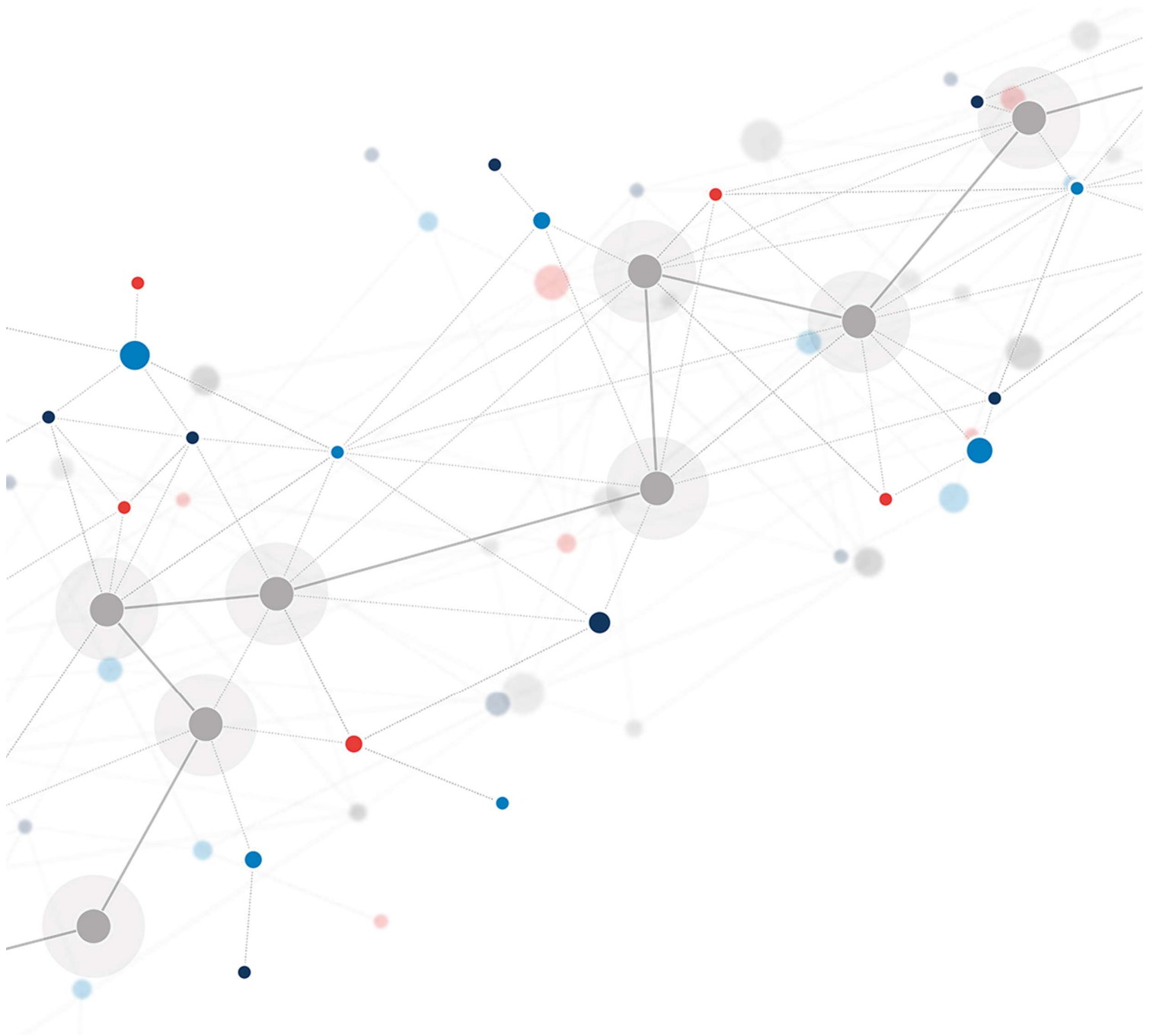


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# DO FOUR-TO-THREE MOBILE MERGERS HARM CONSUMERS? A REVIEW OF POST-MERGER EFFECTS AND CONCENTRATION STUDIES

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# ABSTRACT

This report presents a meta-study of empirical studies of the relationship between mobile market concentration or consolidation and prices, investment and quality, as well as new findings in relation to whether earlier mobile mergers impacted the rate of decline in average revenue per gigabyte consumed, which we use as a proxy for quality-adjusted prices. In setting out the findings of all such empirical studies of four-to-three mobile mergers since 2010 that we are aware of, the aim of the paper is to ensure a better evidence base for authorities in assessing whether proposed mergers are likely to benefit or harm consumers. In particular, we assess to what extent mergers in markets with four operators have been found to have consistent effects on prices, investment and quality or, where differences in effects have been found, what factors explain those differences. We find that when the empirical literature is considered in the round, previous four-to-three mergers typically had little effect (if any) on prices and led, in many cases, to significant improvements in the quality of the merging parties and better national average network quality relative to other countries. We also find that the average revenue per gigabyte consumed (as a measure for quality-adjusted prices) generally fell either at a faster rate post-merger or at a similar rate as pre-merger. Finally, we show why a comprehensive review of previous studies can better inform policy decisions compared with reliance on any individual study or on selective references to evidence.

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# 1 SUMMARY OF CONCLUSIONS AND POLICY IMPLICATIONS

- 1 Since 2010, the European Commission (“EC”) has investigated seven four-to-three mergers between mobile network operators (“MNOs”) in Europe and the UK. At the time of writing this paper, two further investigations, concerning Orange and MasMóvil in Spain (conducted by the EC) and Vodafone and Three in the UK (conducted by the UK Competition and Markets Authority – “CMA”), are ongoing.
- 2 Regulators’ stance with respect to horizontal MNO mergers has hardened substantially over time. The first three – in Austria (Orange and Hutchison – “H3G”), Ireland (Telefonica – “O2” and H3G), and Germany (O2 and E-Plus) – were approved with relatively limited intervention. However, the EC’s decisions were criticised as being too lenient, risking harm to competition and consumers. Since then, authorities have been more stringent. In 2015, two Danish MNOs (Telia and Telenor) abandoned their proposed merger after the EC signalled a concern that competition would be harmed unless a new fourth operator entered the market. In 2016, the EC prohibited H3G’s proposed acquisition of O2. The EC did approve the Wind 3 Italia joint venture in 2016, but only on the condition that sufficient spectrum and sites were transferred to a new entrant. In 2018, the EC approved T-Mobile NL’s acquisition of Tele2’s Dutch operations unconditionally, but this was based on the EC’s finding that Tele2 was struggling and unlikely to remain as an effective competitor absent the merger.
- 3 Across the Atlantic, the US authorities approved the Sprint/T-Mobile merger in 2020, subject to conditions, including divestments to Dish Network and commitments to ensure that the 5G rollout achieved targets for coverage and average downloads speeds.<sup>1</sup>
- 4 Is it true that the EC’s early approach to four-to-three MNO mergers was too lenient, and has the more stringent approach adopted in later investigations been justified? If so, then a review of market developments since these mergers should find that at least the earlier transactions raised prices and/or reduced service quality to the detriment of consumers.
- 5 This paper reviews existing empirical studies of the relationship between mobile market concentration and prices, investment and quality. These studies fall into two categories:
  - a. studies which estimate the effect of specific mergers on market outcomes (in relation to which we focus on four-to-three mergers); and
  - b. studies which estimate the relationship between concentration levels and market outcomes.
- 6 There are significant differences between the findings of existing studies of the effects of earlier four-to-three mobile mergers on price, investment, and quality. Studies also differ on whether there are any statistically significant differences in outcomes between four and three operator markets and the nature of any such differences.

<sup>1</sup> Specifically, commitments to deploy 5G to 97% of the population within three years and to 99% of Americans within six years, and for 90% of Americans to have access to mobile speeds of at least 100 Mbps within six years.

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- 7 Some differences can be attributed to the specific characteristics of the mergers and countries considered, which suggests that market-specific and merger-specific factors matter. Understanding why the effects have varied depending on the nature of the merger (e.g., characteristics pertaining to the merging parties) and on the market circumstances (e.g., the significance of MVNOs) may provide insights into the likely effect of a new transaction. Where market conditions and technologies differ, it would be important to consider how those differences might change the effects of a new merger compared with the effects of previous mergers.
- 8 There are also differences between studies of the estimated effects of the same mergers. Some of these appear to result from different measures of prices and quality showing different trends. This increases the importance of understanding to what extent the examined prices and quality are likely to reflect the prices and quality experienced by most customers or, at least, significant segments of customers. It also cautions against relying on any single study as offering a full assessment of a merger's effect or to predict the likely effects of a new merger. As we set out in this paper, some studies also have methodological flaws.
- 9 This paper also contributes to existing empirical literature by providing new analysis on whether earlier mobile mergers impacted the rate of decline in average revenue per gigabyte ("GB") consumed, which we use as a proxy for quality-adjusted prices.

### 1.1 Four-to-three mergers had limited effects on prices, if any

- 10 An overall assessment of the studies reviewed shows that the mergers had little impact on prices, typically having no effect at all, or increasing prices for some customers for a short period only.
- 11 The EC was criticised for approving the three earlier mergers, in Austria, Ireland, and Germany. But, with hindsight, none of them had a sustained negative impact on prices. Studies find that, in Ireland, the merger had no statistically significant price effect. In Austria and Germany, customers with low data usage did face higher prices a year or so after the merger, but for a limited duration, only before prices reverted to the levels expected from control countries without mergers.
- 12 The circumstances peculiar to the Italian and Dutch mergers may reduce their relevance as barometers for four-to-three mergers elsewhere. Nonetheless, they are not bad omens. In Italy, in the short period before a new operator entered, due to the structural remedies imposed by the EC (returning the market to a 4 MNO market), the merger appeared to have no impact on prices. After entry, prices plummeted, as the entrant brought new capacity into the market and priced aggressively to grow its customer base from nothing. In relation to the Dutch merger, the EC noted reasons as to why the fourth MNO's position and pricing impact may not have been sustainable even without the merger. Nonetheless, after the Dutch merger, prices continued to fall in absolute terms, and relative to the European average.
- 13 In the US, mobile prices are generally higher than in other OECD countries, albeit around the median when adjusting for quality, cost, and demographic differences between countries.<sup>2</sup> However, the effect of the Sprint/T-Mobile merger on prices was negligible. On the contrary: since the merger, real term revenues per customer – which from consumers' perspective is the cost they actually incur – have fallen steadily.<sup>3</sup>

<sup>2</sup> The US Federal Communications Commission found that mobile broadband prices in the US were the 12<sup>th</sup> cheapest out of a comparison group of 26 OECD countries after adjusting for country-level quality, cost and demographic differences (2022 Communications Marketplace Report, para. 363).

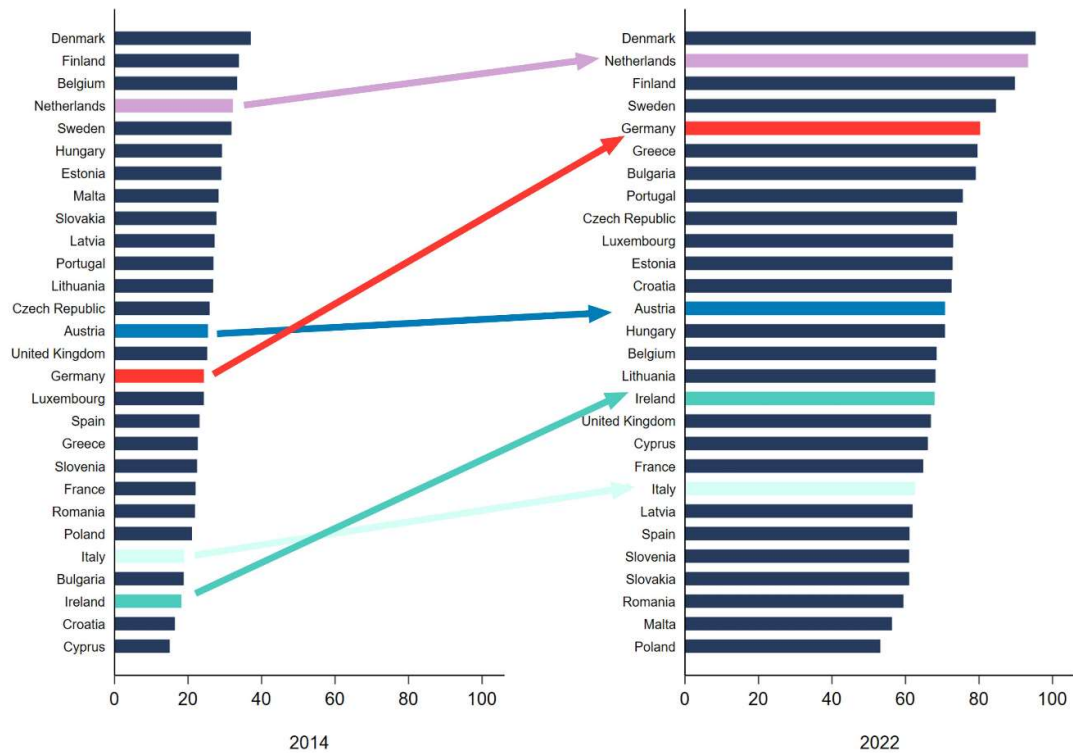
<sup>3</sup> See Figure 6.

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## 1.2 Many four-to-three mergers appear to have led to higher quality

- 14 Far from leading to increases in absolute prices, four-to-three mergers in Europe have generally led to lower quality-adjusted prices. These transactions have generally improved mobile service quality – for instance, by extending network coverage and/or increasing download speeds.
- 15 In Ireland, since the merger, the quality of the country’s networks as measured by the GSMA’s network performance index has increased relative to other European countries (see Figure 1). Germany’s network performance improved from the 16<sup>th</sup> best in Europe in 2014 – the year of the merger – to the 5<sup>th</sup> best in 2022. In Austria, the picture resulting from the studies is less clear. Of two studies, one found a decrease in typical 4G download speeds, and the other found that the merger led to greater coverage and higher speeds. Overall, Austria’s network performance increased from 14<sup>th</sup> best to 13<sup>th</sup> best.
- 16 The Italian and Dutch networks have also increased their rankings in Europe for performance since the respective mergers. In Italy, the merged entities have gone from having slower speeds than their competitors before the transaction, to having the fastest network in the country afterwards. The network performance of the Netherlands, which was already high, improved further from fourth to third best in Europe.
- 17 Similarly, in the US, before the merger, T-Mobile had the second fastest network (albeit with poor coverage) and Sprint had the slowest. By July 2022, the merged entity provided speeds about double those of its competitors. Following the merger, the US has been among the leading countries in terms of network investment per capita and 5G coverage.

