Mark-ups of firms in selected European countries

Growing mark-ups of firms are seen by many as evidence of increasing market power and a falling degree of competition. Indications of such a development in the United States have become more prevalent in the past few years, where recent studies find that both market concentration and mark-ups of firms are on the rise. This raises the question as to which firm mark-up trends are cropping up in EU countries. It should be noted that the EU integration process and the accelerated pace of structural reforms are expected to have pushed up competitive pressure somewhat. The prolonged economic downturn in some European economies may also have had an impact on mark-ups.

Since firms' mark-ups cannot be observed directly, they have to be estimated. To that end, a commonly used econometric method has been applied to data from 27 sectors dominated by private firms in seven European countries for the period from 1996 to 2014. The cross-section analysis of these data shows that mark-ups in manufacturing were on average lower than in services sectors. Within manufacturing, higher mark-ups are demanded in segments where research and development activities are comparatively high. In cross-country comparisons, there are indications of above-average mark-ups in research-intensive branches of manufacturing in Germany and in various service sectors in Italy. The revenue that may result from these mark-ups appears to be shared to some extent with employees.

Over time, mark-ups in the European countries studied have been seen to behave in a largely procyclical manner. This appears to be connected to the sharp dip caused by the financial and sovereign debt crisis. There is no evidence of a long-term increase in mark-ups, and in some cases, the estimations even indicate a decline in the structural component of the mark-ups. The divergent findings between Europe and the United States may suggest that different factors have been at play. It may be assumed that globalisation has raised competitive pressure in general and has therefore had a similar impact on mark-ups on both sides of the Atlantic, but this overall trend is likely to have been augmented in Europe by the European integration process. By way of contrast, the fact that a large number of newer, internet-based firms, which in some cases have pronounced market power owing to network effects, primarily have their origins and bases in the United States may have played a role there. The protracted economic crisis also had an adverse impact on the mark-ups of firms in Europe. The extent to which mark-ups will rise again as the economy recovers remains to be seen. This normalisation could temporarily fuel general inflation pressures in European countries.

Background

Mark-ups as indicators of competitive intensity

Competition is considered to underpin economic prosperity. It induces firms to align themselves with the wishes of customers and to strive to improve. Competition boosts product diversity and quality, and stimulates innovativeness. Competition for labour ensures that employees benefit from economic progress in the form of higher wages. Most importantly, however, competition limits firms' market power, meaning that prices are geared to costs. From this perspective, rising mark-ups would be a sign of increasing market power and a falling degree of competition.

Indications of decreasing degree of competition in United States

In the United States, there have been growing signs of such a development in the past few years. Recent studies indicate a reduced momentum in terms of firms being founded and wound up, an increase in market concentration and a rise in the mark-ups of firms.[1] Among other things, these factors serve as an explanation for the weak investment momentum experienced since the turn of the millennium and for the lower productivity growth.[2]

Focus on market integration and structural reforms in EU

In the European Union (EU), access to what were previously national markets was to be simplified with the single market. Similarly, product market reforms, such as those suggested in the European Commission's country-specific recommendations, often aimed at intensifying competition by taking down barriers to entry. This was also accompanied by the expectation that the scope of firms' market power would be reduced. Furthermore, the question arises as to how the period of prolonged economic weakness has impacted on firms' mark-ups in certain countries.

Only limited analysis of EU countries possible

The mark-ups of firms in selected European countries are analysed below against this backdrop. A comprehensive analysis is precluded by the limited availability of data in Europe compared to the United States. Since the mark-ups of firms cannot be observed directly, they have to be estimated. The standard data on EU countries required for these estimations are only available in a very highly aggregate format and for a limited period of time. This analysis is therefore limited to seven economies[3] and a period of just under 20 years (1996 to 2014); it covers the private sector broken down into 27 sectors.

Determining factors of mark-ups

Mark-ups and competition

The intensity of price competition in a market is typically estimated based on mark-ups resulting from the difference between prices and marginal costs.[4] Strong mark-ups, ie prices that are significantly higher than the marginal costs, serve as an indication of a limited degree of competition or a high level of market power. Firms exposed to high competitive pressures have a greater incentive to keep mark-ups low to prevent market share losses.

Context crucial to competition

The context in which firms operate is a key factor in determining the intensity of competition. In particular, factors such as entry barriers, openness to foreign competition, anti-trust and

1 See OECD (2016), OECD Economic Surveys: United States 2016; D Autor, D Dorn, L Katz, C Patterson and J Van Reenen (2017), The fall of the labor share and the rise of superstar firms, NBER Working Paper, No 23396; and J De Loecker and J Eeckhout (2017), The rise of market power and the macroeconomic implications, NBER Working Paper, No 23687.
2 Gutiérrez and Philippon (2017) present evidence that the subdued increases in investment in the United States are partly connected to the falling degree of competition because this reduces incentives to invest. Decker et al (2017) conclude that a lower allocative efficiency is an explanation for the weakness of aggregate productivity growth in the United States and that the reduced allocative efficiency is related to declining business dynamism, among other factors. See G Gutiérrez and T Philippon (2017), Declining competition and investment in the U.S., NBER Working Paper, No 23583; and R A Decker, J Haltiwanger, R S Jarmin and J Miranda (2017), Declining dynamism, allocative efficiency, and the productivity slowdown, American Economic Review: Papers & Proceedings 107, pp 322-326.
3 This group comprises six euro area economies (Austria, Belgium, Finland, France, Germany and Italy) as well as Denmark, which has pegged its currency to the euro.
4 Marginal costs refer to the costs that arise from the production of an additional unit of a product. For information on the relationships between price-cost margins, returns and profits, see the box on pp 55-56.

Margin concepts and indicators of the profitability of non-financial corporations in the euro area

Price-cost margins shed light on the intensity of price competition. However, it is not possible to directly infer firms' profitability from the size and development of these margins, as fixed costs are not taken into account. For instance, software development can entail high costs. By contrast, the (marginal) costs associated with selling a licence are usually very low. Prices must therefore be higher than marginal costs in order to cover total costs. This should be borne in mind when analysing the profitability of the corporate sector.

The profit share, which in the national accounts framework is the ratio of gross operating surplus to the gross value added of the non-financial corporations sector, is often used as an indicator of the profitability of non-financial corporations.[1] The gross operating surplus itself is defined as gross value added less compensation of employees.[2] It is often interpreted as the share of value added that remunerates the factor capital. However, this indicator falls short in some respects since the incomes of self-employed persons are assigned in their entirety to income from capital. What is more, the gross operating surplus can also contain economic rents, ie gains that go beyond what is needed for the remuneration of the factor capital.

