alternative to labor, the output elasticity of other input factors can be used instead. However, De Loecker and Warzynski (2012) compare markups based on labor elasticities with markups based on material input elasticities and find very similar results.

[6] A detailed description of the empirical implementation and production function estimation can be found in Appendix A.

3 Data

A firm-level panel dataset is used to investigate market power in European countries, which is constructed from a European subsample of Bureau van Dijk's Orbis database. The available information covers the period 2007–2015, which allows us to observe the parameters before, during and after the global financial and economic crisis.

The Orbis database is compiled from information from various national information providers and covers a broad range of balance sheet and profit and loss statement variables and other firm-level information, which has made it an eligible and often used microdatabase for answering various research questions in the context of industrial organization and firm performance (e.g., by the OECD; cf. Pinto Ribeiro et al., 2010).[7] The main advantages of the Orbis database over official business statistics are its broad coverage, the comparability of firms across national borders, and the detailed financial information about individual firms. Furthermore, the possibility of tracking firms over a relatively long period allows exploiting panel data methods, which is possible only to a limited extent with most official statistics due to a new sampling after a couple of years.

However, the Orbis database is neither a census nor a business register, and neither is the process of data collection subject to a specific sampling method. A bias towards larger firms, which are more likely to publish financial statements, has to be assumed (Pinto Ribeiro et al., 2010). The sample that we have used is not restricted to only publicly traded firms, as was the case in the analysis of De Loecker and Eeckhout (2017). This is an advantage because markups may vary greatly by firm size and unlisted firms may even show higher markups on average (De Loecker and Eeckhout, 2017).[8]

We analyzed the development of average markups using a sample of 3,604,391 firm-year observations from 17 EU28 countries.[9] The arithmetic mean of the estimated

[7] For a detailed description of the Orbis database, see Bureau van Dijk (2011).

[8] However, the aim of De Loecker and Eeckhout (2017) is to illustrate the evolution of markups over the longest possible period, which is at odds with sample coverage and firm-level variables.

[9] These countries are Belgium, Bulgaria, Czech Republic, Germany, Estonia, Spain, Finland, France, Croatia, Hungary, Italy, Poland, Portugal, Romania, Sweden, Slovenia, and Slovakia. Firms from Croatia are only included in the sample from 2013 onwards, which was the date when Croatia joined the EU. Details on the data preparation procedure can be found in Appendix B.

firm-level markups in the pooled sample is 2.31, with a standard deviation of 2.11. The median markup is 1.84. This is slightly more than, for example, the median markup estimated by De Loecker and Warzynski (2012) for a sample of Slovenian manufacturing firms. De Loecker and Warzynski (2012) present a set of average markups that differ by specification and methodology, they obtain a maximum average markup of 1.28. However, detailed information about the markup distribution is not available, and it can be broad, as other empirical studies have suggested. For example, Lu and Yu (2013) observe markups between 3 and 4 and De Loecker et al. (2016) obtain industry means of up to 5.66, despite excluding values below the 3rd and above the 97th percentile. In our study, we only treat observations below the 1st and above the 99th percentile as outliers.[10] Therefore, our summary statistics appear to be in line with other applications. Nevertheless, the levels of estimated markups can become relatively large (up to 20 in this application, with a 95th percentile at 5.66) and should be interpreted with caution due to, for example, a likely omitted price variable bias (as discussed in Appendix A). However, as De Loecker and Warzynski (2012) stress, even if the estimated markup level is biased, this should not affect the validity of the markups' changes over time or their correlation with other firm characteristics.

4 The development of average markups in Europe

The analysis of the development of average markups across the EU28 countries reveals a sharp drop during the crisis years 2008 and 2009, followed by a post-crisis increase. Figure 1 illustrates these results and it also shows a noteworthy difference between average markups which have been weighted by sales shares in the respective industry (solid red line) and unweighted averages (solid blue line). Although the weights appear reasonable to adequately consider the fact that firms with higher market shares may also gain more competitive significance, it makes the average more volatile.[11] However, both measures point to the same trends.

[10] Our results without the exclusion of outliers are reported in Appendix B.

[11] It also needs to be kept in mind that the sales shares are inevitably based on an industry classification that does not necessarily reflect markets. Therefore, a weighting may be misleading.