**Figure 1: GSMA network performance index (countries with mergers over period improved network quality relative to the others)**



Notes: Index is composed of performances in mobile download speeds, mobile upload speeds, and latencies collected by Ookla Speedtest Intelligence. Scaled between 0 and 100 with equal weight on each of the three performance indicators. 2014 chosen as base year as this is the earliest year reported by GSMA.

Source: GSMA Mobile Connectivity Index (available online [here](#)).

- 18 These improvements are important in their own right, but they may also be instructive when considering the likely effect on investment when market “laggards” merge – which is potentially the case in the UK, as Three and Vodafone are the smallest MNOs. A merger can transform laggards, intensifying the competition to lead the market. That accelerates investment in new technology, because “neck-and-neck” competition to lead means that each competitor risks falling behind if it delays investment, which is a less credible threat when competing against a laggard.<sup>4</sup> In the US, merging two market ‘laggards’ to create a third competitor with sufficient scale accelerated the deployment of 5G. Similarly, in Austria, creating a third competitor at scale increased investment and hastened the roll-out of 4G.

### 1.3 Four-to-three mergers generally led to better value for money

- 19 With limited effect on prices and better quality, the four-to-three mergers since 2010 appear to have provided customers with better value for money. Officials from the UK Office for National Statistics (“ONS”) and academics have proposed using revenue per unit of data supplied as a parsimonious indicator of changes in quality-adjusted prices on the basis that improvements in coverage,

<sup>4</sup> Aghion, P. et al (2005). “Competition and innovation: an Inverted U-Relationship”, *The Quarterly Journal of Economics*, 120(2), p. 719.

increasing speeds, and new services can be expected to lead to more data usage at any given price level. We have built on this approach by undertaking new analysis of whether the various four-to-three mergers led to a change in the rate of decline in average revenue per GB of data consumed. In two cases – Austria and Ireland – average revenue per GB declined faster after the merger than before it. In the US, Italy and Germany, quality-adjusted prices continued to fall at the same rate (see Table 1). In the Netherlands, revenue per GB did not decline as fast post-merger – this appears to be largely due to slower growth in data volumes from 2019 onwards, as mobile prices in the Netherlands continued to fall to below the EU average. Further, the EC’s T-Mobile/Tele2 merger decision suggests that the pre-merger rate of decline in average revenue per GB might not have been sustained in the Netherlands absent the merger, i.e. it notes that Tele2’s competitiveness and quality was declining and that some of the pre-merger decline in prices was the result of significant additional capacity from the deployment of new spectrum.<sup>5</sup>

**Table 1: Effects of four-to-three mergers on rate of decline in average revenue per GB consumed**

Merger	Was there a statistically significant post-merger deviation from the pre-merger rate of decline?
H3G/Orange, Austria, 2013	Faster decline in average revenue per GB post-merger (**)
H3G/O2, Ireland, 2014	Faster decline in average revenue per GB post-merger (**)
O2/E-plus, Germany, 2014	No statistically significant difference in rate of decline
Wind/Tre, Italy, 2016 <sup>6</sup>	No statistically significant difference in rate of decline in post-merger period prior to Iliad’s entry; then, faster decline
T-Mobile/Tele2, Netherlands, 2018	Slower decline in average revenue per GB post-merger (***)
Sprint/T-Mobile, US, 2020	No statistically significant difference in rate of decline

Notes: Based on measures of mobile service revenues by market divided by market mobile data traffic, and voice and SMS traffic converted to GB equivalent following Abdirahman et al. (2020). Test undertaken with respect to a logarithmic trend, considering four years before and after the merger. For Italy, the period considered ends in Q2 2018 (the quarter of Iliad’s entry). P <.01 \*\*\*, p <.05 \*\*, p <.1 \*  
Source: Compass Lexecon analysis based on data described in Appendix B.

## 1.4 Studies of the relationship between concentration, prices and quality

- 20 In addition to studies considering the effect of specific mergers, there are studies that assess the relationship between concentration and price and/or quality. There is a need for caution in drawing inferences from such concentration studies on the likely effect of a merger, because a relationship between concentration and a market outcome on average need not be predictive of the effects of any particular merger. For example, mobile network mergers typically increase rather than reduce network capacity in a market and there may also be country-specific factors that impact both the level of concentration and price/quality, which may cause spurious correlations.
- 21 Concentration studies have tended to find either that higher concentration is associated with higher prices or that there is no statistically significant effect between concentration and prices.

<sup>5</sup> For example, see EC T-Mobile NL/Tele2 NL merger decision (2018), p.489, p.511 and p.453.

<sup>6</sup> The Wind/Tre merger in 2016 reduced the number of network operators in the market from four to three; however, the remedy package agreed with the EC allowed the entry of Iliad in May 2018 as a new mobile network operator, which restored the four-player structure. The result for Italy in Table 1 considers the post-merger period to end in Q2 2018, the quarter of Iliad’s entry. See Appendix B for results for Italy with the post-merger period lasting three, four or five years after the 2016 merger.



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22 With respect to the impact of concentration on quality, the findings of published studies vary. Some find that higher concentration is associated with higher quality, others that there may be an inverted U-shaped relationship between concentration and speed, or that there is no statistically significant effect of concentration on quality.

23 There may be a range of reasons for the variety of results, including differences in the groups of countries being considered, different time periods, different price and quality measures, and different methods to control for other factors impacting quality.

## 1.5 Policy conclusions

24 The evidence that four-to-three MNO mergers have improved quality without increasing prices may seem surprising. Competition authorities generally find that mergers are at best neutral in their impact on competition and may, in some cases, lead to higher prices and/or lower quality.

25 The evidence does suggest distinctive features of mobile technology. Mobile network consolidation generally increases capacity. That is because the capacity each operator supplies is a product of its sites and its spectrum. Consolidating two networks into one is not additive; it is multiplicative, providing more capacity than the sum of its former parts. This may help explain why the speeds of the merged parties' network improved relative to rivals in the US, Italy, and other countries. Greater capacity also supports the parties in offering more data at any given price, which can lead to falling quality-adjusted prices.

26 Evidence of some effects varying between mergers suggests that market-specific and transaction-specific factors are important (including the relative market positions of the merging firms or the significance of MVNOs in the market, among others). The range of results found in the empirical literature of the effects of mobile mergers and concentration on prices, investment<sup>7</sup> and quality, highlights the importance for authorities to consider a wide evidence base in making a decision as to whether or not to allow a specific transaction to proceed. Differences in prices series and quality metrics raise the importance of identifying which metrics are likely to be most reliable and representative. It is also important to consider whether the assumptions underlying a specific methodology are consistent with the market evidence.

27 We conclude from the studies on past mergers that four-to-three mergers had either no significant effects on prices or had a time-limited effect only, and potentially only for some service bundles. The evidence also suggests that past mergers have in many cases led to quality improvements. Our analysis of average revenue per GB (as a proxy for quality-adjusted prices) finds that four-to-three mergers generally have either led to no change in the rate of decline in quality-adjusted prices or have accelerated that decline.

28 Our study shows that there is no sound basis for a presumption that four-to-three mobile mergers are likely to harm consumers. Instead, assessing the impact of a four-to-three merger will likely require careful assessment of both likely price and quality effects in light of specific merger and market characteristics and, potentially, a need to weigh offsetting effects so as to determine whether consumers will be better or worse off overall.

<sup>7</sup> While changes in quality can have direct implications for customer benefits, the implications of changes in investment is less straight-forward. Where a merger leads to higher investment this could flow through to higher network quality. However, a merger which reduces duplicative investment in fixed costs (such as in coverage sites or IT and billing systems) may not adversely impact customers.

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## 2 INTRODUCTION

- 29 Whether mobile mergers benefit or harm consumers is an important question for competition and regulatory authorities. A significant literature has developed, including studies by regulatory authorities, evaluating the effects of past mobile mergers as well as investigating whether there is any systematic relationship between mobile market concentration, prices, investment and quality.
- 30 This paper aims to provide a comprehensive meta-study of empirical studies of the relationship between mobile market concentration and prices, investment and quality. Meta-studies synthesise the results of numerous individual studies, to provide a richer and fuller evidence base to support better informed policy decisions. Meta-studies avoid the pitfall of relying on a sub-set of studies that may provide only a partial and potentially biased estimate of how changes in concentration may impact consumers.
- 31 The evidence set out in this paper shows that, when the empirical literature is considered in the round, previous four-to-three mergers:
- a. had little impact on prices, typically having no effect at all or increasing prices for some customers for a short period only; and
  - b. led, in many cases, to significant improvements in the quality of the services of the merging parties, and better national average network quality relative to other countries, including wider network coverage and faster download speeds.
- 32 While the likely effects of any new merger would need to be assessed on its facts, we consider that the overall evidence shows the significant potential for four-to-three mobile mergers to benefit consumers or not adversely impact them. The evidence shows that there is no basis for a presumption that four-to-three mobile mergers lead to price increases or adversely impact quality.
- 33 This paper is organised as follows.
- a. First, we discuss the importance of competition authorities considering a wide evidence base to understand how mobile mergers may affect customers, including meta-analyses of earlier studies and metrics that take into account price and quality effects.
  - b. Second, we review the existing empirical literature on the effects on market outcomes of (i) the H3G/Orange merger in Austria in 2013; (ii) the H3G/O2 merger in Ireland in 2014; (iii) the O2/E-Plus merger in Germany in 2014; (iv) the Sprint/T-Mobile merger in the US in 2020 (albeit that only limited observations are available at this time); and (v) other mobile mergers. We assess the methodology, data and robustness of these studies and compare their findings with other datasets on prices, investment and quality.
  - c. Third, we set out our own analysis of whether the mergers led to changes in the rate of decline of revenue per GB.
  - d. Finally, we review studies of the relationship between concentration, prices, investment, and quality in mobile markets.

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In Appendix A, we provide a more detailed review of a number of studies undertaken for competition authorities. In Appendix B, we provide detail on our own econometric analysis to assess whether four-to-three mergers have resulted in significant changes of revenue per GB consumed.

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### 3 THE IMPORTANCE OF A WIDE EVIDENCE BASE TO ASSESS THE EFFECT OF MOBILE MERGERS

35 “Meta-research” refers to the study of past studies. In particular, when there are a number of previous studies investigating similar empirical questions, meta-research summarises and integrates the findings to better understand the results. Where the empirical question is critical to an important policy matter, meta-research can help ensure that policy decisions are taken on the basis of rigorous, credible and valid evidence.

36 Meta-research has grown in prominence, in part because of a concern that individual studies can be subject to intended or unintended bias in the selection of data and reporting of results. Further, by bringing together the findings of studies covering different data sets, meta-research increases the evidence base to help inform policy. Ioannidis et al state:

*“Moreover, meta-analysis can synthesise the results from numerous underpowered studies, filter out various biases and thereby suggest better estimates of underlying empirical economic parameters, necessary for valid inferences. Hence, even if the credibility of economics research is much lower than desirable, a careful systematic review and meta-analysis may improve statistical inference and offer some policy guidance.”<sup>8</sup>*

37 In mobile markets, the complexity of retail prices and the host of mobile service quality parameters heightens the risk that any individual study may reflect only a partial view of the overall impact of a merger on consumers. In addition, studies differ in the period of data and some capture only shorter term effects. This can lead to incomplete conclusions, as there are reasons to expect that the effect of factors such as competitor re-positioning, investment changes and certain types of remedies will grow over time.

38 In some cases, meta-analysis is used to bring together the results of multiple empirical studies to estimate a weighted average estimate of an effect which will more accurately estimate the ‘true’ effect. While we present the results of all empirical studies of the effect of concentration on prices, investment and quality which we are aware of, we do not consider that it is meaningful to focus on a single average of their effects. This is because there are reasons to expect that four-to-three mergers will differ in their effects depending on the nature of the merging parties, the competitive constraint from rival operators and MVNOs, and the broader state of the market. For example, the deployment of new mobile technologies can fundamentally change cost structures, demand and the competitive positioning of operators.

39 Meta-research on post-merger effects can be valuable in helping to understand where there are likely to be actual differences (i) in the effects of different mergers, or (ii) of the effect of a particular merger on different services or customer segments, as well as to consider what might be causing such differences. Meta-research can also reveal where a finding of a particular study reflects trends in prices or quality that are inconsistent with the trends found in the data set of other studies. Where

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<sup>8</sup> Ioannidis, J. P. A. et al. (2017). The Power of Bias in Economics Research. *The Economic Journal*, 127(605), p. 238.

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an authority is interested in understanding the overall effects on consumers, such differences in the data raise the importance of determining which data set is likely to be most representative.

# 4 OVERVIEW OF EXISTING STUDIES OF POST-MERGER EFFECTS

## 4.1 H3G/Orange merger in Austria, 2013

40 Table 2 summarises the findings of all studies we are aware of which have assessed the effects of the Austrian H3G/Orange merger in January 2013 on prices, investment and/or quality.

**Table 2: Summary of studies assessing the effect of the Austrian 2013 merger**

Paper	Findings	Comments
Austrian Regulatory Authority for Broadcasting and Telecommunications ('RTR') (2016) <sup>9</sup>	Price rise of 24% in the first year after the merger for smartphone users, followed by 50-90% in the second year relative to control countries. No change in the first year after the merger for 'traditional' users, followed by a 22%-31% price increase in the second year.	Calculation of prices is flawed; price comparisons across countries are for different baskets and, hence, may suggest differences between countries even when individual service prices movements are the same; the findings can be expected to be distorted by Austria having low pre-merger prices and hence less scope for post-merger price falls than control countries; price increases 6 quarters after the merger completed are unlikely to be driven by the merger; uses simplistic control variables that do not capture all possible causes of prices changes. <sup>10</sup>
Austrian Competition Authority ('BWB') (2016) <sup>11</sup>	Price increases of 14% to 20% between 2012 and 2014 based on merger simulation of combined effects of H3G/Orange and TA/Yess transactions.	Merger simulation approach is heavily assumption-driven. Data only until 2014 and study notes prices falling in 2015.
Houngbonon (2015) <sup>12</sup>	Price per GB of wireless data decreases by 19% while imputed voice price increases.	Data only up to end 2014, and notes that there is a fall in the average price of standalone mobile voice plans following the merger.

<sup>9</sup> Austrian Regulatory Authority for Broadcasting and Telecommunications. (2016). *Ex-post analysis of the merger between H3G Austria and Orange Austria*. [https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/Ex\\_post\\_analysis\\_merger\\_H3G\\_Orange\\_RTR.pdf](https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/Ex_post_analysis_merger_H3G_Orange_RTR.pdf)

<sup>10</sup> Further details on these comments are set out in Appendix A.