In the national accounts framework, moreover, entrepreneurial income is reported; this is conceptually equivalent to profit before distribution and income tax as calculated in business accounting.[3] Essentially, it differs from the gross operating surplus through the addition of income on assets and the deduction of interest and lease expenses.[4] The ratio of gross entrepreneurial income to gross value added is referred to here as the entrepreneurial income ratio. Another measure of profitability is the gross return on capital, ie the ratio of gross operating surplus to capital stock.[5]

An examination of these indicators for the euro area reveals rather divergent developments. The profit share rose markedly until 2007, then declined during the crisis before recovering somewhat later. These developments are also reflected in the entrepreneurial income ratio, which shows an upward trend overall, however. This was attributable to rising property income before the financial crisis and a decline in the interest burden since then. The gross return on capital initially increased quite significantly, then fell again, and has recovered only marginally to date. Most recently, it

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1 This indicator is also referred to as the profit ratio. In the context of business cycle analysis, it is often considered in combination with movements in other real economic variables (such as investment) and prices. The profit share is counterbalanced by the wage ratio. See, for example, European Central Bank, Measuring and analysing profit developments in the euro area, Monthly Bulletin, January 2004, pp 63-73; and National Bank of Belgium, Corporate profit margins: Recent developments in a low inflation context, NBB Economic Review, September 2015, pp 41-54.

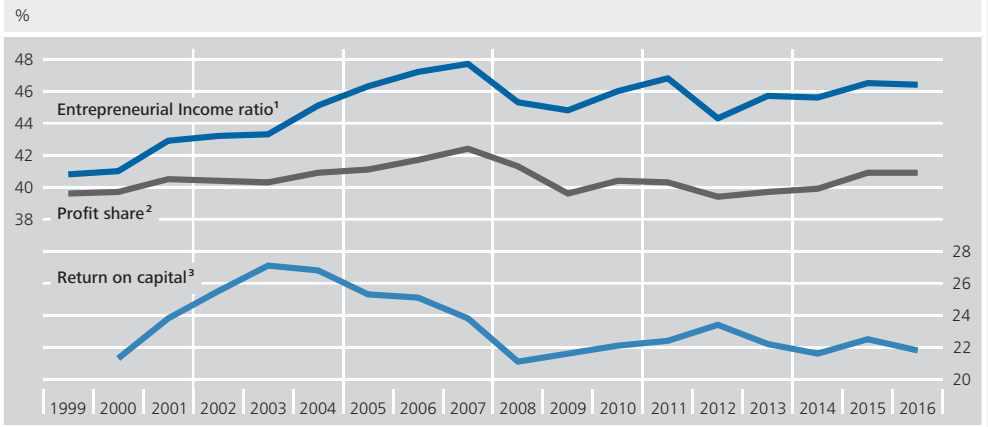
2 In this context, "other subsidies received" are added and "other taxes on production" are subtracted. Both items are less substantial in quantitative terms, however.

3 For more information on this, see the comments on p 209, Eurostat, European system of accounts – ESA 2010, European Commission, 2014.

4 In short-term business cycle analysis, reference is often made to a macroeconomic margin indicator that is calculated as the difference between the rates of growth of the value added deflator (or alternatively, the GDP deflator) and unit labour costs. A positive difference denotes an increase in the profit share and, accordingly, a decrease in the wage ratio.

5 The indicator used here is published by Eurostat and is calculated as the ratio of the gross operating surplus to the (net) assets and liabilities of non-financial corporations.

Indicators of the profitability of non-financial corporations in the euro area



Sources: Eurostat and Bundesbank calculations. **1** Ratio of gross operating income to gross value added. **2** Ratio of gross operating surplus to gross value added. **3** Ratio of gross operating surplus to invested capital.
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stood at roughly the same level as in the year 2000.

Overall, the various indicators for the euro area do not point to a broad-based increase in profitability with regard to the operational business of non-financial corporations.

competition regulations and their implementation are important.

Other structural influences on mark-ups

The size of mark-ups is also affected by a range of other factors, which do not necessarily indicate inefficiencies and anti-competitive behaviour. For example, mark-ups vary with demand's sensitivity to price changes (price elasticity of demand). Product diversity, which takes account of the different wishes of consumers and the need for variety, often goes hand in hand with reduced elasticity. While this does allow higher mark-ups in market segments, these mark-ups may be necessary to cover the higher costs of product diversity. Likewise, firms may temporarily achieve a competitive edge because of their innovations. In this case, higher mark-ups reflect, among other things, prior expenditure on research and development (R&D).[5] Due to returns to scale, there may also be a rise in market concentration, where care should be taken to ensure that gains in efficiency also reach consumers through lower prices. In general, it is important that markets do not become unassailable so that firms cannot continue to amass revenue without assigning it to a function.

Evidence for the US

According to a recent study on the United States, initial competitive restrictions are not the most significant factor in the long-term rise in market concentration.[6] Rather, the most productive firms appear to be increasingly able to acquire larger market shares because of tech-

5 Békés et al (2016), for example, present evidence that innovative firms may demand higher mark-ups and that product quality is positively correlated with the mark-ups of firms. See G Békés, C Hornok and B Muraközy (2016), Globalization and the markups of European firms, IfW Kiel Working Paper, No 2044.
6 It should be noted that an increase in market concentration does not necessarily imply a rise in mark-ups (see also the box on pp 62-63). In a recent study, the OECD nevertheless found evidence of a positive correlation of this kind based on sectoral data for the United States. See OECD (2016), op cit.

nical change and globalisation.[7] This correlation is also referred to as the "superstar firm" hypothesis. These firms include platforms that allow simple price and quality comparisons, from which more productive firms in particular would be able to benefit. The growing importance of information-based goods, which are characterised by high fixed costs and low marginal costs, eg online services, may also explain this development. Furthermore, new technologies may amplify network effects and thus lead to dominant market positions. Nonetheless, there are also indications in the United States that regulatory and competitive aspects may have been a factor in the rise of market concentration.[8]

Cyclical influences on mark-ups

In addition to these structural factors, there are cyclical influences on the mark-ups of firms, though it is not clear *a priori* whether procyclical or countercyclical trends are predominant.[9] Empirical studies also do not give a clear picture in this regard.[10] Mark-ups typically have a countercyclical pattern in New Keynesian macroeconomic models. Owing to adjustment costs, prices respond more slowly than procyclical marginal costs, which are determined by the costs of intermediate goods.[11] By contrast, the fact that the price elasticity of demand could contract during an upswing, for instance, suggests procyclical mark-ups. This would allow firms to increase their mark-ups.[12]

Mark-up estimations for selected European countries

Supply and demand approaches to estimating mark-ups

Neither firms' marginal costs nor mark-ups can be observed directly. Estimation methods therefore have to be applied, in which a distinction can be made between methods that are applied to either the demand side or the production side. Both approaches complement each other in principle, but a production-side method is used here since the data requirements are less exacting.[13]

Basic features of estimating approach

The estimating approach was selected based on considerations regarding the Solow residual, which is calculated from the difference between the growth rate of (gross) output and the contributions to growth from labour, capital and intermediate goods. Under certain conditions, this residual measures the rate of technical change when there is perfect competition. When competition is imperfect, the Solow residual can be shown as a combination of technical change, the growth in the output-capital ratio and price-cost margins.[14] Mark-ups can be estimated based on these findings with the aid of a traditional regression.[15] This method is used in numerous studies; it can be implemented using sectoral data without major