The upward trend in average markups since 2012/2013 cannot be driven by intra-industry restructuring alone, it is also driven by a within firm increase of markups. This is demonstrated by the development of average markups in a balanced sample, as shown in Figure 1 (dashed lines). The balanced sample covers only firms that were active during the entire period between 2012 and 2015. If a raising average markup could be purely driven by industry restructuring, meaning that firms with below average markups left the markets, then the markups of surviving firms could be stable over time. However, this is not the case because both weighted and unweighted average markups are increasing from 2013 for firms that were active during the entire period between 2012 and 2015.

The analysis of a balanced sample also appears to be necessary from a data perspective because, first, the data is based on company accounts that do not become available for all firms at the same moment. Therefore, the number of accounts included in the sample decreases continuously from 2013 to 2015 (sample attrition). Second, it appears to be necessary because Croatian firms enter the sample only in 2013. Therefore, the increase in markups could also be due to sample attrition. However, because average markups also increase in a balanced panel starting in 2012, the sample attrition can be excluded as a reason for the increasing trend. Whereas the sudden drop of the average weighted markup in 2015 is most likely due to sample attrition.

The post-crisis increase of markups has not (yet) reached the pre-crisis level, let alone exceeded it. This finding is in contrast to the results for the United States, where a similarly sharp drop during the crisis years can be observed but where average markups climbed to pre-crisis levels as soon as in 2011, followed by sharp increase in 2013 and 2014 (De Loecker and Eeckhout, 2017).

The picture of a crisis driven drop in markups that is followed by a moderate increase that started around 2013 holds across the different regions of the EU. This is illustrated in Figure 2, where the development of average markups of EU28 countries is contrasted with figures for only EU15, Southern European and Central Eastern European (CEE) countries. In none of these regions is the level of average markups in 2015 higher than the pre-crisis level in 2007. Nevertheless, a slight increase can

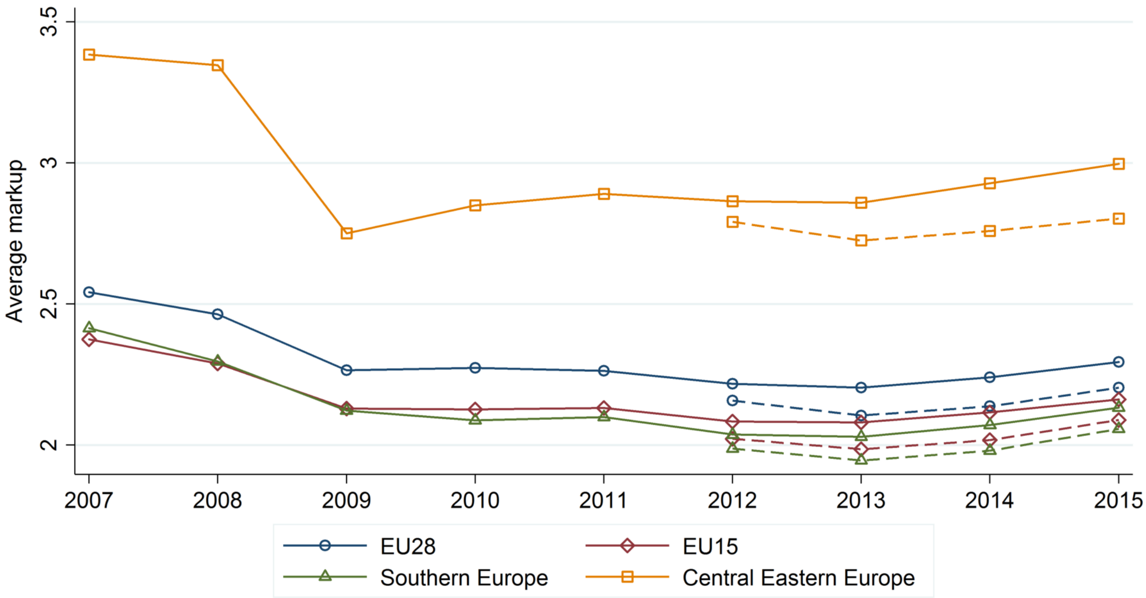
Figure 1: Development of firm-level markups in EU countries

Note: Solid lines represent results for the unbalanced panel and dashed lines represent results for the balanced panel. Balancing on markup information for the period 2012–2015. All values deflated according to country and industry level producer price indices. Weighting by sales shares.

be observed since 2013 for all regions, which is robust against sample attrition and also reflects within firm changes, as the figures for the balanced sample demonstrate (dashed lines).