<sup>11</sup> Austrian Competition Authority. (2016). *The Austrian Market for Mobile Telecommunication Services to Private Customers; An Ex-post Evaluation of the Mergers H3G/Orange and TA/Yess! Sectoral Enquiry Final Report*. [https://www.bwb.gv.at/fileadmin/user\\_upload/PDFs/BWB2016-re-Ex-post\\_evaluation\\_of\\_the\\_mobile\\_telecommunications\\_market.pdf](https://www.bwb.gv.at/fileadmin/user_upload/PDFs/BWB2016-re-Ex-post_evaluation_of_the_mobile_telecommunications_market.pdf)

<sup>12</sup> Houngbonon, G. V. (2015). *The Effects of Market Concentration on the Price of Wireless Communications Services*. Ninth IDEI-TSE-IASST Conference on The Economics of Intellectual Property, Software and the Internet, Toulouse, France, January 7-8, 2016. [https://idei.fr/sites/default/files/IDEI/documents/conf/Internet\\_2016/Articles/concentration\\_price\\_gvh\\_.pdf](https://idei.fr/sites/default/files/IDEI/documents/conf/Internet_2016/Articles/concentration_price_gvh_.pdf)

**Table 2: Summary of studies assessing the effect of the Austrian 2013 merger**

Frontier Economics (2015) <sup>13</sup>	Post-merger revenue per MB was below the pre-merger trend.	Data only up to end 2014.
HSBC (2015) <sup>14</sup>	The merger led to lower overall tariffs (including voice and data).	Uses Italy as the comparator market in a difference-in-difference (DiD) estimation, <sup>15</sup> having identified it as the best comparator through a principal components analysis, although the study also tests for the three next best counterfactual markets.
GSMA (2017) <sup>16</sup>	The merger had positive effects on the coverage of the merged entity's 4G network, download and upload speeds, and also improved the quality of networks in the Austrian market as a whole.	The positive effect on the merged entity's 4G network is only statistically significant after 2 years.
Body of European Regulators for Electronic Communications ('BEREC') (2018) <sup>17</sup>	Price rise in 2014 and 2015 for low and medium usage baskets under preferred synthetic control group (SCG) <sup>18</sup> approach, which became statistically insignificant from 2016 onwards.	BEREC's own tests do not consistently find significant price increases. BEREC's SCG approach has mixed findings; no effect is found on high usage tariffs, while effects on low usage and medium usage tariffs are generally not confirmed by BEREC's robustness tests. BEREC considers its DiD approach is not appropriate for its higher usage basket given Austria's low pre-merger prices, while its low and medium usage baskets are not representative of the data use of most customers in 2015. <sup>19</sup>
Aimene et al. (2019) <sup>20</sup>	Average price of data decreased 42% and average price of voice increased 49% post-merger, relative to control countries. <sup>21</sup>	Not clear how the authors allocated bundle revenues between voice and data.

<sup>13</sup> Frontier Economics (2015). *Assessing the case for in-country mobile consolidation: A report prepared for the GSMA*. [https://www.gsma.com/publicpolicy/wp-content/uploads/2015/05/Assessing\\_the\\_case\\_for\\_in-country\\_mobile\\_consolidation.pdf](https://www.gsma.com/publicpolicy/wp-content/uploads/2015/05/Assessing_the_case_for_in-country_mobile_consolidation.pdf)

<sup>14</sup> HSBC. (2015). *Supersonic European telecoms mergers will boost capex, driving prices lower and speeds higher*.

<sup>15</sup> A difference-in-difference estimation compares how the difference in an outcome between the unit of interest (here, Austria) and other control units (here, a reference group of other countries) evolves before and after an event (here, the 2013 merger).

<sup>16</sup> GSMA. (2017). *Assessing the impact of mobile consolidation on innovation and quality An evaluation of the Hutchison/Orange merger in Austria*. [https://www.gsma.com/publicpolicy/wp-content/uploads/2017/07/GSMA\\_Assessing-the-impact-of-mobile-consolidation-on-innovation-and-quality\\_36pp\\_WEB.pdf](https://www.gsma.com/publicpolicy/wp-content/uploads/2017/07/GSMA_Assessing-the-impact-of-mobile-consolidation-on-innovation-and-quality_36pp_WEB.pdf)

<sup>17</sup> Body of European Regulators for Electronic Communications. (2018). *BEREC Report on Post-Merger Market Developments - Price Effects of Mobile Mergers in Austria, Ireland and Germany*. [https://www.berec.europa.eu/sites/default/files/files/document\\_register\\_store/2018/6/BoR\\_%2818%29\\_119\\_BEREC\\_Report\\_Mergers\\_Acquisitions.pdf](https://www.berec.europa.eu/sites/default/files/files/document_register_store/2018/6/BoR_%2818%29_119_BEREC_Report_Mergers_Acquisitions.pdf)

<sup>18</sup> An SCG analysis involves estimating the impact of the merger in the merging country in reference to a constructed ('synthetic') control which can be thought of as the weighted average of outcomes in a sample of other countries that are chosen with the aim that the synthetic control will provide a good indication of what would have happened in the merging country had the mergers not occurred.

<sup>19</sup> Further details on these comments are set out in Appendix A.

<sup>20</sup> Aimene L. et al. (2019). *Impact of mobile operators consolidation on unitary price*. 30th European Conference of the International Telecommunications Society (ITS): "Towards a Connected and Automated Society", Helsinki, Finland, 16th-19th June, 2019. <https://www.econstor.eu/bitstream/10419/205161/1/Aimene-et-al-prices.pdf>

<sup>21</sup> We note that Aimene et al. (2019) also consider the average effect across Germany, Ireland, and Norway, and find that the mergers led to a reduction in the price of data by 18% and an increase in the prices of voice by 18%.

**Table 2: Summary of studies assessing the effect of the Austrian 2013 merger**

Ofcom (2020) <sup>22</sup>	Unable to find an effect on country-level investment. Finds that the merger had a negative effect on 4G download speeds for two years, before returning to a similar level as that predicted to have occurred without the merger.	Ofcom only includes a small number of predictor variables in its SCG analysis, and the importance and relevance of the included predictor variables for download speeds is questionable. Ofcom does not include industry capex as a predictor variable despite identifying industry capex as an important determinant of download speeds. Ofcom only controls for the differences in the commencement date for 4G rollout, but not the speed of rollout. <sup>23</sup>
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Notes: Further explanation of the comments on particular studies is set out in Appendix A.

- 41 Of the studies which examine pricing effects, three find that the merger resulted in higher prices, two find the merger led to lower prices and two find the merger led to higher prices for voice services and lower prices for data services.
- 42 The DiD approaches of RTR (2016) and BEREC (2018) find a merger effect of higher prices by comparison with the prices that would be expected had Austria followed the price trend in a control group of countries. Figure 2 shows BEREC's estimate of trends in prices for a medium usage profile in Austria and the average of seven control group countries. BEREC's DiD approach finds no statistically significant price effect in the 12 months after the merger, higher prices in 2014 and 2015 and generally no statistically significant effect in the first half of 2016 (which BEREC attributes to MVNO entry). An issue with the DiD approach when applied to Austria is that its low pre-merger prices make it less likely that Austria would be able to match the downward price trend of other countries in the post-merger period.<sup>24</sup>
- 43 BEREC's SCG approach, which BEREC considers has methodological advantages over DiD approaches, has mixed findings. BEREC's analysis focuses on 2013 usage (and understates average data use in 2013<sup>25</sup>) – BEREC's 2013 low and medium data usage is unlikely to be representative of most customers' usage in later years given that RTR data shows that mobile data use in Q4 2015 was four times as high as data use in Q1 2013, and data use in Q4 2016 was almost 8 times as high as data use in Q1 2013.<sup>26</sup> BEREC's high-usage basket is likely to be most representative of later-year usage and BEREC finds no effect on high-usage tariffs under its SCG approach. BEREC does find effects on low-usage and medium-usage tariffs but they are not confirmed by BEREC's robustness tests (e.g., no effect on low-usage tariffs is found when considering 2013 and 2014 usage, and no effect on medium-usage tariffs is found when considering the two cheapest tariffs, except for a questionable single effect in the second half of 2015 for a merger which completed in January 2013).

<sup>22</sup> Ofcom. (2020). *Market structure, Investment and Quality in the mobile industry*. [https://www.ofcom.org.uk/\\_\\_data/assets/pdf\\_file/0036/209799/market-structure,-investment-and-quality-in-the-mobile-industry-discussion-paper.pdf](https://www.ofcom.org.uk/__data/assets/pdf_file/0036/209799/market-structure,-investment-and-quality-in-the-mobile-industry-discussion-paper.pdf)

<sup>23</sup> Further details on these comments are set out in Appendix A.

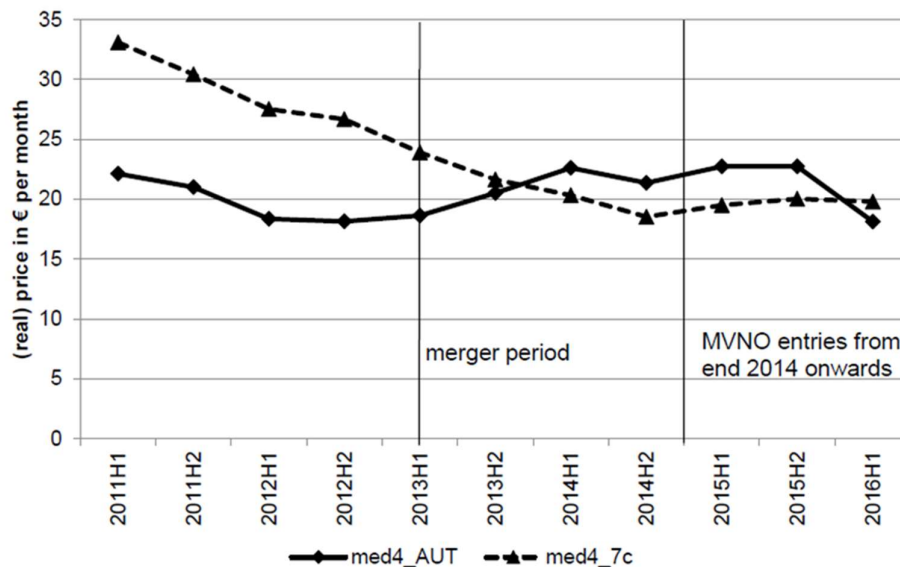
<sup>24</sup> BEREC (2018) notes this point in relation to the high-usage basket.

<sup>25</sup> BEREC's medium use basket incorrectly assumes that Ericsson's Mobility Report November 2014 had estimated that around half of mobile data in 2013 is used by data-only devices. Ericsson's Report actually suggests that data-only devices account for around 30% of mobile data in 2013 and, hence, BEREC is likely to be understating average mobile phone data use.

<sup>26</sup> Austrian Regulatory Authority for Broadcasting and Telecommunications. (2016). *RTR Telekom Monitor 2015* (p. 12), and Austrian Regulatory Authority for Broadcasting and Telecommunications. (2017). *RTR Telekom Monitor 2016* (p. 12), available at [https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/m/tm/TKMonitor\\_2015.en.html](https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/m/tm/TKMonitor_2015.en.html) and [https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/m/tm/TKMonitor\\_2016.en.html](https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/m/tm/TKMonitor_2016.en.html), respectively.



**Figure 2: BEREC's estimate of price trends for 2013 medium usage profile in Austria and the average of seven control countries**



Notes: the control countries are BE, DK, ES, EL, IT, PT and SE.

Source: BEREC (2018), Figure 5.

- 44 As well as focusing on prices for new tariffs, BEREC's pricing data ignores handset prices, MVNO prices and changes in data allowances for existing customers. There is some evidence of deflationary effects with respect to each in Austria post-merger.<sup>27</sup> As explained in Appendix A, BEREC's pricing data (which found prices similar to the European average) is also inconsistent with that of the EC (which shows that Austrian customers could acquire a basket with more service volumes at a price significantly below that of other European countries).
- 45 Hougbonon (2015) and Aimene et al. (2019) found that imputed prices for data fell while imputed prices for voice increased. This appears to provide an explanation for the differences between the studies' results. Price increases are found when giving no or relatively little weight to data and price decreases found when considering prices for usage profiles which include more data. Given rapid data use growth in Austria, it is questionable how many customers were taking new tariffs for BEREC's assumed levels of low or medium data usage.
- 46 In summary, a number of studies have considered the effect of the Austrian merger on prices, but we consider that the two main studies finding price increases – RTR (2016) and BEREC (2018) – do not robustly reflect the effects on prices taken by most customers in the years after the merger.
- 47 With respect to effects on quality:
- a. BEREC (2018) suggests that the merged entity's quality dipped before returning to the pre-merger quality of H3G and above the pre-merger quality of Orange. This implies higher average quality for the merged entity's customers. Moreover, BEREC relied on a scoring approach which

<sup>27</sup> For example, Telekom Austria Group Annual Financial Report 2015 states "In Austria, new mobile virtual network operators (MVNOs) entering the market increased competitive pressure, particularly in the no-frills and SIM-only segments. To secure the premium customer business, the subsidy level was again raised significantly and tariffs for existing and new customers were enriched to include additional data volumes and bandwidths in 2015" (p.7).

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changes between years<sup>28</sup> and likely rises in line with users' expectations. As such, a constant (or even lower) score could be consistent with rising quality.