7 See Autor et al (2017), op cit. The study's findings also match a situation in which established firms are more likely to produce innovations and the persistence of this innovation advantage has increased with time.
8 See CEA (2016), Benefits of competition and indicators of market power, Council of Economic Advisers Issue Brief, April 2016; and B A Blonigen and J R Pierce (2016), Evidence for the effects of mergers on market power and efficiency, Federal Reserve Board, Finance and Economics Discussion Series, No 2016-082.
9 See O J Blanchard (2008), The state of macro, NBER Working Paper, No 14259.
10 See, for example, M Bils, P J Klenow and B A Malin (2014), Resurrecting the role of the product market wedge in recessions, NBER Working Paper, No 20555; and C J Nekarda and V A Ramey (2013), The cyclical behavior of the price-cost markup, NBER Working Paper, No 19099.
11 See J J Rotemberg and M Woodford (1999), The cyclical behavior of prices and costs, NBER Working Paper, No 6909. Furthermore, models with an oligopolistic market structure or endogenous market entry and exit of firms may account for countercyclical mark-ups. See J J Rotemberg and G Saloner (1986), A supergame-theoretic model of price wars during booms, American Economic Review 76, pp 390-407; and N Jaimovich and M Floetotto (2008), Firm dynamics, markup variations, and the business cycle, Journal of Monetary Economics 55, pp 1238-1252.
12 See J Stroebel and J Vavra (2014), House prices, local demand, and retail prices, NBER Working Paper, No 20710. Models with consumer markets can also produce procyclical and countercyclical mark-ups. See J A Chevalier and D S Scharfstein (1996), Capital-market imperfections and countercyclical markups: Theory and evidence, American Economic Review 86, pp 703 to 725.
13 See J De Loecker and P T Scott (2016), Estimating market power: Evidence from the US brewing industry, NBER Working Paper, No 22957; and J De Loecker (2011), Recovering markups from production data, International Journal of Industrial Organization 29, pp 350-355.
14 See R E Hall (1988), The relation between price and marginal cost in U.S. industry, Journal of Political Economy 96, pp 921-947.
15 See W Roeger (1995), Can imperfect competition explain the difference between primal and dual productivity? Estimates for U.S. manufacturing, Journal of Political Economy 103, pp 316-330.

Average price-cost margins in selected European countries*

Sectors	Austria	Belgium	Denmark	Finland	France	Germany	Italy
All sectors	1.35	1.27	1.29	1.34	1.40	1.39	1.54
Excluding sectors 19 and 68	1.28	1.20	1.24	1.29	1.19	1.33	1.35
Manufacturing	1.20	1.14	1.20	1.21	1.13	1.21	1.16
High R&D intensity[1]	1.23	1.17	1.25	1.23	1.14	1.26	1.15
Low R&D intensity[1]	1.14	1.10	1.07	1.18	1.11	1.13	1.18
Other sectors	1.34	1.25	1.28	1.35	1.25	1.42	1.50
High R&D intensity[1]	1.32	1.24	1.26	1.34	1.25	1.49	1.60
Low R&D intensity[1]	1.36	1.26	1.29	1.36	1.25	1.37	1.43

Source: Estimations based on OECD STAN and AMECO data for the period from 1996 to 2014. * Sector-specific mark-ups are included when calculating the average (arithmetic mean) if the parameter for this sector's market power is estimated to be statistically significant at the 10% level. Sectors 19 (coke and refined petroleum products) and 68 (real estate activities) are only considered in the first row (All sectors). Sectors 01 to 03 (agriculture, forestry and fishing) and 05 to 09 (mining and quarrying) are not included in the analysis. A value of, say, 1.2 implies a price-cost margin of 20%. 1 R&D stands for research and development.
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difficulty. It is based, however, on a number of assumptions that should be taken into account when interpreting the results. For instance, there is an assumption of constant returns to scale, and an approximation of the user cost of capital is also necessary. Moreover, the original approach permits the estimation of time-invariant mark-ups only. For details of the estimation method and the selection of data, see pages 65 to 67.

Cross-section analysis of sectoral mark-ups

Prices typically higher than marginal costs

First, the mark-ups are calculated separately for each of the seven countries under review and each of the 27 sectors for the period from 1996 to 2014. The results show clear indications that prices exceed marginal costs in most sectors. Exceptionally high mark-ups are reported for real estate. This is also likely to be due to the fact that these calculations use a high degree of notional revenue (for instance, hypothetical rents for owner-occupied housing). As a result, this sector is excluded from further analysis.[16]

It can be seen that, on average, the dispersion of mark-ups within countries (ie between sectors) is greater than that of the sector-specific mark-ups between countries,[17] which suggests that there are sectoral particularities that span national borders. For instance, the mark-ups demanded in the manufacturing industry are typically lower than in other areas which are predominantly associated with services. The reason for this finding is often attributed to the international competition that firms operating in these sectors face due to the greater tradability of goods.[18] Moreover, if the sectors are sorted according to the level of spending on research and development, all countries (with the exception of Italy) demand higher mark-ups in those manufacturing sectors that are

Intra-country dispersion of mark-ups wider than inter-country dispersion

16 The manufacture of coke and refined petroleum products is also excluded from the analysis as estimates of pricing in this sector are often only imprecise.
17 On average, the standard deviation of mark-ups within countries is 0.15, while the average dispersion of sector-specific mark-ups between countries is 0.11.
18 See, for example, J Amador and A Soares (2016), Markups and bargaining power in tradeable and non-tradeable sectors, Empirical Economics 53, pp 669-694. It should also be noted that returns to scale may be higher for the manufacturing industry, meaning that mark-ups would be underestimated.

R&D intensive.[19] In the other sectors, the picture is not entirely clear. According to the estimation, among the countries under review, mark-ups were highest in Italy, closely followed by Germany. This was due, amongst other things, to the fact that mark-ups in the R&D-intensive manufacturing industry in Germany were slightly above average and those for other sectors in Italy, especially the services industry, were well above average.

Mark-ups over time

Modelling of changes in mark-ups over time

The question is whether market power has changed over the past few years. In order to answer this, the empirical model is extended and mark-ups are decomposed into a structural and a cyclical factor which varies over time depending on the output gap.[20] The structural component can change once, with a possible structural break occurring in any of the years from 1999 to 2011. Ultimately, the model with the least sum of squared errors is chosen.

Panel estimations to ensure larger number of observations

To ensure that the number of observations is sufficient to enable the parameters to be identified, average mark-ups across countries and sectors are estimated in a panel. The previous results showed that mark-ups between sectors and countries vary to a lesser extent when broadly classified according to tradability and R&D intensity. It therefore appears appropriate to estimate these four items separately.

Indications predominantly point to procyclical development of mark-ups

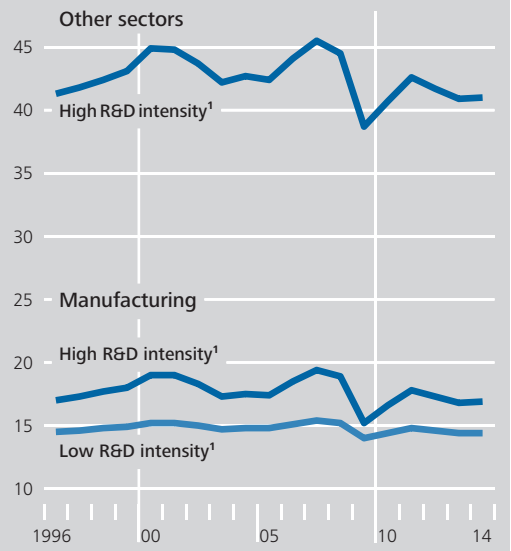
The application of the extended estimation approach initially confirms that, on average, lower mark-ups are demanded in the manufacturing industry than in the other sectors, and that, on average, R&D-intensive sectors have higher mark-ups. Furthermore, in three of the four sector aggregates (manufacturing industry and R&D-intensive other areas), mark-ups demonstrate procyclical behaviour.