The average estimated markups in this study are significantly higher than estimated markups for the United States (De Loecker and Eeckhout, 2017). The results for the US census data reveal that there is a peak of average weighted markups in 2014 at 1.66. The results of the European accounting data show a peak at 3.61. An important difference between the studies is that the study of European markups does not only consider publicly traded firms. This broader set of firms may be the reason why the reported average markups in our study are higher; for example, because niche markets and regional monopolies may be more relevant for small firms. The fact that smaller firms do not necessarily also have smaller markups is also supported by the results of De Loecker and Eeckhout (2017). Another reason for the different markup size may be methodological differences in terms of different types of data, a

Figure 2: Development of firm-level markups by EU region



Note: Solid lines represent results for the unbalanced panel and dashed lines represent results for the balanced panel. Balancing on markup information for the period 2012–2015. All values deflated according to country and industry level producer price indices. Unweighted averages.

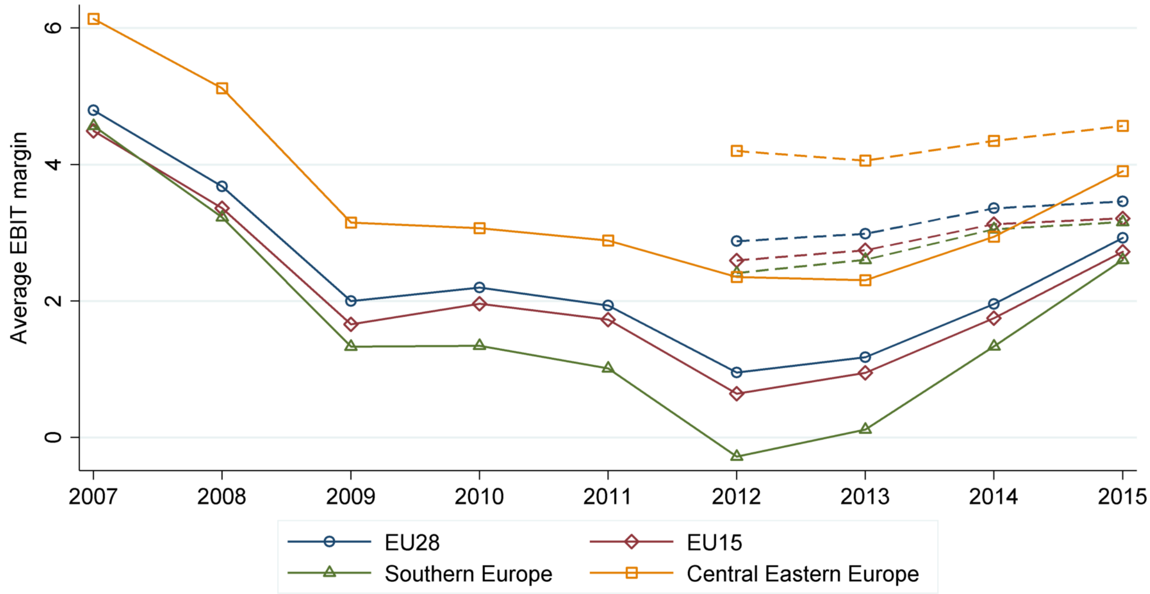
different treatment of outliers, and different industry levels.[12]

4.1 The development of average profitability in Europe

The average EU firm-level profitability, measured as the return on sales margin (RoS), increases simultaneously to markups (Figure 3). This is an important indicator because it shows that it is likely that the estimated markups do indeed measure market power and are not flawed by changes in fixed costs. Given that the estimation of markups is based on output elasticities for variable inputs, it may be the case that higher revenues in relation to variable input costs are required to cover additional fixed costs. Hence, increasing markups do not necessarily point to increasing market

[12] For example, De Loecker and Eeckhout (2017) estimate firm-level markups at the 4-digit industry level, whereas the 3-digit level is used in our study to be able to further disaggregate the EU data according to regions and countries. Furthermore, some values have been treated as outliers and it turns out that this treatment is crucial for the results of the analysis. Figure 6 in Appendix B shows that the average markup may indeed exceed the pre-crisis level from the year 2012 once observations of the upper and lower one percent of the observations are included, albeit this is most likely due to a sample attrition bias.