- b. GSMA (2017) found that the merger had positive effects on coverage and led to faster download and upload speeds relative to its control group of countries.
- c. The main conclusion of Ofcom (2020) is that the empirical evidence does not support a positive link between mobile mergers in general and quality. However, Ofcom (2020) does present estimates suggesting that the Austrian merger led to slower download speeds for two years after the merger before the effect disappeared, with speeds returning to the level which Ofcom predicts would have resulted without the merger. We consider that there are methodological issues with the SCG analysis of download speeds, including that: (i) the predictor variables used in the analysis are not important or relevant to download speeds; (ii) industry capex (which is an important determinant of download speeds) is not used as a predictor variable; and (iii) differences in the timing and speed of the rollout of 4G suggest download speeds are not being determined by the same process in the control countries.<sup>29</sup>

48 We have found that following the merger, H3G went from having relatively slow average download speeds to overtake even Telekom Austria in 2015 (Figure 3). T-Mobile then increased its speeds in 2016 to close the gap with the others and the ranking of the three operators has fluctuated since then. We also found that H3G reached almost ubiquitous 4G coverage a year earlier than its competitors.<sup>30</sup> The FCC collects data on mobile download speeds for 28 countries, which showed a significant improvement in Austria's overall country rank: from 20<sup>th</sup> in 2014 to 7<sup>th</sup> in 2016.<sup>31</sup>

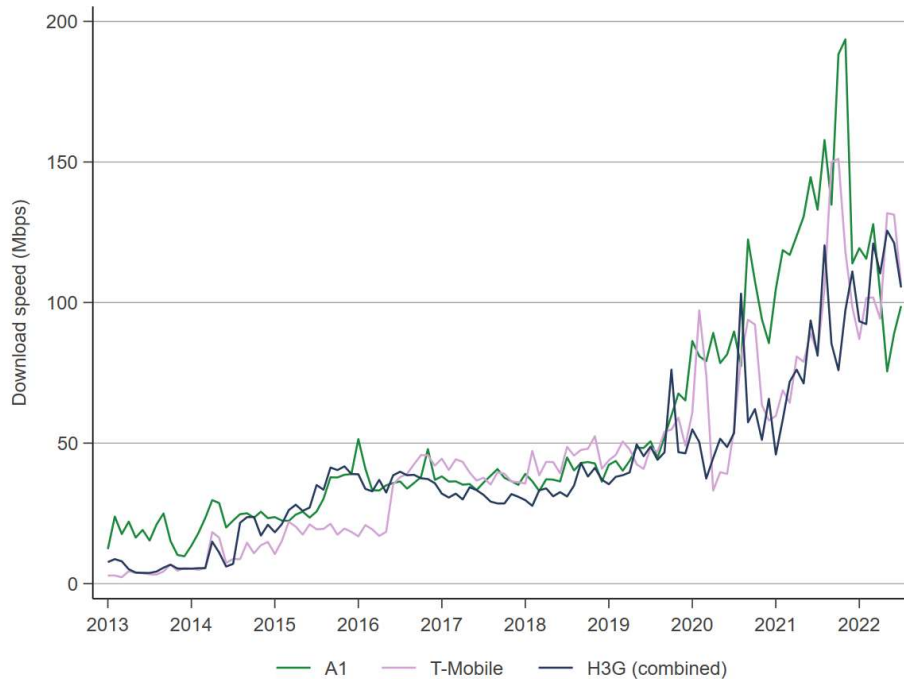
<sup>28</sup> See BEREC (2018), p.87.

<sup>29</sup> These issues are discussed in more detail in Appendix A.

<sup>30</sup> Data from GSMA.

<sup>31</sup> See Federal Communications Commission (2018). *International Broadband Data Report – the Sixth Report*, Table 8, p. 36.

**Figure 3: Average download speed of Austria's operators**



Source: Compass Lexecon analysis based on RTR data.

49 Frontier Economics (2015) found that average revenue per MB in Q4 2014 was lower than what would have been predicted based on the pre-merger trend. This was also before the price falls in 2015 noted by the Austrian Competition Authority (BWB). In section 5, we present new analysis we have undertaken considering data over a longer period post-merger. We similarly found that the rate of decline in market revenue per GB consumed was faster post-merger compared with pre-merger.

50 In summary, we consider that evidence of a faster decline in revenue per GB post-merger is consistent with the merger having contributed to lower quality-adjusted market prices. We do not preclude that some prices for customers taking no or relatively little data were higher for a period following the merger, but such effects soon disappeared. However, even these customers may not have been disadvantaged if they benefitted from lower handset prices, lower prices through MVNOs, and/or improved coverage and speeds – all of which are factors which were not considered in the studies showing temporary price increases for these customer segments.

## 4.2 H3G/O2 merger in Ireland, 2014

51 Table 3 summarises the findings of two studies that have assessed the effects of the Irish H3G/O2 merger in 2014.

**Table 3: Summary of studies assessing the effect of the Irish 2014 merger**

Paper	Findings	Comments
BEREC (2018)	SCG approach shows no statistically significant effect on prices. DiD approach finds a positive effect in the first 6 months after the merger which then disappears except for high-usage basket. The effect on high-usage basket is shown to be not statistically significant once BEREC takes 2014 usage into account.	BEREC's own tests do not consistently find any significant price increases. There are also significant inconsistencies between BEREC's price series, showing a price increase, and those of the EC and ComReg. <sup>32</sup>
Ofcom (2020)	The merger had a negative effect on industry investment. The merger had no impact on average 4G download speeds for the first 18 months post-merger, and then a negative effect after 18 months.	Ofcom does not control for differences in the speed of 4G rollout. There are large differences in the level of capex between Ireland and the control countries which Ofcom ignores by averaging them out. The synthetic control becomes a less accurate and reliable estimate of industry capex within 18 months, and if a five-year pre-merger period is used to construct the synthetic control, then the estimated effects of the merger are not significant. Ofcom's SCG analysis of speed effects in Ireland is subject to the same issues as its analysis for Austria. <sup>33</sup>

- 52 The SCG approach in BEREC (2018) finds no statistically significant effect of the Irish merger on prices. The DiD approach finds a positive price effect of the merger for the first half year after the transaction, which then disappears except for the high-usage basket (and, even in that case, the effect disappears by the second half year when considering 2014 usage).
- 53 As with Austria, rapidly growing data usage over the period suggests that considering only 2013 usage is unlikely to reflect prices that most Irish consumers would be facing in the following years. The evidence in BEREC (2018) suggests the merger may have had, at most, only a very short-term (6 month) effect on prices faced by most Irish customers.
- 54 Even the finding of a price effect in the initial first half year is peculiar to the price series used in BEREC (2018); these data are inconsistent with the price series of the Irish regulator, ComReg, which shows prices falling.<sup>34</sup> EC pricing comparisons suggest that Irish prices for a similar basket have remained around the EU average and not higher, as suggested by BEREC's price series.<sup>35</sup>
- 55 Ofcom (2020) finds that the merger had a negative effect on industry investment and average 4G download speeds. However, Ofcom's synthetic-control prediction of industry capex does not provide an accurate estimate of industry capex in Ireland in the 3 years prior to the merger, and the significance of the estimated effects of the merger disappears if a 5-year pre-merger period is instead used to create the synthetic control. Ofcom's SCG approach for download speeds suffers from the same problems identified in paragraph 47. Ofcom's panel data analysis of download speeds is based on an assumed indirect effect via investment, but Ofcom's finding of an effect on investment uses a panel data model for which the underlying assumption that the process which determines capex per capita is essentially the same across the countries in the Ofcom dataset does not hold. In particular, we find there is considerable variation in the size and significance of the estimated effects between countries. Further, if Ofcom's panel data capex model is re-estimated using data for the same time period used to estimate Ofcom's download speed model based on panel data, then market concentration had no significant effect on industry capex per capita.

<sup>32</sup> Further details on these comments are set out in Appendix A.

<sup>33</sup> Further details on these comments are set out in Appendix A.

<sup>34</sup> This is shown in more detail in Appendix A.

<sup>35</sup> See the discussion of the BEREC study in Appendix A.

- 56 Ofcom (2020) assessed download speed data to 2018. However, integration of the merging parties' network in Ireland was not substantially completed until 2019, as merger clearance required Three to enter into a new network sharing agreement with eir, which also entailed unwinding the existing eir-O2 agreement. Once the integration of the network was completed, there was a significant improvement in Three's average download speeds.<sup>36</sup> Pre-merger H3G had slower average download speeds than Vodafone and eir; now has the fastest network.<sup>37</sup>
- 57 The GSMA network performance index (Figure 1) shows Ireland's ranking increasing from the 26<sup>th</sup> position in 2014 to the 17<sup>th</sup> in 2022.
- 58 In section 5, we present new analysis which finds that average revenue per GB consumed fell at a faster rate the four years following the merger in Ireland, compared with decline that would have been expected based on the pre-merger trend.<sup>38</sup>

### 4.3 O2/E-Plus merger in Germany, 2014

- 59 Table 4 summarises the findings of two studies that have assessed the effects of the German O2/E-Plus merger in 2014.

**Table 4: Summary of studies assessing the effect of the German 2014 merger**

Paper	Findings	Comments
BEREC (2018)	No statistically significant effects under the SCG approach, except for a year and a half after the merger, which seems implausible and is not confirmed by BEREC's robustness tests. The DiD approach finds an effect for low-usage contracts in each period, but effects for medium- and high-usage contracts are generally not found to be robust, and a price effect that only arises a year and a half after the merger seems implausible.	BEREC's analysis does not consistently find significant price increases. There are also significant inconsistencies between BEREC's price series and that of other regulators.
Ofcom (2020)	The merger had no effect on industry capex for 2 years after the merger, and then suggests an apparent decrease in the 3 <sup>rd</sup> and the 4 <sup>th</sup> years. No significant effect on download speeds	There are issues with: the choice of control (i.e., the large weight given to the UK despite the potential for long run effects of the 2010 merger in the UK); not controlling for differences in the time taken to rollout 4G; and Ofcom's choice of predictor variables.

- 60 The SCG approach in BEREC (2018) suggests a single statistically significant price effect only for low-usage tariffs a year and a half after the merger, which seems implausible (given that any change in pricing incentives would be expected to occur from merger completion) and is not confirmed by BEREC's robustness tests. BEREC's DiD approach finds price effects on the low-use basket, with the magnitude of the estimated effect varying significantly under the different robustness tests. BEREC's DiD approach finds an effect for medium-use and high-use baskets in the first half year

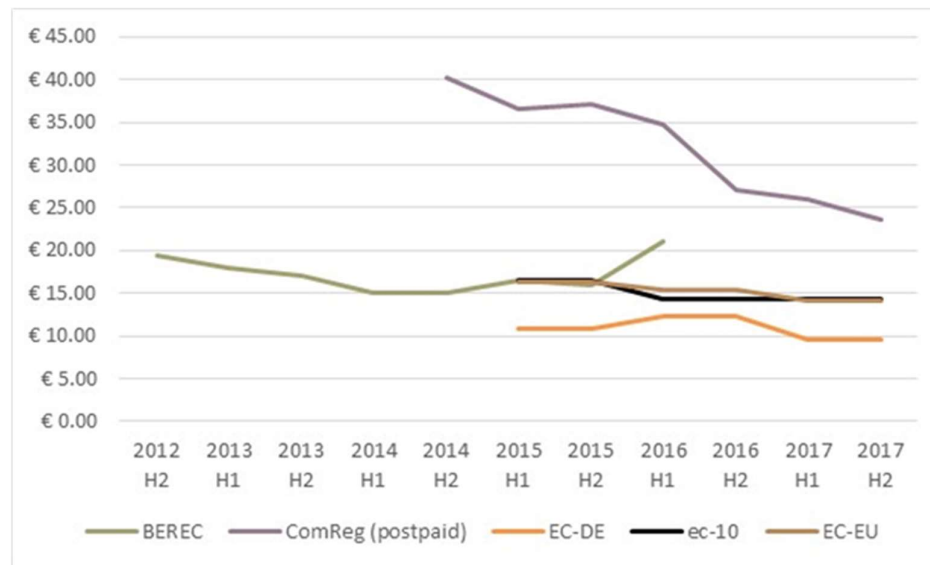
<sup>36</sup> Frontier Economics (2021). *The Impact of Mobile Market Consolidation on Quality*, December 2021, p.26-27. [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0033/237498/three-pt-2.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0033/237498/three-pt-2.pdf)

<sup>37</sup> Frontier Economics (2021). *The Impact of Mobile Market Consolidation on Quality*, December 2021, p. 27. [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0033/237498/three-pt-2.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0033/237498/three-pt-2.pdf); OpenSignal. (2023). *Ireland - Mobile Network Experience Report*, September 2023. <https://www.opensignal.com/reports/2023/09/ireland/mobile-network-experience>

and the third half year after the merger, although the former and, in some cases, the latter are not confirmed by BEREC's robustness tests.

61 The finding in BEREC (2018) of a price impact under some of its approaches seems to result from its pricing data suggesting a significant price increase in Germany in 2015 and 2016. However, these price increases are not found in the ComReg data for Germany which shows falling prices (see Figure 4). The European Commission's price data shows a small potential price increase in 2016, but with prices then being lower in 2017 than 2015. A study for the Canadian regulator found significant falls in prices in Germany for 7 out of 8 baskets over 2014 to 2016, with a small price increase for the remaining basket (of 1.4%).<sup>39</sup>

**Figure 4: BEREC, ComReg and EC price data for German medium-use basket**



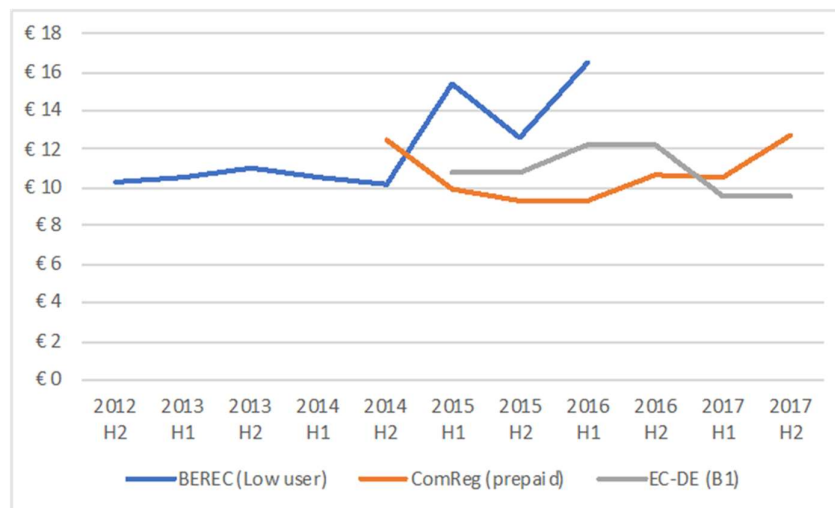
Source: BEREC (2018), ComReg,<sup>40</sup> and EC.<sup>41</sup>

<sup>39</sup> Nordicity. (2016). 2016 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions, p. 96-201. <https://www.nordicity.com/de/cache/work/98/CRTC-%20Price%20Comparison%20Study%20of%20Telecommunications%20Services%202016.pdf>

<sup>40</sup> ComReg's data compiled using an OECD-approved methodology shows prices of 3 mobile phone usage baskets: (1) Prepaid Residential 30 calls (50 mins), 100 SMS and 0.1GB data; (2) Postpaid Residential: 100 calls (182 mins), 140 SMS and 2GB data; and (3) Business: 300 calls (569 mins), 225 SMS and 1 GB data.

<sup>41</sup> The EC has published three mobile broadband price studies: Van Dijk Management Consultants, Mobile Broadband Prices, 2015 and 2016 and Empirica Mobile Broadband Prices in Europe, 2017. The studies use 6 different price baskets to benchmark mobile broadband prices across Europe. We have chosen the EC basket closest to the usage bundle used by BEREC for a medium user in that country.

**Figure 5: BEREC, ComReg and EC price data German medium-use basket**



Source: BEREC (2018), ComReg, and EC.

62 Ofcom (2020) finds that the merger had a negative effect on industry investment after two years, but it had no statistically significant effect on download speeds. However, Ofcom’s analysis of speeds for Germany suffers from the same methodological problems as those described in paragraph 47. As set out in Figure 1, Germany’s network performance improved from 16<sup>th</sup> best in 2014 to 5<sup>th</sup> best in 2022.