Indications of structurally declining mark-ups, too

With regard to the structural component of the mark-ups, indications of declining mark-ups can be found for three of the four broad sector definitions considered (less R&D-intensive manufacturing industry and other areas). Here, the break date identified varies across sectors.

Price-cost margins according to model calculations*

in %



Source: Bundesbank calculations based on OECD STAN and AMECO data. * Country-specific price-cost margins based on parameter estimates and the development of output gaps, and then weighted by the gross value added of 1996. The development of other sectors with low R&D intensity is not shown as the parameter for the cyclical market power factor was estimated to be not significant. The group of countries comprises Austria, Belgium, Denmark, Finland, France, Germany and Italy. 1 R&D: research and development.

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19 The classification of sectors according to R&D intensity is in line with the OECD's definition. The OECD defines five levels of R&D intensity. The OECD does not assign the last category "low" to any of the manufacturing sectors. In this analysis, the manufacturing sectors that are assigned one of the first three categories are referred to as R&D intensive. The OECD categorises most of the other non-manufacturing sectors as having a "low" R&D intensity. For this reason, in this analysis, the non-manufacturing sectors that are assigned one of the first four categories are referred to as R&D intensive. The OECD-STAN data used for the analysis combine some sectors at a higher level of aggregation. As a result, the classification for sector aggregates 24 to 25 and 58 to 60 of the fourth revision of the International Standard Industry Classification (ISIC Rev 4) is not entirely clear. However, in this analysis, the former is considered to comprise manufacturing sectors with low R&D intensity whereas the latter encompasses non-manufacturing sectors with high R&D intensity (see also the table in the annex on page 66). See F Galindo-Rueda and F Verger (2016), OECD taxonomy of economic activities based on R&D intensity, OECD Science, Technology and Industry Working Papers, No 2016/04.

20 See H Badinger (2007), Has the EU's single market programme fostered competition? Testing for a decrease in mark-up ratios in EU industries, Oxford Bulletin of Economics and Statistics 69, pp 497-519.

Price-cost margins over time°

Parameter estimates	Changes to price-cost margins owing to cyclical factors				Changes to price-cost margins owing to cyclical and structural factors			
	Manufacturing		Other sectors		Manufacturing		Other sectors	
	Research and development intensity							
	high	low	high	low	high	low	high	low
Lerner index[1]	0.151***	0.129***	0.299***	0.258***	0.168***	0.157***	0.471***	0.320***
	(0.014)	(0.009)	(0.020)	(0.026)	(0.018)	(0.015)	(0.075)	(0.048)
Cyclical factor	0.484***	0.171**	0.553***	0.058	0.440***	0.146*	0.495***	– 0.042
	(0.139)	(0.072)	(0.122)	(0.083)	(0.148)	(0.078)	(0.113)	(0.109)
Change to Lerner index after break	–	–	–	–	– 0.035	– 0.044**	– 0.197**	– 0.094**
	–	–	–	–	(0.022)	(0.016)	(0.088)	(0.042)
Observations	931	532	798	1,064	931	532	798	1,064
R-squared (within)	0.569	0.703	0.633	0.629	0.571	0.712	0.649	0.641
Break test – statistics	–	–	–	–	5.323	15.018	34.464	33.448
Break test – p-value	–	–	–	–	0.077	0.000	0.003	0.000
Break date	–	–	–	–	2009	2007	1999	2005
Implied price-cost margin[2]								
Total	1.18	1.15	1.43	1.35	–	–	–	–
Prior to break	–	–	–	–	.	1.19	1.89	1.47
After break	–	–	–	–	.	1.13	1.38	1.29

Source: Weighted estimations based on OECD STAN and AMECO data for the period from 1996 to 2014. ° Estimations based on equation 4 in the annex. Weights for estimations correspond to the sectoral value added in 1996. Robust standard errors in brackets. */**/*** denote the statistical significance of the parameter estimates at the usual levels. Estimations include fixed country/sector and annual effects. The break test's p-value is calculated based on the bootstrapping method by Hansen (1999), with 300 simulation rounds. A value below 0.05 indicates a significant structural break. **1** The Lerner index is a measure of market power. **2** A value of, say, 1.2 implies a price-cost margin of 20%.

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Impact of the crisis years and the long-term interest rate measure on mark-up estimations°

Parameter estimates	Sample: 1996 to 2008				Constant real interest rate			
	Manufacturing		Other sectors		Manufacturing		Other sectors	
	Research and development intensity							
	high	low	high	low	high	low	high	low
Lerner index[1]	0.158***	0.174***	0.486***	0.320***	0.148***	0.172***	0.505***	0.467***
	(0.023)	(0.023)	(0.078)	(0.051)	(0.033)	(0.014)	(0.085)	(0.088)
Cyclical factor	– 0.070	– 0.000	0.453**	– 0.059	0.365***	0.121	0.371***	– 0.098
	(0.156)	(0.108)	(0.208)	(0.170)	(0.117)	(0.073)	(0.126)	(0.100)
Change to Lerner index after break	0.041	– 0.047**	– 0.176	– 0.092*	0.080*	– 0.052**	– 0.229*	– 0.169***
	(0.033)	(0.021)	(0.106)	(0.050)	(0.043)	(0.019)	(0.115)	(0.058)
Observations	637	364	546	728	931	532	798	1,064
R-squared (within)	0.556	0.671	0.650	0.628	0.569	0.695	0.419	0.452
Break test – statistic	4.028	7.129	20.412	11.808	11.536	5.396	30.660	39.996
Break test – p-value	0.123	0.017	0.013	0.013	0.013	0.037	0.023	0.000
Break date	2001	2001	1999	2005	2001	2011	1999	2002
Implied price-cost margin[2]								
Prior to break	.	1.21	1.95	1.47	1.17	1.21	2.02	1.88
After break	.	1.15	1.45	1.30	1.30	1.14	1.38	1.42

Source: Weighted estimations based on OECD STAN and AMECO data for the period from 1996 to 2014. ° Estimations based on equation 4 in the annex. Weights for estimations correspond to the sectoral value added in 1996. Robust standard errors in brackets. */**/*** denote the statistical significance of the parameter estimates at the usual levels. Estimations include fixed country/sector and annual effects. The break test's p-value is calculated based on the bootstrapping method by Hansen (1999), with 300 simulation rounds. A value below 0.05 indicates a significant structural break. **1** The Lerner index is a measure of market power. **2** A value of, say, 1.2 implies a price-cost margin of 20%.