Figure 3: Development of firm-level profitability by EU region



Note: Solid lines represent results for the unbalanced panel and dashed lines represent results for the balanced panel. Balancing on markup information for the period 2012–2015. All values deflated according to country and industry level producer price indices.

power if the fixed costs have increased proportionately; for example, caused by technological change. De Loecker and Eeckhout (2017) stress this issue and use the dividends paid to shareholders and the market value to contrast the development of markups with the development of profits. Given that this study also includes non-listed firms, alternative accounting based profit measures must be used. Figure 3 shows the development of the average return on sales margin (RoS) measured as earnings before interest and taxes over total sales (EBIT margin). It can be seen that the upward trend in markups from 2013 is accompanied by increasing accounting profits. When depreciation and amortization are excluded from the RoS measure by using the EBITDA margin, this pattern does not change much and all of the regions show increasing average profits from 2012.[13]

[13] The results for EBITDA margins are not reported for brevity.

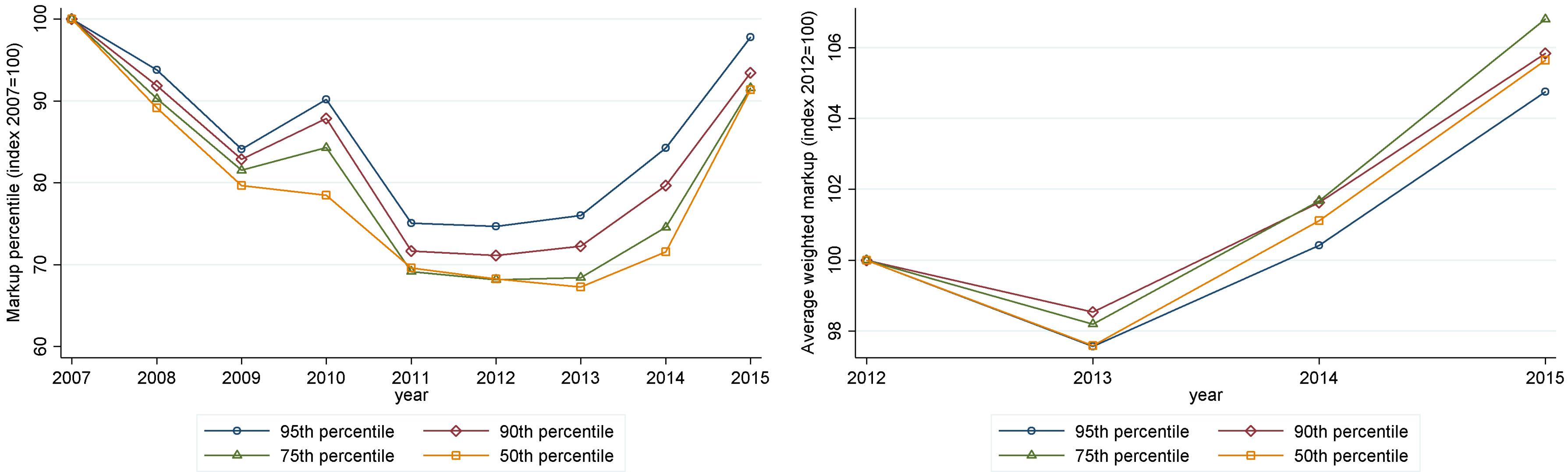
4.2 Heterogeneity regarding countries and the markup distribution

The post-crisis increase of markups can be observed along the entire upper half of the markup distribution. In other words, not only do firms with already high markups increase their markups further but the median markup has also increased in recent years; as Figure 4 illustrates. This is again in contrast to the findings for the United States, where the increase in average markups is entirely driven by firms with markups in the top half of the markup distribution and the 90^{th} percentile is increasing clearly disproportionately (De Loecker and Eeckhout, 2017). Nevertheless, Figure 4a shows that the median markup in Europe rose slightly less than the 75^{th}, 90^{th} and 95^{th} percentiles between 2012 and 2014. However, Figure 4b shows that a disproportionate development is not supported by an analysis of the balanced panel, which is robust against sample attrition.