63 As set out in section 5, our new analysis of the average annual revenue per GB across all German operators between 2011 and 2018 finds no statistically significant difference in the rate of decline of revenue per GB consumed before and after the acquisition of E-Plus by Telefónica Deutschland in 2014.<sup>42</sup>

#### 4.4 Sprint/T-Mobile merger in US, 2020

64 Table 5 summarises the findings of the only paper we are aware of providing an assessment of the effects of the Sprint/T-Mobile merger in the US, which closed in April 2020.<sup>43</sup>

<sup>43</sup> For completeness, we note that Melody Wang and Fiona Scott Morton published the article ‘*The Real Dish on the T-Mobile/Sprint Merger: A Disastrous Deal From the Start*’ in 2021 (available online at <https://www.promarket.org/2021/04/23/dish-t-mobile-sprint-merger-disastrous-deal-lessons/>). The main source of evidence presented in the article to argue that aggressive price competition is over is a quote from T-Mobile that they have competed mostly on price in the past but now have a premium product. However, to argue that competition on price has diminished would require an analysis of pricing data, which was not presented in the article. The article also argues that the Dish remedy was being undermined by the closure of Sprint’s CDMA network. However, since the publication of the article, Dish and T-Mobile reached an agreement in June 2022 allowing Dish customers to use T-Mobile’s 5G network, while Dish further deploys its own 5G network.

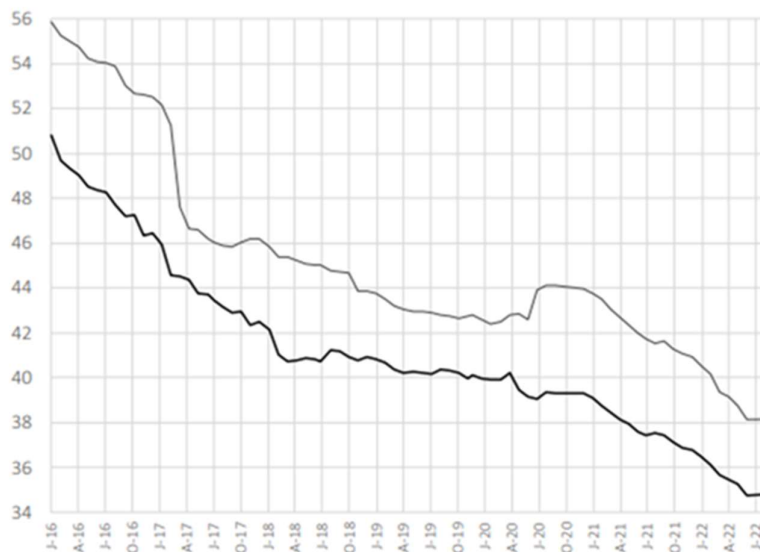
**Table 5: Summary of studies assessing the effect of other mergers**

Paper	Findings	Comments
Asker, J., & Katz, M. L. (2022) <sup>44</sup>	3 months after completion of the merger, a one-period increase in price indexes was followed by return to downward trend (attributed to removal of Sprint data from price index measure). T-Mobile's investments, speed and capacity increased dramatically after the merger. Dish met its rollout target. Evidence of MVNOs undercutting MNO prices.	Analysis labelled as premature, given only 2 years since merger completed. Price indexes do not adjust for quality, and it is likely that quality-adjusted prices fell further. Analysis does not show how prices would have evolved absent the merger.

65

Asker and Katz (2022) present a Producer Price Index and a Consumer Price Index for wireless services published by the US Bureau of Labor Statistics, adjusted for inflation (see Figure 6). The Producer Price Index is a measure of average revenue per subscriber whereas the Consumer Price Index reflects prices available on new tariffs. The indices show a temporary increase in prices available to consumers followed by prices returning to the earlier downward trend, which the authors consider may reflect the removal of Sprint's pricing plans from the data, as opposed to price increases of the other service providers. The authors also note that the index would not have adjusted for Sprint's lower quality services or the take-up of better-quality 5G services, meaning that the indices would understate the decrease in quality-adjusted real prices. However, the price indices on their own do not constitute conclusive evidence on whether prices would have fallen faster or slower absent the merger.

**Figure 6: Pre- and post-merger real producer (bold) and consumer (light) prices for US wireless services**



Notes: The heavy line plots the PPI data for Wireless telecommunications carriers as constructed by the BLS (series id PCU517312517312), after adjusting for changes in the aggregate CPI level (using series id CUUR0000SA0) since January 2016. The lighter solid line plots the CPI data for Wireless telephone service as constructed by the BLS (series id CUUR0000SEED03) and similarly adjusted by the aggregate CPI.

Source: Asker and Katz (10-15-2022), Figure 2, p. 40.

<sup>44</sup> Asker, J., & Katz, M. L. (2022). The Sprint/T-Mobile Merger. *Antitrust Economics at a Time of Upheaval*



A range of evidence shows that, post-merger, investment and quality have grown at a faster rate than pre-merger (although this does not necessarily imply that the improvement was caused by the merger).

- a. Data from CTIA shows that the rate of growth of total investment in the US wireless industry grew much more significantly post-merger than pre-merger; with total investment growing gradually from \$26 billion in 2017 to \$30 billion in 2020, but jumping to \$35 billion in 2021 (i.e., a year after the merger) and then continuing to grow to \$39 billion in 2022.<sup>45</sup>
- b. While, prior to the merger, AT&T and Verizon deployed 5G at a relatively slow pace, following the merger, both operators announced plans to significantly increase their C-band spectrum rollout.<sup>46</sup>
- c. Prior to the merger, AT&T had the fastest download speeds (27.5 Mbps), T-Mobile and Verizon were slower with similar speeds (25.8 Mbps and 25.3 Mbps respectively), and Sprint the slowest speeds (23.9 Mbps).<sup>47</sup> A July 2023 Opensignal report states that T-Mobile's download speed has grown to be over double its competitors (see Figure 7) and that T-Mobile leads across most mobile experience categories.<sup>48</sup> An Ookla report on evidence from New York and Philadelphia, where T-Mobile was first able to utilise Sprint's spectrum, shows large increases in download speeds following the merger.<sup>49</sup>

<sup>45</sup> CTIA. (2023). *2023 Annual Survey Highlights*. <https://www.ctia.org/news/2023-annual-survey-highlights>.

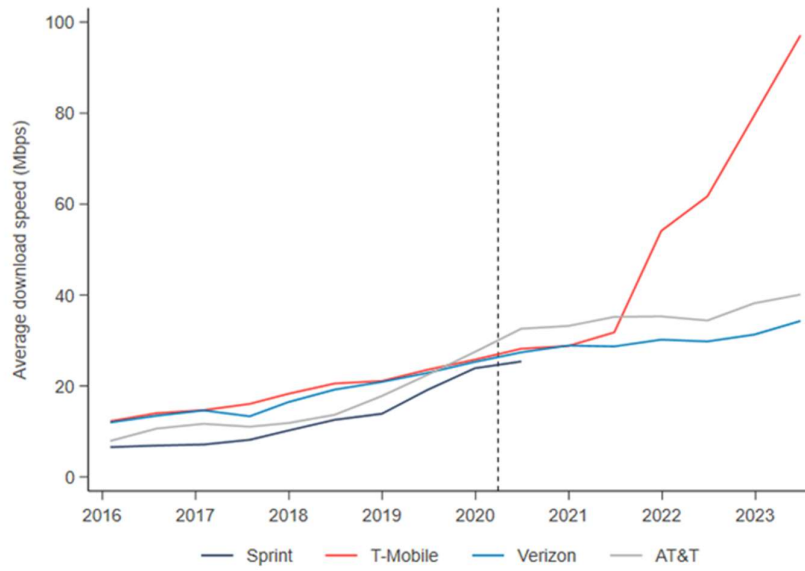
<sup>46</sup> Following the transaction, AT&T announced plans to cover 70 to 75 million people with its C-Band rollout by the end of 2022. In February 2023, the company announced its coverage reached 150 million people at the end of 2022. Verizon's plans originally had it reaching 175 million points of presence (POPs) by the end of 2023. It recently passed 200 million POPs covered. Further, T-Mobile launched its 5G standalone network in 2020 with AT&T and Verizon launching 5G standalone in 2022. Light Reading (2023). *Standalone 5G progress remains 'a disappointment'*. <https://www.lightreading.com/mobile-core/standalone-5g-progress-remains-a-disappointment->

<sup>47</sup> OpenSignal. (2020). *USA - Mobile network experience report*, January 2020. <https://www.opensignal.com/reports/2020/01/usa/mobile-network-experience>

<sup>48</sup> OpenSignal. (2023). *USA - Mobile network experience report*, July 2023. <https://www.opensignal.com/reports/2023/07/usa/mobile-network-experience>

<sup>49</sup> Ookla. (2020). *How T-Mobile's Merger with Sprint is Changing the Game for 5G*, May 2020. <https://www.ookla.com/articles/t-mobile-merger-sprint-changing-5g>

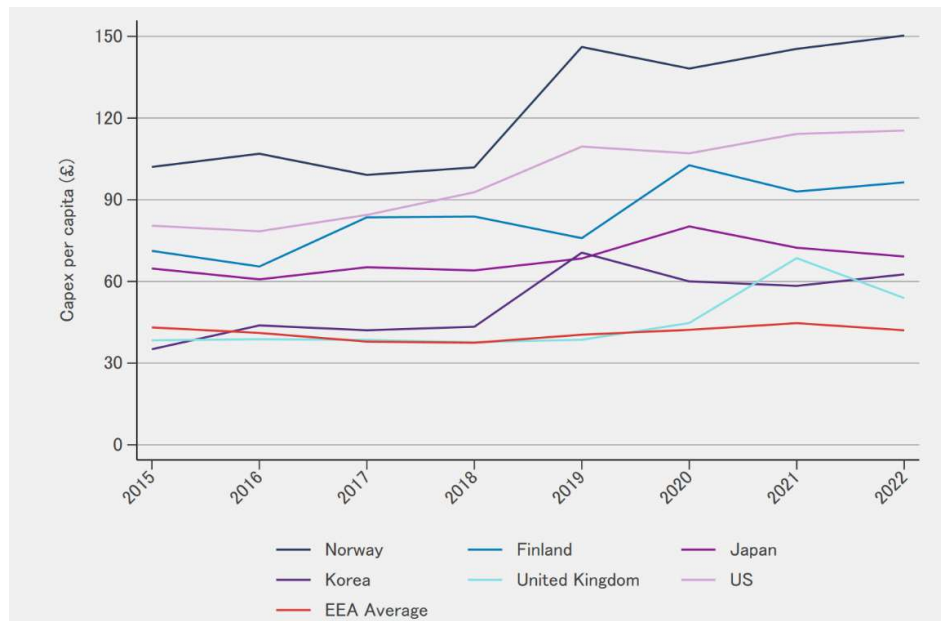
**Figure 7: Average download speed (Mbps, February 2016 – July 2023), all technologies**



Notes: Download speeds are based on user measurements.  
Source: Opensignal.

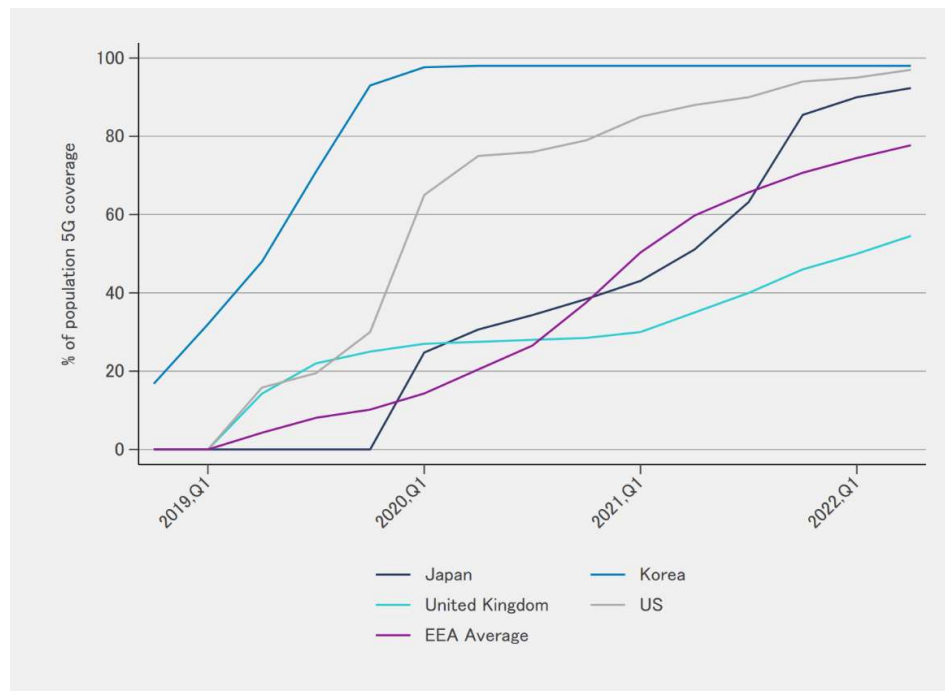
d. Mobile capex per capita and 5G coverage are relatively high in the US compared with the EEA average (see Figure 8 and Figure 9).

**Figure 8: Mobile capex per capita**



Source: Compass Lexecon analysis based on data from GSMA intelligence.

**Figure 9: Per cent of population covered by at least one 5G network**



Source: Compass Lexecon analysis based on data from GSMA intelligence.

67 As set out in section 5, our new analysis of the average annual revenue per GB consumed across all US operators finds no statistically significant difference in the rate of decline of revenue per GB consumed before and after the Sprint/T-Mobile merger in 2020.

#### 4.5 Other recent mergers

68 We have conducted empirical analyses of two additional recent mergers that have not been studied in published literature:

- a. the Italian Wind/Tre merger in 2016; and
- b. the Dutch Tele2/T-Mobile merger in 2018.

69 The 2016 Wind/Tre merger in Italy initially reduced the number of network operators from four to three, but the commitments agreed with the EC allowed the entry of Iliad in May 2018 as a new mobile network operator, so that the four-player structure was restored. The Italian regulator's mobile price index<sup>50</sup> indicates that prices remained around their pre-merger level in the 1.5 years following the merger and then fell sharply starting in 2018, which was likely, at least in part, caused by the entry of Iliad. Concerning network quality, both parties were lagging the other operators pre-merger. Wind Tre improved its network quality dramatically to become the fastest network in the market in early 2020.<sup>51</sup> Italy's network performance, as ranked by the GSMA Mobile Connectivity Index, went from the 24<sup>th</sup>-best in Europe in 2014 to 21<sup>st</sup>-best in 2022 (see Figure 1). As set out in

<sup>50</sup> Mobile telephony price index quarterly series, reported by AGCOM, from ISTAT.