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Impact of bargaining power in the labour market on margin estimations°

	Assumption of constant parameters				Modelling of one-off change to parameters			
	Manufacturing		Other sectors		Manufacturing		Other sectors	
	Research and development intensity							
Parameter estimates	high	low	high	low	high	low	high	low
Lerner index[1]	0.281***	0.179***	0.365***	0.368***	0.272***	0.200***	0.577***	0.453***
	(0.028)	(0.020)	(0.039)	(0.068)	(0.027)	(0.023)	(0.082)	(0.084)
Bargaining power parameter	0.225***	0.088***	0.129***	0.194**	0.190***	0.076*	0.229**	0.271***
	(0.036)	(0.029)	(0.048)	(0.088)	(0.041)	(0.038)	(0.099)	(0.102)
Change to Lerner index after break	–	–	–	–	0.045	– 0.034	– 0.250**	– 0.158**
	–	–	–	–	(0.061)	(0.025)	(0.118)	(0.071)
Change to bargaining power parameter	–	–	–	–	0.100	0.017	– 0.126	– 0.159*
	–	–	–	–	(0.088)	(0.042)	(0.124)	(0.086)
Observations	931	532	798	1,064	931	532	798	1,064
R-squared (within)	0.632	0.721	0.636	0.659	0.636	0.730	0.654	0.671
Implied price-cost margin[2]	1.39	1.22	1.58	1.58	–	–	–	–

Source: Weighted estimations based on OECD STAN and AMECO data for the period from 1996 to 2014. ° Estimations based on equation 5 in the annex. Weights for estimations correspond to the sectoral value added in 1996. Robust standard errors in brackets. */**/*** denote the statistical significance of the parameter estimates at the usual levels. Estimations include fixed country/sector and annual effects. **1** The Lerner index is a measure of market power. **2** A value of, say, 1.2 implies a price-cost margin of 20%.

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For the R&D-intensive other industries, a structural break is identified in 1999, which may be connected to deregulation efforts in the EU. In the case of less R&D-intensive other areas, the results suggest a connection with the eastward enlargement of the EU (break date in 2005). This may also be true for the less R&D-intensive manufacturing industry, although the structural break is identified in 2007 and may also be accounted for by the global financial crisis. No clear trend could be identified for the R&D-intensive manufacturing industry.

Special features of the period under review

Results excluding the crisis years

The time period underlying the analysis was characterised by exceptional developments due to the global financial and economic crisis as well as the subsequent European sovereign debt crisis, and these may have an impact on the estimation results. If the period from 2009 to 2014 is thus excluded from the sample, the parameter for measuring the cyclicality of mark-ups is estimated to be statistically significant in one case only. This suggests that the economy primarily had a procyclical impact on mark-ups during the crisis years. With regard to the structural component of mark-ups, break tests continue to show declines for three of the four sector aggregates.[21]

Alternative assumption regarding user cost of capital

During the period under review, there was also a sharp decline in yields on corporate bonds. This has an impact on the assumed user cost of capital. However, other return on capital indicators imply only smaller declines or even a rise in the period under review.[22] For this reason, the user cost of capital was calculated under

21 In one case, however, the break date was estimated to be somewhat earlier. In the estimations, tests were conducted for breaks potentially occurring in any of the years from 1999 to 2005.

22 See Deutsche Bundesbank, Developments in the real return on capital in Germany, Monthly Report, October 2017, pp 37-41.

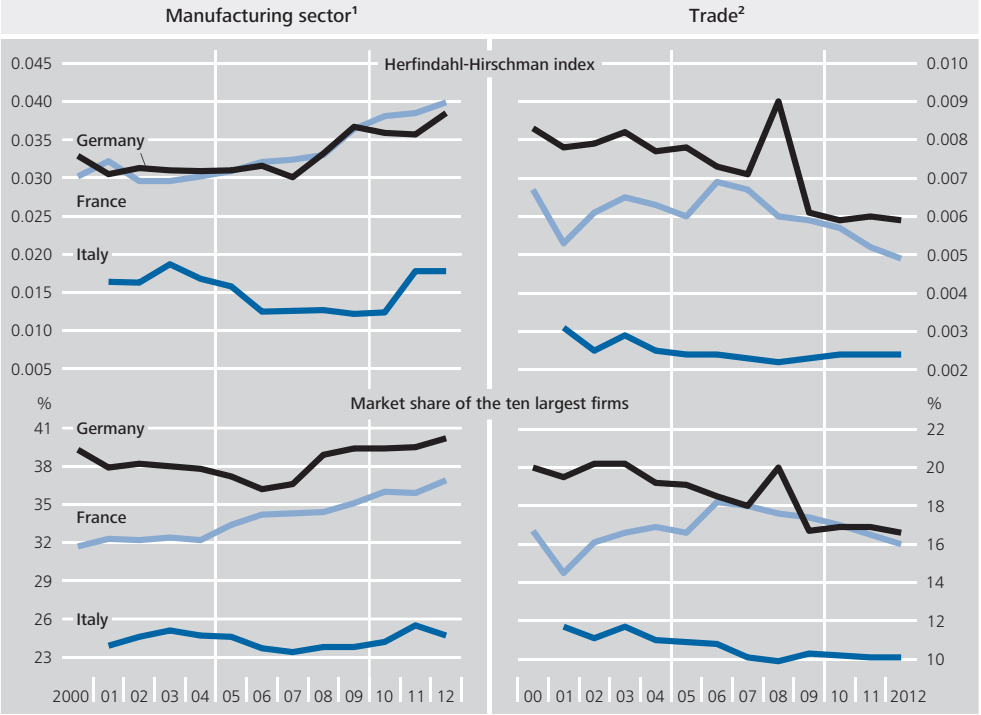
Market concentration in selected European countries

Estimations of price-cost margins provide no indication of a general increase in price-setting scope for European countries. This suggests that the intensity of competition in this group of countries has probably not receded markedly in the past years. To that extent, the question arises as to whether this outcome can be supported by other indicators. Measures of concentration are often used as an alternative means of examining market structures.[1] A small number of firms accounting for a high proportion of sales may point to dominant market positions. In the United States, such measures show a general increase in sales concentration, which is in line with the finding of higher margins.[2]

In the EU, unlike in the United States, the statistical offices do not, as a rule, publish market concentration indicators. However, in 2008, as part of the work for EU KLEMS, measures of concentration for the years 1997 to 2006 were published on a one-off basis.[3] In particular, the Herfindahl-Hirschman index (HH index) – the sum of the squared market shares of the firms belonging to a given sector – was reported.

1 It is important to emphasise that indicators of market concentration do not constitute a perfect measure of competition intensity, which depends on a wide range of factors such as market entry barriers, competition with imports, strategic interaction and economies of scale.
2 See OECD (2016), OECD Economic Surveys: United States 2016; D Autor, D Dorn, L Katz, C Patterson and J Van Reenen (2017), The fall of the labor share and the rise of superstar firms, NBER Working Paper No 23396; and J De Loecker and J Eeckhout (2017), The rise of market power and the macroeconomic implications, NBER Working Paper No 23687.
3 The data were published in the context of EU KLEMS – Linked Data 2008 Release – Company Accounts. See M O'Mahony, C Castaldi, B Los, E Bartelsman, Y Maimaiti and F Peng (2008), EU KLEMS – Linked Data: Sources and Methods. University of Birmingham, October.