Despite very similar markup developments across EU regions, the analysis for particular member states reveals a significant heterogeneity. For Belgium, the Czech Republic, Finland, Germany and Slovakia, the average post-crisis markup is even higher than their pre-crisis level. The process of average markups for these countries is reported in Figure 5a. For these countries, the aggregated European figures understate the markup increase during the observed period. At the same time, in Estonia, Hungary, Romania, Slovenia and Sweden the most recent average markups are lower than they were pre-crisis. The markup development of these countries is reported in Figure 5b.

Figure 4: Development of markup percentiles

a) Unbalanced sample b) Balanced sample

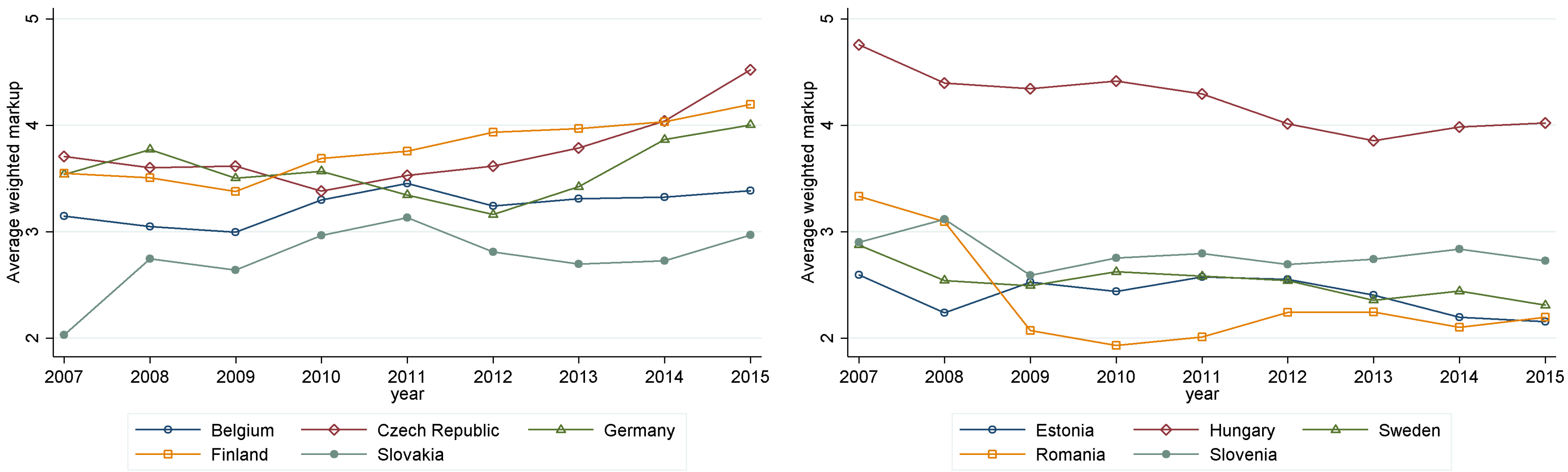


Note: Weighting by sales shares. Balancing on markup information for the period 2012–2015.

Figure 5: Development of markups for selected countries

a) Countries with increasing markups

b) Countries with decreasing markups



Note: Weighting by sales shares.

5 Conclusion

This paper presents an analysis of the recent developments of average market power in Europe by using a broad firm-level database for EU member states. To indicate competitive pressure at the firm-level, markups were estimated according to an approach that was recently proposed by De Loecker (2011), and De Loecker and Warzynski (2012).