<sup>51</sup> OpenSignal. (2020). *Italy - Mobile network experience report*, May 2020. <https://www.opensignal.com/reports/2020/05/italy/mobile-network-experience>; Ookla SpeedTest award, Q1-Q2 2020 (available at: [https://www.speedtest.net/awards/italy/2020/?time\\_period=q1-q2](https://www.speedtest.net/awards/italy/2020/?time_period=q1-q2)).

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- section 5, we have found that revenue per GB consumed fell at the same rate post-merger as pre-merger.<sup>52</sup>
- 70 In the Netherlands, Tele2 and T-Mobile merged at the end of 2018. Nominal prices were 5.4% lower one year after the merger, and 2.4% lower 2 years after the merger.<sup>53</sup> The EC's price benchmarking found that mobile prices in the Netherlands fell relative to other countries following the merger. In particular, the EC found that mobile prices in the Netherlands were 7% below the EU average in 2018 (average across the results for the different mobile usage baskets considered),<sup>54</sup> while in 2023 they were 23% below the EU average in 2020 (average across the results for the different mobile usage baskets considered and noting some differences to the usage considered in 2018).<sup>55</sup>
- 71 Since the merger, network quality has improved in the Netherlands, increasing the country's position in the GSMA ranking from 4<sup>th</sup> position (2014, pre-merger) to 2<sup>nd</sup> position (2022, post-merger) in Europe (see Figure 1). 5G population coverage in the Netherlands was 95% in Q2 2022 compared with 55% in the UK.<sup>56</sup>
- 72 As set out in section 5, we calculate the average quarterly revenue per GB consumed across all Dutch operators and find that revenue per GB fell at a slower rate following the merger.<sup>57</sup> However while this might suggest that the merger slowed the rate of price decline, given that the EC found that Dutch mobile prices fell relative to other countries post-merger, the slower rate of post-merger decline following 2019 may instead reflect that the pre-merger rate of decline may have been unsustainable. Indeed, comments by the EC in its T-Mobile/Tele2 merger decision suggests that the pre-merger rate of decline in average revenue per GB might not have been sustained in the Netherlands absent the merger.<sup>58</sup>

<sup>52</sup> Based on measures of mobile service revenues by market divided by market mobile data traffic. Test undertaken with respect to a logarithmic trend, considering four years before and after the merger. See Appendix B for sources and methodology.

<sup>53</sup> Eurostat HICP Wireless telephone services monthly series.

<sup>54</sup> European Commission, Directorate-General for Communications Networks, Content and Technology, (2018). *Mobile broadband prices in Europe 2018: final report and executive summary*, p. 76. Publications Office. <https://data.europa.eu/doi/10.2759/137481>

<sup>55</sup> European Commission, Directorate-General for Communications Networks, Content and Technology, (2020). *Retail Broadband Prices in Europe 2020*, p. 270.

<sup>56</sup> Compass Lexecon analysis based on GSMA Intelligence data.

<sup>57</sup> Based on measures of mobile service revenues by market divided by market mobile data traffic, and voice and SMS traffic converted to GB equivalent following Abdirahman et al. (2020). Test undertaken with respect to a logarithmic trend, considering the period starting four years before and after the merger and ending in Q2 2018, when Iliad entered the Italian market. See Appendix B for sources, and methodology and results with the post-merger period lasting three, four or five years after the 2016 merger.

<sup>58</sup> For example, see EC T-Mobile NL/Tele2 NL merger decision (2018), p.489, p.453, and p.511 ("The additional capacity resulting from this spectrum increased the ability and incentive of market players to compete more aggressively for new subscribers by offering larger data bundles coupled with lower prices.").

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## 5 ANALYSIS OF THE RATE OF DECLINE IN REVENUE PER GB

73 Studies of post-merger effects in mobile markets have tended to either investigate price effects or quality effects or, if both are considered, to do so without seeking to determine what is likely to be the overall impact on consumers.

74 Consumer welfare will be impacted by the combination of price and quality effects. Hedonic pricing approaches can enable the combination of effects to be assessed by using estimates for customers' valuation of quality changes. However, a hedonic approach would be data-intensive if it is to capture all factors that customers value including bandwidth, average and variability in download and upload speeds, coverage and latency.

75 Officials at the ONS and academics have examined how to assess telecommunications price changes taking into account quality changes. One approach they propose is to use total revenues in the industry divided by total data volume. In particular, Abdirahman et al. (2020) note that the approach:

*“...better reflects the significant technical advances and quality improvements observed in telecoms services, and is capable of capturing in a simple measure a variety of quality aspects without further adjustment: increased coverage, for example, allows more people to get access to telecommunications services and thus increases data traffic. Likewise, an increase in speed increases volume as users can consume more data in any given time period. Finally, future changes in technology may be more easily reflected in a data usage based deflator. This is because, as long as the service is defined as the transport of data, any new technology or service will be adding to the volume of data. The impact that the new service will have on prices is then determined by its impact on total revenue relative to its impact on total volume.”<sup>59</sup>*

76 As Abdirahman et al. (2020) note, considering average revenue per unit of data allows capturing the impact of quality changes over time. In this paper, we assess changes in the rate of decline in average revenue per GB as a parsimonious indicator of changes in quality-adjusted market prices. In this regard, while we do not consider it to be a perfect measure of quality-adjusted market prices (in that it is unlikely to fully capture quality changes), we consider that it provides a reasonable and practical indicator to assess a merger's effect on quality-adjusted prices by testing whether there was a change in the logarithmic trend rate of decline in average revenue per GB.<sup>60</sup>

77 A drawback of average revenue per GB, as the authors note, is that it ignores different prices currently charged for different services. A benefit of our meta-study is that we present the various price effects found across studies. This can help identify whether there were any significant groups of consumers who faced higher prices from a merger. If this was the case, it would also be necessary to consider to what extent they also experienced quality changes to identify whether they benefitted or were harmed overall.

<sup>59</sup> Abdirahman, M. et al. (2020). A Comparison of Deflators for Telecommunications Services Output. *Economie et Statistique*, 517-518–519, p. 116.

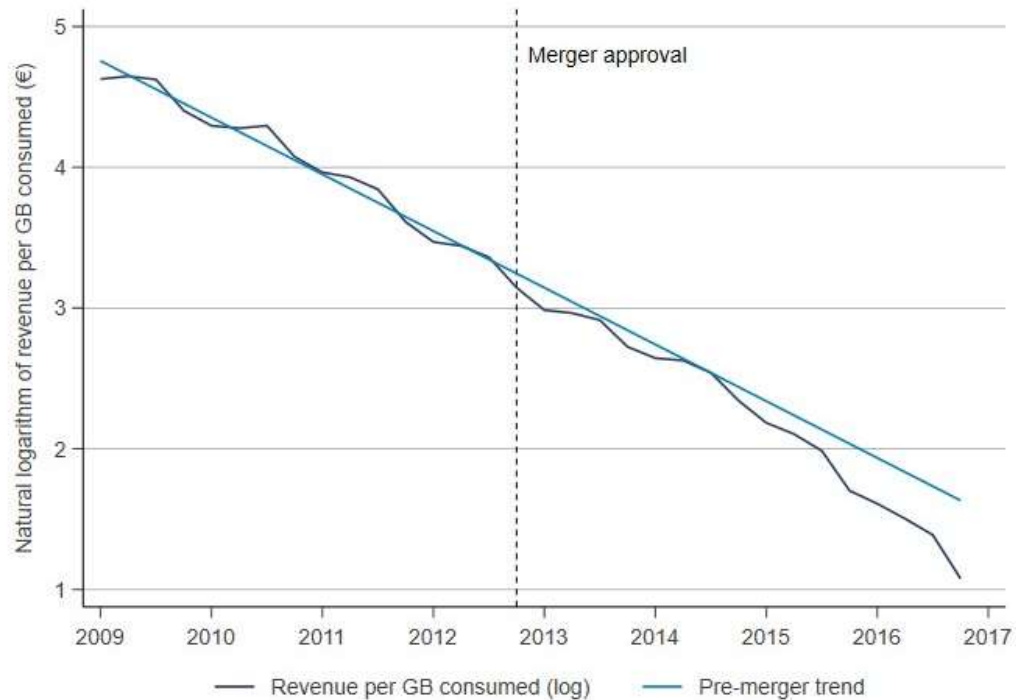
<sup>60</sup> We use a logarithmic trend to reflect that the rate of decline in revenue per GB tends to fall at a decreasing rate over time (e.g., see Abdirahman et al. (2020), Figure VI).

78 This section summarises the results of our analysis of whether the four-to-three mergers led to a statistically significant change in the rate of decline in average revenue per GB of data consumed.<sup>61</sup>

## 5.1 Austria

79 Our analysis compares the rate of decline in market-wide average revenue per GB consumed in the four years post-merger with the rate of decline in the four-years pre-merger.<sup>62</sup> We find that the post-merger rate of decline was faster, which is consistent with the merger having led to lower unit prices (as illustrated in Figure 10).

**Figure 10: Evolution of average revenue per GB in Austria**



Source: Based on measures of mobile service revenues divided by market mobile data traffic, and voice and SMS traffic (converted to GB equivalent following Abdirahman et al. (2020)), sourced from Rundfunk und Telekom Regulierungs-GmbH (RTR). Test undertaken with respect to a logarithmic trend, considering four years before and after the merger. See Appendix B for sources, methodology and statistical significance.

80 As noted above, a drawback of the reliance on average revenue per data unit is that it takes no account of differences in prices of different services. This could be an issue if there were quite different effects on a significant customer segment. However, we have found that evidence of price increases is limited to voice bundles and low data usage bundles, which only relatively few customers would have been buying, particularly from the end of 2014 onwards.

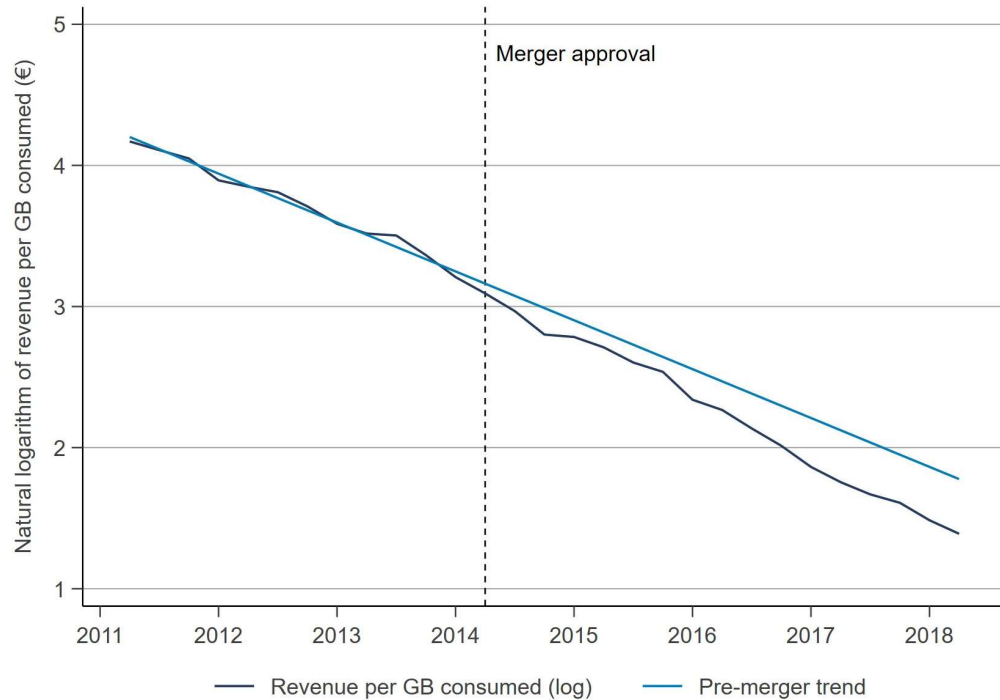
<sup>61</sup> More details are set out in Appendix B.

<sup>62</sup> As noted in Appendix B, we consider a four-year period (rather than a shorter period) so that the post-merger period would be likely to include some of the effect of network integration. In Appendix B, we also consider alternative period lengths.

## 5.2 Ireland

81 Our analysis finds that, in the four years following the merger, the average revenue per GB consumed declined faster than would have been expected given the pre-merger trend (see Figure 11).

**Figure 11: Evolution of average revenue per GB in Ireland**

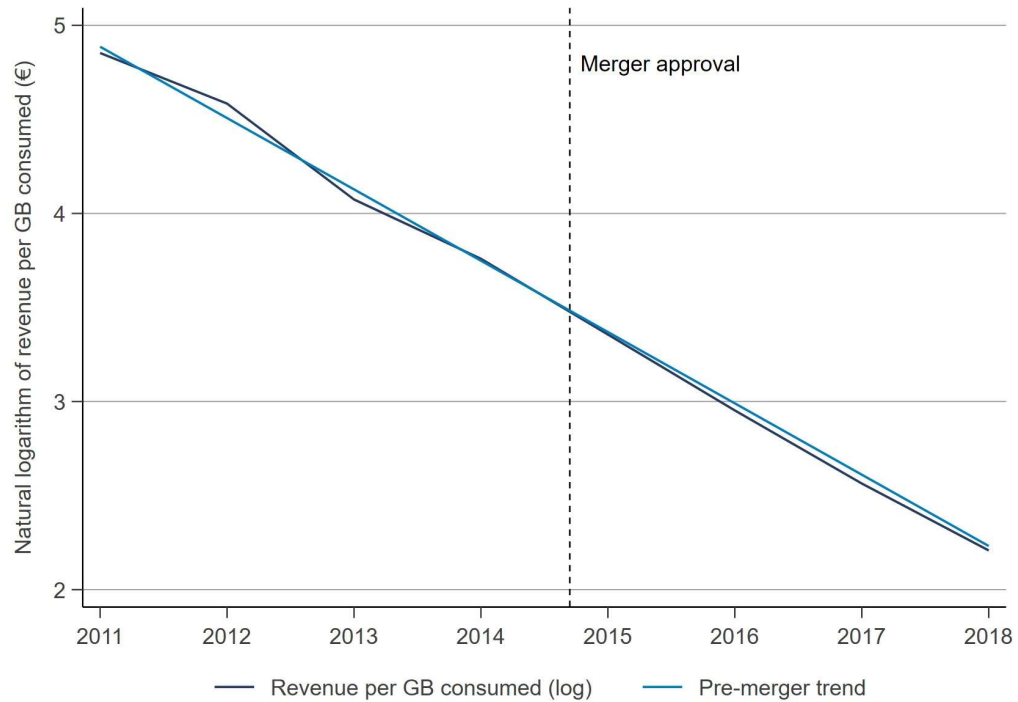


Source: Based on measures of mobile service revenues divided by market mobile data traffic, and voice and SMS traffic (converted to GB equivalent following Abdirahman et al. (2020)), sourced from Commission for Communications Regulation (ComReg). Test undertaken with respect to a logarithmic trend, considering four years before and after the merger. See Appendix B for sources, methodology and statistical significance.