Market concentration in selected countries



Sources: CompNet and Bundesbank calculations. **1** Arithmetic average of the information provided for 22 sectors in manufacturing. **2** Arithmetic average of the information provided for the sectors in trade.
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The indicator assumes values between (close to) zero and one; larger figures imply a higher market concentration.[4]

More recent information on the development of concentrations stems from indicators that were generated within CompNet.[5] In addition to the HH index, the share held by the ten largest firms of the total sales of a sector is reported here. CompNet provides better coverage of areas outside the manufacturing sector than EU KLEMS.[6] For the most part, relevant data are available for the years 2000 to 2012.

The different indicators do not show a uniform trend. Although in isolated cases there are signs of an increase in market concentration in the manufacturing sector, market concentration seems to be decreasing in other areas, such as trade, or showing little change. Combined, concentration indicators do not point to a broad-based change in the competitive conditions in the countries observed.[7]

4 The HH index is published there for sectors according to NACE Revision 1 (mostly using the 2-digit level, partly in more detail). On the whole, a distinction is made between up to 43 sectors, of which up to 30 are in manufacturing. Besides the traditional HH index, an adjusted index is also calculated within EU KLEMS with the aim of controlling for distortions where only few firms report their information. See O'Mahony et al (2008), op cit.
5 CompNet is a research network in which indicators on the competitiveness of European countries are determined on the basis, amongst other things, of firm-level data. The data used here are based on a 2014 survey. See P Lopez-Garcia, F di Mauro and the CompNet Task Force (2015), Assessing European competitiveness: the new CompNet microbased database, ECB Working Paper No 1764.
6 Within CompNet, indicators are calculated according to the classification of industries according to NACE Revision 2 for up to 53 (2-digit) sectors.
7 However, it should be noted that the definition of the relevant market plays an important role when calculating these indicators. In the case at hand, markets are defined on the basis of relatively rough sector classifications and national borders. It cannot therefore be ruled out that the results would in some cases be different given a more appropriate sectoral and regional classification.

the alternative assumption that the real interest rate relevant for the firms' activities amounted to 5% throughout the period. This modification has only a slight impact on the results, which continue to imply that mark-ups fell in three of the four sector aggregates. However, under this approach, there may have been a structural increase in mark-ups in the R&D-intensive manufacturing industry. In addition, the breaks are now estimated to have occurred on different dates. In this specification, however, there are again a number of indications of procyclical mark-ups.

Role of bargaining power on the labour market

Imperfect competition on labour market

So far the estimations of mark-ups have not included the particular features of wage formation. However, the behavioural patterns on product and labour markets can influence one another.[23] If firms have market power, they may generate income. The degree of employees' bargaining power determines how this income is shared. The method applied here does not take into consideration such income to be shared with employees. As a result, it is possible that the price-cost margins are underestimated. Recent studies therefore expand the original models of Hall and Roeger to allow for potential imperfect competition on the labour market.[24]

For the countries reviewed here, the estimated parameter of employees' bargaining power, on

23 See, for example, O Blanchard and F Giavazzi (2003), Macroeconomic effects of regulation and deregulation in goods and labor markets, Quarterly Journal of Economics 118, pp 879-907.
24 See S Dobbelaere (2004), Estimation of price-cost margins and union bargaining power for Belgian manufacturing, International Journal of Industrial Organization 22, pp 1381-1398; B Crépon, R Desplatz and J Mairesse (2005), Price-cost margins and rent sharing: Evidence from a panel of French manufacturing firms, Annals of Economics and Statistics 79-80, pp 583-610; and J Amador and A Soares (2016), op cit.

Mark-ups somewhat higher; evidence of structural breaks weaker

average, is significantly positive and the estimated mark-ups are also higher. This is particularly reflected in the R&D-intensive manufacturing industry and the less R&D-intensive other areas; sectors where trade unions are likely to be relatively strong. However, for the most part, the remaining results from the analysis conducted thus far are qualitatively confirmed, in particular with regard to the grading of mark-ups between the industries. However, evidence of possible changes in the structural component is weaker.[25] The results indicate a decline in market power over time for the two non-manufacturing sector aggregates only. Employees' bargaining power does not appear to have changed on the whole. It should be noted, however, that the assumption of an average parameter for bargaining power inherent in the panel estimations is highly simplified given the heterogeneous labour market structures in Europe.[26]

Classification

Largely in line with other studies

The analysis presented here does not point to a long-term rise in mark-ups during the past 20 years in the EU countries under review. Instead, the results reveal some signs of a decline in mark-ups. However, it should be noted that the scope of the underlying data and thus the basis for the analysis are limited.[27] Nevertheless, the results are largely in line with other studies on European countries.[28] Figures on market concentration do not suggest that there has been a broad-based increase either (see the box on pages 62 and 63). Indicators on the profitability of non-financial corporations do not show any evidence of sharp increases in returns on capital or profit ratios in the euro area (see the box on pages 55 and 56). These findings stand in contrast to those for the United States.[29]

Empirical evidence still at an early stage

A comprehensive assessment of the developments in the United States and Europe currently appears to be premature. Evidence on the development of price-cost margins is still rather limited and is not always clear. For instance, a recent study for the United States for the period from 1992 to 2005 finds welfare gains in connection with advancing globalisation, which can be partly explained by lower mark-ups as a result of increased import competition.[30] However, should the evidence of increasing mark-ups in the United States continue to be substantiated, the causes will need to be identified. For example, rising price-cost margins could be explained by both greater market power and an increasing importance of fixed costs.

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25 The break dates calculated in the base model are used for this analysis.

26 See Deutsche Bundesbank, Wage dynamics amid high euro area unemployment, Monthly Report, December 2016, pp 33-55. It is also possible that a structural break occurred at another point in time with this parameter.

27 For instance, the modelling of a one-off, immediate structural break in otherwise time-invariant mark-ups is restrictive.

28 Badinger (2007) finds evidence of declining mark-ups in the manufacturing industry but rising mark-ups in the services industry for ten European countries in the period from 1981 to 1999. Bassanetti et al (2010) confirm unchanged or decreasing mark-ups (ten European countries; period from 1982 to 2005). Christopoulou and Vermeulen (2012) estimate the Roeger model for eight EU countries in two periods (1981 to 1992 and 1993 to 2004) and find no indications of systematic changes in mark-ups. Thum-Thysen and Canton (2015) come to the conclusion that mark-ups in most of the services sectors that they examined declined over the period from 1996 to 2013 owing to regulations to promote competition. Montero and Urtasun (2014) find mark-ups in Spain remained virtually constant until the outbreak of the financial crisis and then tended to increase. Other country-specific studies using firm-level data suggest that pro-competitive effects in conjunction with globalisation have had a negative impact on mark-ups in the manufacturing industry. See H Badinger (2007), op cit; A Bassanetti, R Torrini and F Zollino (2010), Changing institutions in the European market: The impact on mark-ups and rents allocation, Banca d'Italia Working Papers, No 781; R Christopoulou and P Vermeulen (2012), Markups in the euro area and the US over the period 1981-2004: A comparison of 50 sectors, Empirical Economics 42, pp 53-77; A Thum-Thysen and E Canton (2015), Estimation of service sector mark-ups determined by structural reform indicators, European Commission Economic Papers, No 547; J M Montero and A Urtasun (2014), Price-cost mark-ups in the Spanish economy: A microeconomic perspective, Banco de Espana Working Paper, No 1407; as well as M Bugamelli, S Fabiani and E Sette (2015), The age of the dragon: The effect of imports from China on firm-level prices, Journal of Money Credit and Banking 47, pp 1091-1118.