The results show a sharp drop in markups during the crisis, followed by a post-crisis increase. The upward trend in average markups since 2012/2013 is not driven only by industry restructuring, but also by a within firm increase of markups. However, the pre-crisis level of average market power was not reached in 2015. This is in contrast to results for the United States, where average markups climbed to pre-crisis levels as soon as in 2011, followed by a sharp increase in 2013 and 2014. The post-crisis increase of markups can be observed along the entire upper half of the markup distribution, meaning that not only firms with already high markups increased their markups further but the median markup has also increased in recent years. This is again in contrast to the findings for the United States, where the increase in average markups is entirely driven by firms with markups in the top half of the markup distribution. The analysis of particular EU member states reveals a significant heterogeneity. In some countries, the average post-crisis markup is even higher than before the crisis and in some countries the average markups are decreasing.

These results matter for both researchers as well as policy makers. First and foremost, because an intersectoral rise in market power may significantly affect overall resource allocation and thus may have significant macroeconomic consequences. These are, for example, a declining labor share or a declining productivity growth.

Our study also contributes to the recent debate on whether or not competition authorities are enforcing competition law sufficiently. As markup figures for Europe are very much different from those in the United States, one should be cautious by transferring arguments in this debate from the United States to Europe.

We thus conclude that more research is needed on the causes and consequences of rising market power with a special focus on Europe. To do this it is necessary to cover a longer time period as well as to conduct industry-specific analyses. Also it appears necessary to further evaluate the reliability of available empirical measures for market power and its abuse, including markups estimated from production data.

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A Appendix: Estimation of firm-level markups

For the derivation of firm-level markups, as described in Section 2, a production function has to be estimated to yield output elasticities. There exists a vast literature on the estimation of production functions. A major challenge is to overcome a potential simultaneity bias, because the output may be determined by unobserved factors, such as productivity shocks, which are likewise correlated with a firm's input choice. De Loecker and Warzynski (2012) follow the control function or proxy approach, developed by Ackerberg et al. (2015), based on Olley and Pakes (1996) and Levinsohn and Petrin (2003), to correct markup estimates for unobserved productivity shocks (for a discussion of different approaches see Ackerberg et al., 2007). However, two assumptions have to be made to rely on this approach: First, firms can be pooled together by time-invariant common production technology at country-industry level. Second, the production is Hicks-neutral in productivity, meaning that changes in productivity do not affect the proportion of factor inputs. The production function (1) is then given as

$$Q_{it} = F(L_{it}, K_{it}; \beta) \exp(\omega_{it}). \tag{5}$$

Since there are no units of physical output for Q_{it} available in the data at hand, Q_{it} can be measured as deflated value added (VA_{it}).[14] For the estimation of firm-specific markups, a general translog production function is chosen and Equation (5) can be translated into the following empirical specification, in which the input and output variables are logarithmized:

$$va_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{lk} l_{it} k_{it} + \omega_{it} + \epsilon_{it}. \tag{6}$$

In the empirical model above, ϵ_{it} is an idiosyncratic error term which captures unexpected productivity shocks that do not have the potential to determine input decisions since they cannot be anticipated. ω_{it} denotes productivity shocks that are not observed in the data, but can be anticipated by a firm's management and thus affect input decisions. Levinsohn and Petrin (2003) suggest approximating serially correlated productivity shocks by intermediate inputs. In line with this approach, ω_{it} is assumed to be a function of material and capital inputs, supplemented by other explanatory variables z_{it} ($\omega_{it} = h_t(k_{it}, m_{it}, \boldsymbol{z}_{it})$).[15]

The production function is estimated in a two-stage approach according to Ackerberg et al. (2007) in order to avoid multicollinearity in the first stage due to a

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[14] Value added is defined as $Operating\ revenue_{it} - Cost\ of\ materials_{it}$. Price changes over time are accounted for by using producer price indices. Country-specific price index data is taken from Eurostat. Nevertheless, price differences across individual firms cannot be accounted for and may impose an omitted price variable bias, because a firm's input choice may be correlated with price changes that deviate from the industry mean (Klette and Griliches, 1996). However, De Loecker and Warzynski (2012) conclude that even if this biases the level of estimated markups, neither the markups' changes over time nor their correlation with firm characteristics should be biased.