## 5.3 Germany

82 We calculated the average annual revenue per GB consumed across all German operators in the period from 2011 to 2018. We find no statistically significant difference between the rates of decline of revenue per GB consumed before and after the acquisition of E-Plus by Telefónica Deutschland in 2014 (see Figure 12).

**Figure 12: Evolution of average revenue per GB in Germany**



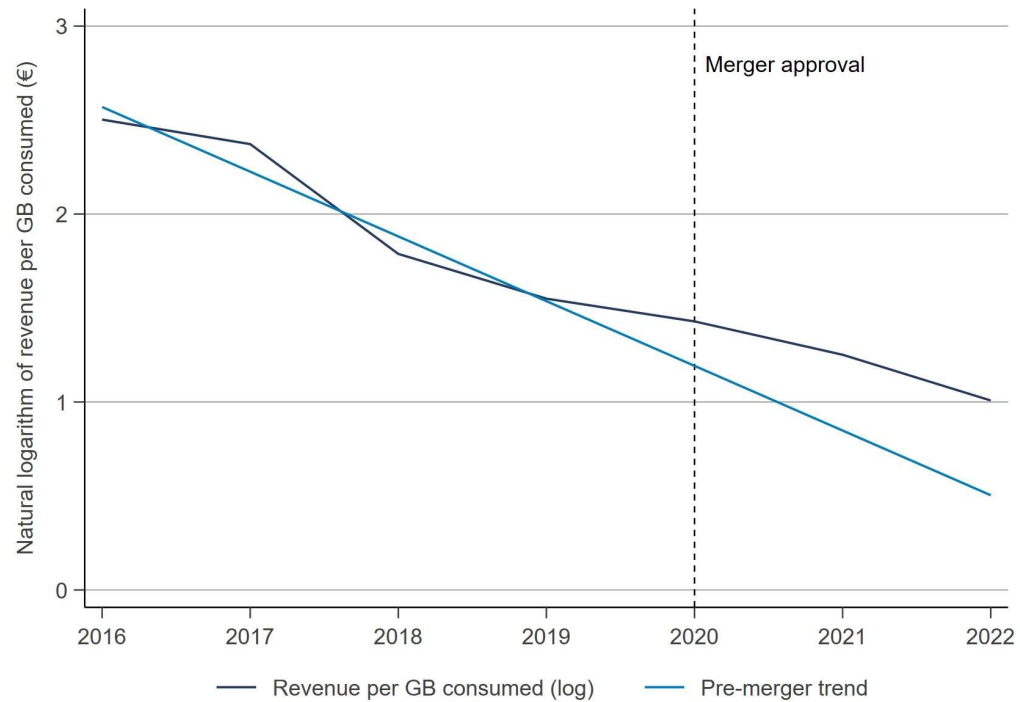
Source: Based on measures of mobile service revenues divided by market mobile data traffic, and voice and SMS traffic (converted to GB equivalent following Abdirahman et al. (2020)), sourced from Bundesnetzagentur. Test undertaken with respect to a logarithmic trend, considering four years before and after the merger. See Appendix B for sources, methodology and statistical significance.

## 5.4 USA

83 We calculated the average annual revenue per GB consumed across all US operators between 2016 – 2022. We found no statistically significant difference between the rates of decline of revenue per GB consumed before and after the Sprint/T-Mobile merger in 2020 (see Figure 13).



**Figure 13: Evolution of average revenue per GB in USA**



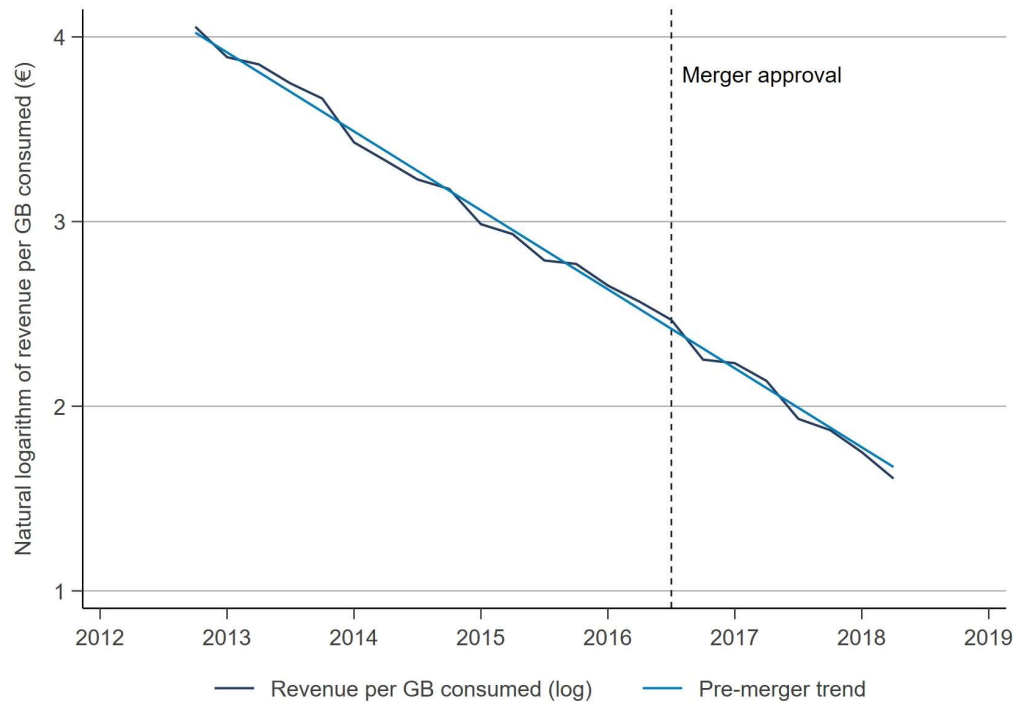
Source: Based on measures of mobile service revenues by market divided by market mobile data traffic, and voice and SMS traffic (converted to GB equivalent following Abdirahman et al. (2020)), using (i) recurring revenue from GSMA<sup>63</sup> and (ii) usage data from CTIA. Test undertaken with respect to a logarithmic trend, considering four years before the merger and considering all available data (ending in 2022) for the post-merger period. See Appendix B for sources, methodology and statistical significance.

## 5.5 Italy

84 We have calculated the average annual revenue per GB consumed across all Italian operators. We have focused on the post-merger period ending Q2 2018, as this was the quarter in which Iliad launched services in Italy and restored the four-operator structure of the market. We find no statistical difference between the rates of decline of revenue per GB consumed before and after the merger (see Figure 14). As set out in more detail in Appendix B, when extending the post-merger period to 3, 4, and 5 years, which includes the period after Iliad's entry, we find a statistically significant faster decline in average revenue per GB post-merger.

<sup>63</sup> Note that these are nominal revenues and therefore price increases may be driven by changes in the overall price level. This is a caveat to the analysis of the U.S. market in particular, as the post-merger period of 2020 – 2022 coincided with a period of high inflation.

**Figure 14: Evolution of average revenue per GB in Italy**



Source: Based on measures of mobile service revenues divided by market mobile data traffic, using (i) recurring revenue from GSMA and (ii) usage data from AGCOM. Usage data excludes voice and text traffic because it is not reported by in AGCOM data traffic statistics. Test undertaken with respect to a logarithmic trend, considering four years before the merger and considering the post-merger period ending Q2 2018. See Appendix B for sources, methodology and statistical significance.

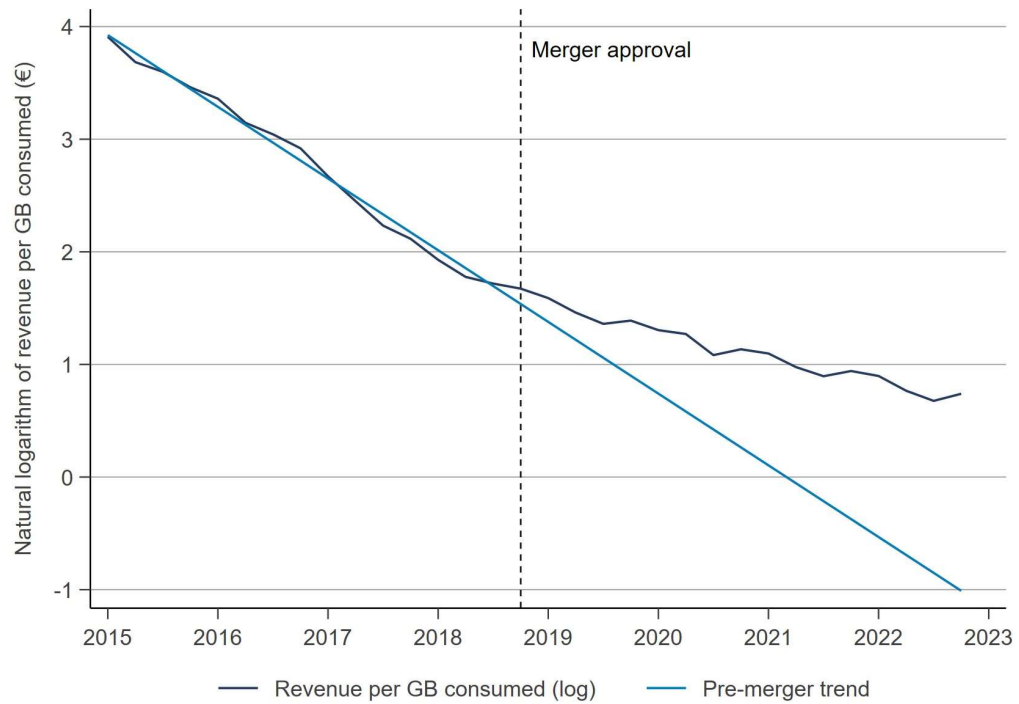
## 5.6 Netherlands

85 We calculated the average quarterly revenue per GB consumed across all Dutch operators between 2015 – 2022. We found that revenue per GB fell at a slower rate following the merger (see Figure 15).

86 While this might suggest that the merger slowed the rate of price decline, given that the EC found that Dutch mobile prices fell relative to other countries post-merger, the slower rate of decline from 2019 forward might also reflect that the pre-merger rate of decline (particularly driven by very rapid growth in data volumes) may have been unsustainable. The EC's merger decision suggests that the pre-merger rate of decline in average revenue per GB might not have been sustained absent the merger. It notes that Tele2's competitiveness and quality was declining and that some of the pre-merger decline in prices was the result of significant additional capacity from the deployment of new spectrum.<sup>64</sup>

<sup>64</sup> See Case M.8792 - T-Mobile NL/Tele2 NL (2018), p.489, p.511 and p.453 ("The additional capacity resulting from this spectrum increased the ability and incentive of market players to compete more aggressively for new subscribers by offering larger data bundles coupled with lower prices.").

**Figure 15: Evolution of average revenue per GB in Netherlands**



Source: Based on measures of mobile service revenues by market divided by market mobile data traffic, and voice and SMS traffic (converted to GB equivalent following Abdirahman et al. (2020)), using (i) recurring revenue data from GSMA and (ii) usage data from the ACM. Test undertaken with respect to a logarithmic trend, considering four years before and after the merger. See Appendix B for sources, methodology and statistical significance.

## 6 STUDIES ON THE EFFECT OF CONCENTRATION ON PRICES, INVESTMENT AND QUALITY

- 87 There are a number of studies that have examined the relationship between mobile market concentration and market outcomes, including cross-sectional analyses that compare geographic markets with different concentrations at a given point in time, as well as analyses based on panel data that take into account both differences in concentration across countries and changes in concentration over time. This section considers these studies in more detail.
- 88 Table 6 summarises the approach and findings of the relevant papers that we are aware of which assess the relationship between mobile market concentration and market outcomes.

**Table 6: Summary of studies analysing the impact of concentration on market outcomes**

Paper	Approach	Findings	Comments
CERRE (2015) <sup>65</sup>	Panel analysis of 33 OECD countries (2002 - 2014) analysing the relationship between (i) number of operators and (ii) HHI index on prices paid by customers and industry-level capex.	Four-to-three mergers in a market with symmetric operators would cause prices to increase by 16.3%, while country-level capex would remain stable. Market exits had increased prices by only 4.3% (with significance at the 10% level), which the authors attribute to mergers mainly involving smaller operators.	Results suggest a four-to-three merger between relatively small players may lead to much lower price increases than for a merger between players with 25% share each. The paper also suggests that mobile mergers may lead to quality improvement, such that impact on consumer welfare may depend on the balance of quality and price effects.
Csorba and Papai (2015) <sup>66</sup>	Panel analysis of 27 European countries (2003 – 2010) analysing the relationship between a series of 'shock dummies', including entry and mergers, and prices.	The effect of entries and mergers depend on the number of active operators and the type of entrant. With respect to 4-to-3 mergers, the study finds no significant price rise in the first two years after the merger, and a 29% increase in the third year only. For 5-to-4	Only one 4-to-3 merger covered by the data. No price change for two years and then a price increase does not seem a plausible merger effect.