29 This is consistent with a forthcoming study by Gutiérrez (2017) which concludes that the share of economic gains in value added in the United States has risen since the 1970s, while no significant increase was found for an aggregate of developed economies in Europe. See G Gutiérrez (2017), Investigating global labor and profit shares, Mimeo, New York Stern University, October.

30 See R C Feenstra and D E Weinstein (2017), Globalization, markups, and U.S. welfare, Journal of Political Economy 125, pp 1041-1074.

Explanatory approaches

Some of the factors which affect mark-ups are global phenomena. Greater import competition or increasing online trading should have a similar impact on mark-ups in the United States and in Europe, depending on the specific conditions.[31] However, there are also a number of region-specific factors. For instance, the European integration process is likely to have intensified competition in the EU. One factor that may help explain US developments is that a large number of newer, internet-based firms, which in some cases have pronounced market power owing to network effects, primarily have their origins and bases in the United States. Most of their European branches are located in countries that are not analysed here. In addition, the protracted economic crisis has had an adverse impact on the mark-ups of firms in Europe over the past few years. The extent to which mark-ups will rise again as the economy recovers remains to be seen. This normalisation could temporarily fuel general inflation pressures in European countries.

31 It should be noted that there is no clear connection between online trading and the degree of competition. On the one hand, the internet has made it easier to compare prices, which should promote competition. On the other hand, online trading opens up greater opportunities for firms to offer customers differentiated and tailor-made products, which may restrict price competition. See Y Bakos (2001), The emerging landscape for retail e-commerce, Journal of Economic Perspectives 15, pp 69-80.

Annex

Method to estimate price-cost margins

Interpreting the Solow residual under imperfect competition

In a neoclassical growth decomposition model, the Solow residual is given by the difference between the growth rate of (gross) output and the contributions to growth from labour, capital and intermediate goods. Under a number of assumptions – including profit maximisation and perfect competition – the Solow residual represents technical change.[32] In the case of imperfect competition, Hall calculates the Solow residual as a weighted sum of changes to the output-capital ratio and to the rate of technical change, where the weights are functions of the mark-ups.[33] Regressing the Solow residual on the change in the (real) output-capital ratio therefore allows conclusions to be drawn about the mark-ups. However, in such estimations, technical change – which cannot be observed directly – is included in the error term. If technical change has an impact on the output-capital ratio, this distorts the estimation results. Instrumental variables could be helpful in this regard; however, it is difficult to find suitable instruments.

Roeger's modification of Hall's approach

Alternatively, the (dual) Solow residual can be determined under the assumption that firms endeavour to minimise their costs. According to Roeger, if both approaches are combined, the unobservable technical change drops out of the estimation equation.[34] Mark-ups can then be estimated on the basis of a simple regression of the (non-price-adjusted) Solow residual y_t on the rate of change of the (nominal) output-capital ratio x_t using the method of least squares:[35]

$$y_t = \beta x_t + \varepsilon_t. \quad (1)$$

In this representation, t indexes one year, ε_t is the error term and β stands for the Lerner index,[36]

32 In addition, it is assumed that technical change is Hicks-neutral and that returns to scale are constant. Hicks-neutral technical change means that technical change has a proportional impact on the factors of production such that there is no change in their balance. Constant returns to scale means that a proportional change of one factor in the production resources changes output by this factor, too.

33 See R E Hall (1988), The relation between price and marginal cost in U.S. industry, Journal of Political Economy 96, pp 921-947.

34 See W Roeger (1995), Can imperfect competition explain the difference between primal and dual productivity? Estimates for U.S. manufacturing, Journal of Political Economy 103, pp 316-330.

35 In formal terms, this produces $y_t = (\Delta p_t + \Delta Q_t) - \alpha_{Nt}(\Delta w + \Delta N_t) - \alpha_{Mt}(\Delta m_t + \Delta M_t) - (1 - \alpha_{Nt} - \alpha_{Mt})(\Delta r_t + \Delta K_t)$ as well as $x_t = (\Delta p_t + \Delta Q_t) - (\Delta r_t + \Delta K_t)$, where Δ is the difference operator and t indexes one year. Q, N and M give the natural logarithm of output as well as the factor inputs for labour and intermediate goods. p, w and m are the corresponding logarithmised prices; α_{Nt} and α_{Mt} are the shares of the relevant input factors in revenue. $(\Delta p_t + \Delta Q_t)$ thus shows growth of the nominal output value; $(\Delta w + \Delta N_t)$ and $(\Delta m_t + \Delta M_t)$ show the growth rates of the costs for labour and intermediate goods. $(\Delta r_t + \Delta K_t)$ shows the change in capital costs where K_t is the natural logarithm of real net capital stock and r_t is the logarithmised user cost of capital.

36 The Lerner index is a measure of a firm's market power. It is defined as $(P - MC)/P$, where P is the price and MC the marginal costs of a firm, or as $1/|E|$, where $|E|$ shows the absolute price elasticity of demand. The index takes values between zero and one, with higher values indicating greater market power.

Estimated sectoral price-cost margins and sectoral division according to tradability and R&D intensity*

Sector description[1]	R&D intensity[2]	Austria	Belgium	Denmark	Finland	France	Germany	Italy
Manufacturing								
Food products, beverages and tobacco products (10-12)	low	1.13	1.05	1.06	1.10	1.15	1.06	1.13
Textiles, wearing apparel, leather and related products (13-15)	low	1.13	1.14	[3] 1.05	1.11	1.08	1.14	1.20
Wood and paper products, and printing (16-18)	low	1.13	1.12	1.08	1.29	1.09	1.15	1.23
Coke and refined petroleum products (19)	low	[3] 1.13	1.06	[3] 0.98	1.09	1.03	[3] 1.07	1.07
Chemical and pharmaceutical products (20-21)	high	[3] 1.06	1.20	1.58	1.28	1.14	1.24	1.10
Rubber and plastics products, and other non-metallic mineral products (22-23)	high	1.25	1.09	1.17	1.21	1.11	1.17	1.16
Basic metals and fabricated metal products, except machinery and equipment (24-25)	low	1.19	1.11	1.08	1.21	1.14	1.18	1.16
Computer, electronic and optical products (26)	high	1.33	1.21	1.28	1.48	1.17	1.45	1.17
Electrical equipment (27)	high	1.22	1.23	1.23	1.26	1.10	[3] 1.07	1.10
Machinery and equipment n.e.c.[4] (28)	high	1.26	1.27	1.06	1.15	1.17	1.24	1.17
Transport equipment (29-30)	high	1.13	1.05	1.16	1.12	1.10	1.29	1.15
Other manufacturing, and repair and installation of machinery and equipment (31-33)	high	1.22	1.10	1.28	1.13	1.18	1.15	1.20
Other sectors								
Electricity, gas, steam and air-conditioning supply (35)	low	1.11	1.35	1.67	1.65	[3] 1.06	1.46	1.31
Water supply, sewerage, waste management and remediation (36-39)	low	1.52	1.24	1.35	1.52	1.23	1.41	1.17
Construction (41-43)	low	1.25	1.18	1.13	1.15	1.18	1.15	1.25
Wholesale and retail trade, repair of motor vehicles and motorcycles (45-47)	low	1.38	1.26	1.18	1.33	1.23	1.40	1.67
Transportation and storage (49-53)	low	1.28	1.17	1.19	1.23	1.20	1.25	1.36
Accommodation and food service activities (55-56)	low	1.56	1.31	1.12	1.16	1.30	1.21	1.55
Publishing, audiovisual and broadcasting activities (58-60)	high	1.38	1.26	1.28	1.25	1.27	1.45	1.34
Telecommunications (61)	high	[3] 0.95	1.28	1.27	1.29	[3] 1.18	1.41	1.96
IT and other information services (62-63)	high	1.25	1.24	1.21	1.35	1.28	1.64	1.37
Financial and insurance activities (64-66)	low	1.35	1.38	1.55	1.64	1.30	1.61	1.77
Real estate activities (68)	low	2.84	3.08	2.38	2.85	6.58	2.85	6.66
Legal, accounting, management, architecture, engineering, technical testing and analysis activities (69-71)	high	1.33	1.34	1.22	1.35	1.20	1.57	1.96
Scientific research and development (72)	high	1.51	[3] 1.10	1.40	1.57	1.27	1.44	1.29
Other professional, scientific and technical activities (73-75)	high	1.14	1.08	1.17	1.21	1.24	1.41	1.66
Administrative and support service activities (77-82)	low	1.42	1.16	1.11	1.23	1.30	1.45	1.34