[15] This expression is the inverse of the assumed material input function $m_{it} = m_t(k_{it}, \omega_{it}, \boldsymbol{z}_{it})$ by assuming strict monotonicity ($\frac{\partial m}{\partial \omega} > 0$), given k_{it} and $\boldsymbol{z}_{it}$. De Loecker and Warzynski (2012) include industry and year indicators in $\boldsymbol{z}$ to capture general variables affecting input use. In the application at hand, year indicators together with industry indicators are used, accordingly.

correlation between labor and material input choice. In the first stage, the following specification is estimated via Ordinary Least Squares only to separate the expected output $\widehat{\phi_{it}}$ from the residuals $\widehat{\epsilon_{it}}$ by replacing the unobserved productivity term with the proxy term:

$$va_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{lk} l_{it} k_{it} + h_t(k_{it}, m_{it}, \boldsymbol{z_{it}}) + \epsilon_{it} \quad (7)$$

$$= \phi(l_{it}, k_{it}, m_{it}, \boldsymbol{z_{it}}) + \epsilon_{it}. \quad (8)$$

In the second stage, the coefficients can be estimated using the fitted values $\widehat{\phi_{it}}$ to calculate the productivity ω_{it} for any value of β (where $\beta = (\beta_l, \beta_k, \beta_{ll}, \beta_{kk}, \beta_{lk})$) as $\omega_{it}(\beta) = \widehat{\phi_{it}} - \beta_l l_{it} - \beta_k k_{it} - \beta_{ll} l_{it}^2 - \beta_{kk} k_{it}^2 - \beta_{lk} l_{it} k_{it}$. The productivity shock is assumed to follow a first-order Markov process, meaning that present values are a function of values of the previous period. Therefore, productivity can be estimated with a nonparametrical GMM estimator as $\omega_{it}(\beta) = g(\omega_{it-1}(\beta)) + \xi_{it}$, where $g(\cdot)$ is a first-order polynomial function.[16] ξ_{it} denotes an idiosyncratic error. The output elasticity for labor θ_{it}^L can be subsequently computed using the estimated production function coefficients:

$$\widehat{\theta_{it}^L} = \widehat{\beta_l} + 2\widehat{\beta_{ll}} l_{it} + \widehat{\beta_{lk}} k_{it}. \quad (9)$$

Finally, the markup μ_{it} can be computed according to Equation (4) as the quotient of the labor factor's output elasticity by its cost share in revenues. However, it is assumed that the observed output in the data $\widetilde{Q_{it}}$ is not the correct output to reveal the input cost's revenue shares, as it is given by $\widetilde{Q_{it}} = Q_{it} exp(\epsilon_{it})$. Therefore, it needs to be corrected using the estimated errors in the first stage regression to obtain the actual output Q_{it} ($Q_{it} = \frac{\widetilde{Q_{it}}}{\exp(\widehat{\epsilon_{it}})}$). This correction eliminates variation in the expenditure share term that is due to output changes not correlated with $\phi(l_{it}, k_{it}, m_{it}, \boldsymbol{z_{it}})$ (cf. Equation 8).

[16] Higher-order forms of $g(\cdot)$ are also possible and may improve the functional form of the empirical model. In order to account for endogeneity issues due to a correlation of ω_{it} and ξ_{it}, a set of instruments is used. The instruments suggested by De Loecker and Warzynski (2012) are present values of capital (k_{it}, k_{it}^2), lagged values of labor (l_{it-1}, l_{it-1}^2), and an interaction of capital and labor ($l_{it-1} k_{it}$). The reasoning behind this is that decisions related to the capital factor are made prior to the current period and should therefore not be correlated with current productivity changes. For the validity of the lagged labor variables it is assumed that input prices are highly correlated over time, but that the current labor input responds to productivity shocks.