Source: Estimations based on OECD STAN and AMECO data for the period from 1996 to 2014. * Estimations based on equation 1 in this annex. A value of, say, 1.2 implies a price-cost margin of 20%. **1** The sector descriptions according to ISIC (International Standard Industrial Classification of All Economic Activities, Rev. 4) can be found in brackets. **2** R&D stands for research and development. **3** The parameter for market power (Lerner index) is estimated to be not significant (at least at the 10% level). **4** n.e.c. stands for not elsewhere classified.

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which – after rearranging – gives the price-cost margin μ:

$$\mu = \frac{1}{1-\beta}. \quad (2)$$

Limitations of this approach

As outlined in the main text, this approach initially allows the estimation of time-invariant mark-ups only. In addition, it is based on the assumption of constant returns to scale and the user cost of capital has to be approximated.[37]

Data used

Information on revenue, labour, intermediate costs and costs of capital is required to estimate the mark-ups. This analysis uses data from the OECD's STAN database.[38] In order to ensure comparability of the data, only those countries are included which have the relevant data for 27 sectors dominated by private firms for the period from 1995 to 2014 without any major statistical breaks. This group comprises the three major economies of France, Germany and Italy as well as Austria, Belgium, Denmark and Finland.

Consideration of cyclical factors …

Additions to this methodology enable dynamic aspects to be taken into consideration, too. To identify the cyclical impact, the Lerner index can be shown as the sum of a structural component $\bar{\beta}$ and a cyclical component γGAP_t:

$$\beta_t = \bar{\beta} + \gamma GAP_t, \quad (3)$$

where GAP_t is the macroeconomic output gap in year t.[39] Estimations by the European Commission are used for the output gaps.

… and structural breaks

With a dummy variable ϕ_t^T, which takes the value of one if $t \geq T$ and zero in all other cases, structural breaks can also be identified:[40]

$$\begin{aligned} y_{cst} = {} & \bar{\beta}_1 x_{cst} + \bar{\beta}_2 \phi_t^T x_{cst} \\ & + \gamma(x_{cst} GAP_{ct} + \Delta GAP_{ct}) \\ & + \alpha_{cs} + \gamma_t + \varepsilon_{cst}, \end{aligned} \quad (4)$$

where Δ is the difference operator. $\bar{\beta}_1$ shows the Lerner index prior to the structural break and $\bar{\beta}_1 + \bar{\beta}_2$ shows the index after the break.[41] The model is estimated numerous times with the possible year in which the break occurs varying from 1999 to 2011. The model with the least sum of squared errors is chosen and a break test on the basis of a bootstrapping method is carried out for this model.[42] Furthermore, c stands for a country and s for a sector. The model is estimated in a panel in order to allow for a sufficient number of observations to identify the parameters. Country-sector dummies (α_{cs}) as well as year dummies (γ_t) control for time-constant, unobservable country-sector-specific aspects and aggregated shocks. The models are estimated using weights, thus ensuring that the impact of an observation is in proportion to the value added of the sector in 1996.

Consideration of bargaining power on the labour market

The method used here underestimates the scope for market power if revenue earned is shared with employees. Thus the estimation approach is expanded to include a parameter (λ) for employees' bargaining power. This is based on the change in the ratio of labour cost to cost of capital z_t:[43]

$$y_{cst} = \beta x_{cst} + \lambda z_{cst} + \alpha_{cs} + \gamma_t + \varepsilon_t. \quad (5)$$

37 With regard to the returns to scale, it should be noted that the estimation method results in an underestimation (overestimation) of the mark-ups for increasing (decreasing) returns to scale. Moreover, measurement errors in the capital stock, for example, may distort the estimated mark-ups. See R Christopoulou and P Vermeulen (2012), Markups in the euro area and the US over the period 1981-2004: A comparison of 50 sectors, Empirical Economics 42, pp 53-77.

38 One exception is user cost of capital ($r_t = ln(R_t)$), which is approximated in accordance with conventional practice and in line with Hall and Jorgensen (1967) as: $R_t = P_I[i - \pi + \delta]$, where $i - \pi$ is a real interest rate, δ the rate of depreciation and P_I the deflator for capital goods. A value of 10% is used forδ, the relevant deflator from the European Commission's AMECO database is taken for P_I and $i - \pi$ is approximated using the real long-term interest rate according to the AMECO database, with any negative values being set to zero. See R E Hall and D W Jorgensen (1967), Tax policy and investment behavior, American Economic Review 57, pp 391-414.

39 Oliveira Martins et al (1996) derive a corresponding estimation equation in the context of the Roeger approach. See J Oliveira Martins, S Scarpetta and D Pilat (1996), Mark-up pricing, market structure and the business cycle, OECD Economic Studies, No 27.

40 See H Badinger (2007), Has the EU's single market programme fostered competition? Testing for a decrease in mark-up ratios in EU industries, Oxford Bulletin of Economics and Statistics 69, pp 497-519.

41 In principle, an estimation of time-varying firm-specific (or sector-specific) mark-ups would be preferable. Although there are approaches for conducting such estimations, these usually require firm-level data. See, for example, J De Loecker and F Warzynski (2012), Markups and firm-level export status, American Economic Review 102, pp 2437-2471.

42 See B E Hansen (1999), Threshold effects in non-dynamic panels: Estimation, testing, and inference, Journal of Econometrics 93, pp 345-368.

43 Amador and Soares (2016) derive this estimation equation in line with Roeger (1995), taking into account the aspect of bargaining power on the labour market. In formal terms, this produces $z_t = (\alpha_{nt}$ -1)$[(\Delta w_t + \Delta N_t) - (\Delta r_t + \Delta K_t)]$. Measures for the output gap are included in the regressions to control for cyclical factors. See J Amador and A Soares (2016), Markups and bargaining power in tradeable and non-tradeable sectors, Empirical Economics 53, pp 669-694.