B Appendix: Data preparation

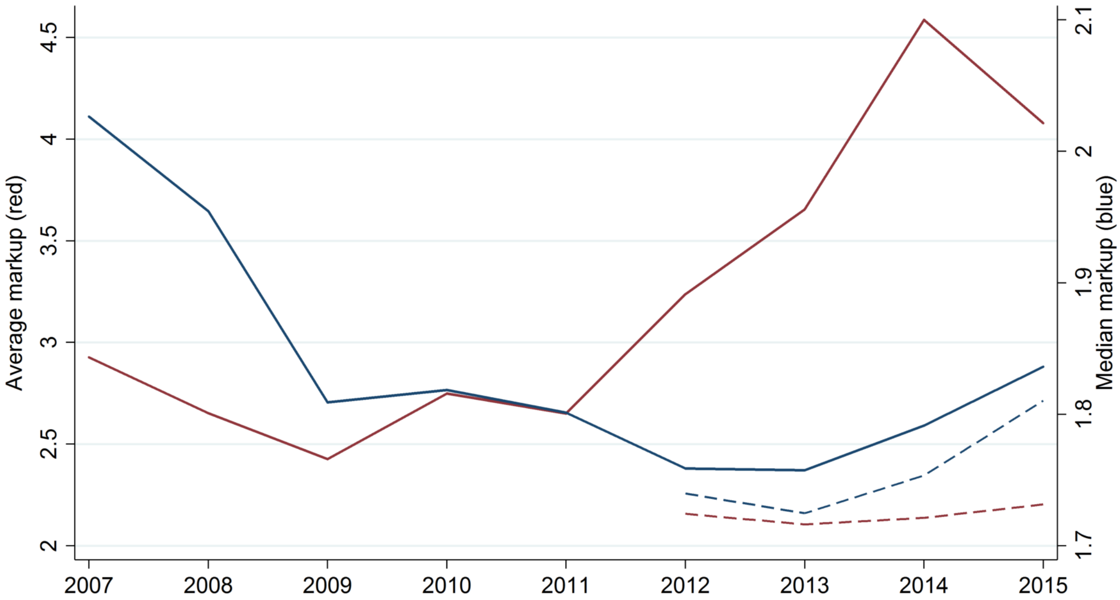
The database that we used is the Orbis version, as of January 2017. All EU28 firms with a turnover of at least 2 million EUR in at least one year during the observation period and an available unconsolidated account were extracted for 2007–2015. Some countries were excluded from the final sample because less than 100 observations were available in at least one year after the markup estimation. The countries covered in the final sample are are Belgium, Bulgaria, Czech Republic, Germany, Estonia, Spain, Finland, France, Croatia, Hungary, Italy, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, and Croatia. The industries covered are the NACE Rev. 2 main sections B to J and L to N.

All of the Euro variables were deflated at the country 2-digit industry level by using the producer price indices (PPI) that are published by Eurostat. Only services industries (NACE Rev. 2 main sections H–J and L–N), construction (F), mining and quarrying (B) were deflated using a uniform PPI for services, construction or mining and quarrying, respectively.

Although the data provider executes a number of plausibility checks, implausible values remain in the data which have to be addressed in order to reach unbiased results. Therefore, observations were dropped from the sample if the reported number of employees is missing or zero, or if the following variables were missing or less than zero: operating revenue, material costs, labor costs, fixed tangible assets. For the descriptive analysis of average markups, the following observations were excluded from the analysis to enable us to avoid implausible or very exceptional values: operating revenue $>$ EUR 100 billion, labor costs $>$ EUR 8 billion, fixed tangible assets $>$ EUR 50 billion, return on sales (both using EBIT and EBITDA) $>$ 100 percent or $<$ -200 percent.

Observations with markups greater than the 99th percentile or smaller than the 1st percentile were also dropped, as is common practice in the literature (De Loecker et al., 2016 even exclude observations below the 3rd and above the 97th percentile). However, the outlier treatment regarding the estimated markups appears to be crucial for the results and it is therefore discussed in more detail in the main text in Section 3. Figure 6 shows the development of unweighted average markups when the top and bottom one percent of the sample observations are not treated as outliers. In contrast to the development of the median values (blue line), which is not affected by outliers, the arithmetic mean (red line) does indeed exceed the pre-crisis level from the year 2012. It is most likely that this stark increase is due to a sample attrition bias because it almost completely disappears in the balanced sample analysis (dashed red line), although an industry restructuring cannot be ruled out completely. In summary, it cannot be taken for granted that the—somewhat arbitrary—exclusion of the lower and upper one percent of the observations (which include highly unrealistic markup values of even more than 400,000) does not underestimate the real average markup, even though it appears to be unlikely.

Figure 6: Development of firm-level markups in EU countries including outliers



Note: Solid lines represent results for the unbalanced panel and dashed lines represent results for the balanced panel. Balancing on markup information for the period 2012–2015. All values deflated according to country and industry level producer price indices. Weighting by sales shares.

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