<sup>65</sup> CERRE. (2015). *Evaluating Market Consolidation in Mobile Communications*. [https://cerre.eu/wp-content/uploads/2020/07/150915\\_CERRE\\_Mobile\\_Consolidation\\_Report\\_Final.pdf](https://cerre.eu/wp-content/uploads/2020/07/150915_CERRE_Mobile_Consolidation_Report_Final.pdf)

<sup>66</sup> Csorba and Papai. (2015). *Does one more or one less mobile operator affect prices? A comprehensive ex-post evaluation of entries and mergers in European mobile telecommunication markets*. <https://www.econstor.eu/bitstream/10419/129867/1/834392011.pdf>

**Table 6: Summary of studies analysing the impact of concentration on market outcomes**

		mergers, it finds no price-increasing effects.	
Frontier Economics (2015) <sup>67</sup>	Estimates whether concentration impacts capex per subscriber.	No statistically significant difference is found using several different measures of concentration.	Notes that a finding that greater concentration does not lead to higher overall investment could be consistent with higher quality-enhancing investment if duplicative costs are saved.
WIK (2015) <sup>68</sup>	Estimates relationship between concentration (HHI) and investment.	HHI is found to have no statistically significant impact on investment at the country or operator level.	Relies on limited data.
Ofcom (2016) <sup>69</sup>	Panel analysis of 25 countries for which data were available (2010 – 2015), estimating the relationship between the concentration and the existence of 'disruptive' MNOs and price.	Presence of disruptive MNO associated with prices being 12% lower than in markets without a disruptive MNO; prices decrease by around 8% where one additional (non-disruptive) operator is present.	The study's baseline results consider the combined price of tariffs and handsets; when considering the prices of tariffs alone, the study finds small price effects; Ofcom's measure of price does not account for the take-up of tariffs. Analysis fails to account for quality apart from whether a tariff is 4G or not.
Jeanjean and Hounbonon (2017) <sup>70</sup>	Analysis of impact of changes in the number of operators on investment at operator and firm level.	More operators in a symmetric market are associated with less industry investment in the short-run and more investment in the long-run.	Notes that changes in investment need not imply changes in quality.
Wellman (2019) <sup>71</sup>	Panel analysis of 14 European countries (2011 – 2016), estimating the relationship measures of MNO network quality and the number of MNOs	Reductions in market players and increases in HHI may increase network quality.	This paper estimates that a reduction in the number of players has a lower positive effect compared to other studies, which the authors note may be driven by differences in the mergers contained in their dataset.
Ofcom (2020)	Panel analysis of 30 European countries	Evidence that higher mobile consolidation is associated with	Predominantly measures the impact of new entry rather than mergers; assumptions of its methodology are not tested and may not hold;

<sup>67</sup> Frontier Economics (2015). *Assessing the case for in-country mobile consolidation: A report prepared for the GSMA*. [https://www.gsma.com/publicpolicy/wp-content/uploads/2015/05/Assessing\\_the\\_case\\_for\\_in-country\\_mobile\\_consolidation.pdf](https://www.gsma.com/publicpolicy/wp-content/uploads/2015/05/Assessing_the_case_for_in-country_mobile_consolidation.pdf)

<sup>68</sup> WIK Consult. (2015). *Competition & investment: An analysis of the drivers of investment and consumer welfare in mobile telecommunications*. [https://www.wik.org/fileadmin/files/\\_migrated/news\\_files/Competition\\_and\\_investment\\_mobile\\_telecommunications.pdf](https://www.wik.org/fileadmin/files/_migrated/news_files/Competition_and_investment_mobile_telecommunications.pdf)

<sup>69</sup> Ofcom. (2016). *A cross-country econometric analysis of the effect of disruptive firms on mobile pricing*.

<sup>70</sup> Jeanjean, F. and G. Hounbonon. (2017). Market structure and investment in the mobile industry. *Information Economics and Policy*, 38, 12-22.

<sup>71</sup> Wellman. (2019). *Hello . . . Are You Still There? An Empirical Analysis How Market Structure Affects Quality of Mobile Networks*. <https://www.econstor.eu/bitstream/10419/203579/1/VfS-2019-pid-27694.pdf>

**Table 6: Summary of studies analysing the impact of concentration on market outcomes**

	(2000 – 2018 for investment; and 2011 – 2018 for quality).	lower investment and lower average 4G download speeds.	comes to conclusions on capex based on nominal rather than real measure; does not account for cross-country differences in the rollout of 4G.
	SCG to review Austrian, Irish and German mergers (all four-to-three), to review effect on prices and download speeds.		
Rewheel (2020) <sup>72</sup>	Groups 41 countries into three-MNO markets, four-MNO markets, and transitioning markets (markets that have been transitioning from four to three or three to four MNO) and compares median prices across these.	Median monthly price of 4G and 5G plans with at least 1000 minutes in four-MNO markets was a little over half the price of equivalent plans in three-MNO markets” and “the median gigabyte price in four-MNO markets was a quarter of the price in three-MNO markets.	Ignores any price differences between the countries within these groups and presents only the median price within each group, which can mask a significant variation in prices within these groups. These median prices may bear little to no relationship with the actual purchasing decisions of consumers and, therefore, with the outcome of competition between MNOs. Rewheel’s simple comparison of prices and concentration will not capture many other factors which are relevant to consumers. Rewheel argues that non-competition factors have no relationship with price, but does not test for the joint significance of these factors.
GSMA (2020) <sup>73</sup>	Panel analysis of 29 European countries (2011 – 2018), estimating the relationship between various measures of MNO network quality and capex per operator; and various measures of market concentration.	More concentrated markets lead to greater capex per operator, greater speed of 4G rollout, and lower latency.	The study’s results with respect to the speed of 4G rollout and lower latency are not statistically significant for all of its robustness tests.
Woroch (2020) <sup>74</sup>	Estimates the relationship between concentration in holding of spectrum and subscriber penetration rates, coverage, and speeds in the U.S. across	Finds an inverted U-shaped relationship between concentration and subscriber penetration rates, with the vast majority of US CMAs lying in the increasing portion of the inverted-U. Generally finds	An inverted U-shaped relationship implies that the impact of a change in concentration depends on which part of the curve the market is in initially.

<sup>72</sup> Rewheel research. (2020). *4G&5G prices are 2x to 4x lower in markets with four MNOs*. [https://research.rewheel.fi/downloads/4G\\_5G\\_prices\\_2x\\_to\\_4x\\_lower\\_in\\_markets\\_with\\_4\\_MNOs\\_PUBLIC.pdf](https://research.rewheel.fi/downloads/4G_5G_prices_2x_to_4x_lower_in_markets_with_4_MNOs_PUBLIC.pdf)

<sup>73</sup> GSMA. (2020). *Mobile market structure and performance in Europe*. <https://www.gsma.com/publicpolicy/resources/mobile-market-structure-and-performance-in-europe>

<sup>74</sup> Woroch. (2020). *Spectrum Concentration and Performance of the U.S. Wireless Industry*. GSMA. (2020). *Mobile market structure and performance in Europe*. <https://www.gsma.com/publicpolicy/resources/mobile-market-structure-and-performance-in-europe>

**Table 6: Summary of studies analysing the impact of concentration on market outcomes**

	different Cellular Market Areas (CMAs).	greater spectrum concentration associated with higher coverage, speeds and reliability.	
Frontier Economics (2021)	Panel analysis for 30 European countries (2009-2020), estimating the relationship between investment per connection and mergers/entry	No evidence of a positive or negative impact of consolidation on investment per connection or on average download speeds.	Focus on period from 2009 is likely to better reflect current mobile markets than the period in the early 2000s before strong data take-up.
Bahia and Castells (2022) <sup>75</sup>	Panel analysis of 29 countries (2011 – 2021), estimating the relationship between performance and investment outputs of particular MNOs and market competition measures (HHI, or number of operators)	No statistically significant relationship between market structure and ARPU, or 1GB or 5GB price baskets. No statistically significant relationship between concentration and country-level investment. Higher concentration associated with faster download speeds.	The findings with respect to download speeds have the clearest implication for benefits to consumers. No relationship between concentration and investment may imply that quality-enhancing investment is higher because fewer operators would avoid duplicative investment. The study covers a period in which 4G was being deployed as well as initial 5G deployments.
Rewheel (2022) <sup>76</sup>	Six scatterplots compare various measures of smartphone plans prices against an adjusted Herfindahl-Hirschman Index (HHI). Shows changes in market price for different groups of countries: (i) three groups of countries - those with three or fewer MNO, those with four or more MNOs, and markets in transition (four to three or three to four MNOs) - and (ii) two groups of	Positive correlation between concentration and prices by plotting a line of best fit through scatterplot of HHI and the price of smartphone plans.	Fails to control for factors that might influence both price and the level of concentration in a country, hence no basis for a finding that higher concentration drives higher prices. Rewheel compares prices to six factors unrelated to concentration and finds no statistically significant bilateral relationships, but does not test for the combined statistical significance of these factors. Rewheel's use of the median or minimum prices across all plans gives all plans equal weight regardless of the degree to which consumers have actually purchased different plans, and may therefore bear little relationship with the actual purchasing decisions of consumers. Rewheel attempt to ensure comparability of prices across countries by capturing prices only for smartphone plans with at least 1000 mins and 10 Mbit/s peak speed, and varying levels of data allowance. However, this comparison will be based on significantly different levels of quality, including network capacity, average speed, service reliability, and the presence of innovative tariffs. Therefore, simple correlation of prices and concentration

<sup>75</sup> Bahia, K., Castells, P. (2022). *The Dynamic Effects of Competition on Investment: the Case of the European Mobile Communications Industry*. [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=4175243](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4175243)

<sup>76</sup> Rewheel research. (2022). *Mobile prices are 2x to 5x lower in markets with 4 or more MNOs*. [https://research.rewheel.fi/downloads/Mobile\\_prices\\_\\_2\\_to\\_5\\_times\\_lower\\_in\\_markets\\_with\\_4\\_MNOs\\_PUBLIC\\_VERSION.pdf](https://research.rewheel.fi/downloads/Mobile_prices__2_to_5_times_lower_in_markets_with_4_MNOs_PUBLIC_VERSION.pdf)

**Table 6: Summary of studies analysing the impact of concentration on market outcomes**

	countries - those with no maverick MNO present and those with at least one maverick MNO present.		will not capture many factors relevant to consumers.
Abate et al. (2020) <sup>77</sup>	Panel analysis of 29 European countries between 2011 – 2018.	Capex per firm is higher in more concentrated markets; more concentrated markets are linked to higher download speeds from 2015 onwards; and there is no statistically significant relationship between ARPU and market concentration.	The period of interest reflects 4G technology and it would need to be assessed whether the findings would also be likely to apply to 5G deployments. The findings with respect to capex per firm and ARPU do not have clear implications for customers (e.g., overall market investment in enhancing quality is likely to be more relevant and ARPU is impacted by both prices and usage).
Bryson et al. (2023) <sup>78</sup>	Comparison of average capital expenditure as a proportion of firm revenue for the largest fixed and mobile telecom operators in Europe, as compared to the United States.	Capex as a percentage of revenue for the largest operators has been increasing in Europe and falling in the US.	It is difficult to draw any conclusions from the study as it combines fixed and mobile capex for a number of large operators, it does not present a relevant market concentration index and capex as a percentage of revenue may change because of changes in capex and/or revenues. Study does not distinguish between elimination of duplicative capex and reductions in quality-enhancing capex.
Valletti (2023) <sup>79</sup>	Review of literature.	Evidence that mergers result in higher prices, lower quality, and lower investment. Estimates that a merger between Vodafone and Three in the UK would lead to a £4 - £14 rise in the average per-user monthly cost of mobile phones (£60 - £300 annually).	Selectively summarises a limited number of papers, ignoring others that reach differing conclusions and does not acknowledge the limitations of the papers it references. Misrepresents the results of the Genakos et al. (2017) paper, by stating that a typical 4-to-3 merger would increase prices by 16.3% without acknowledging that the result is specific to a merger in a market with symmetric players and that the paper finds that previous exits have increased prices by only 4.3% on average. Estimates a £4 - £14 price rise by combining figures sourced from Genakos, C., T. Valletti and F. Verboven (2017), Rewheel (2022), and Rewheel (2020), without acknowledging any caveats to these analyses or any errors that may arise from combining their disparate results. It is also based on the assumption that the average monthly cost of mobile use is £30 per month, which is not consistent with Ofcom data that shows instead a significantly lower range, with the average monthly price of a handset and

<sup>77</sup> Abate et al. (2020). *Mobile market performance and market structure in Europe during the 4G era*. [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3748463](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3748463)

<sup>78</sup> Bryson et al. (2023). *Big Telcos Aren't Necessarily Better: A Case Study of EU versus US Market Concentration*. <https://osf.io/preprints/socarxiv/m42uh/>

<sup>79</sup> Tommaso Valletti in partnership with the Balanced Economy Project. (2023). *Report: Why the proposed Vodafone – Three merger will harm Britain*. <https://www.balancedeconomy.net/wp-content/uploads/2023/06/2306-Vodafone-3-merger-FINAL.pdf>



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**Table 6: Summary of studies analysing the impact of concentration on market outcomes**

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mobile contract ranging from £10 – £21 for low and medium-capacity tariffs, and reaching £44 only for the highest-capacity tariff. Does not acknowledge that inferring the effect of any future merger (i.e. one in 2023/2024) based on evidence from past mergers requires caution.

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- 90 As shown in Table 6, studies examining the relationship between concentration and price/quality come to differing conclusions on the direction and magnitude of the effect of concentration.
- a. Studies have tended to find either that higher concentration is associated with higher prices or that there is no statistically significant difference.
  - b. Studies have varied in their findings on the impact of concentration on quality, including that higher concentration is associated with higher quality, that there is an inverted U-shaped relationship, or that there is no statistically significant effect between concentration and quality. Woroch (2020) suggests that combining the parties' spectrum may be a significant source of quality improvements in terms of speed and reliability.
- 91 There is a need for caution in drawing inferences from such studies on the likely effect of any particular merger. Even if the studies correctly measure a relationship between concentration and a market outcome on average, such a relationship need not be predictive of the effects of any particular merger. For example, while a merger may reduce the number of operators in a market, the network capacity in the market may increase due to the merging parties being able to deploy their combined spectrum on their integrated site network. Combining the sites and spectrum can lead to greater capacity than the sum of the operators' existing capacity because of the multiplicative relationship between capacity, sites and spectrum.<sup>80</sup> Thus, a mobile market in which a merger has taken place may have more capacity, which will tend to drive down prices, compared to a market which has always had that number of operators. The outcome of any merger will depend on what the merged entity decides to do with their assets and details of their network integration.
- 92 The differences in results may be driven by a range of reasons, including differences in the groups of countries considered, time periods, price and quality measures, and methods to control for changes in technology (i.e., the rollout of 4G). By way of illustration, Bahia and Castells (2022) conduct a panel analysis of 104 operators in 29 European countries and present evidence indicating that the relationship between concentration and investment and quality may have changed since 2015.
- 93 As discussed in Table 6, and in the more detailed review of the studies produced by authorities presented in Appendix A, a number of these studies have data and methodological issues. The results of these studies should therefore be treated sceptically.

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<sup>80</sup> For example, see Real Wireless (2012), Techniques for increasing the capacity of wireless broadband networks: UK, 2012-2030, p.22.

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## Appendix A

# Detailed review of selected studies

1 This Appendix sets out in detail a review of a number of studies undertaken by authorities.

### Ofcom's Research Paper "A cross-country econometric analysis of the effect of disruptive firms on mobile pricing" (2016)

#### Summary of the paper

2 Ofcom's Research Paper<sup>81</sup> examines the effects of the presence of a 'disruptive' operator (which Ofcom defines to include Free in France and H3G in the UK) and the number of operators on market-wide prices.

3 Ofcom applies a subjective approach to identify disruptive firms. Firms qualify as disruptive if they have a relatively small share of supply, set prices aggressively in Ofcom's view, and/or have launched new services such as unlimited data.

4 Ofcom conducts a 'hedonic' pricing analysis using data for twenty-five countries between 2010 and 2015. The analysis decomposes post-paid price differences into differences attributable to certain quality differences and differences attributable to market structure (e.g., the presence of a 'disruptive' firm and the number of operators). Ofcom claims that this allows for a like-for-like comparison of prices.

5 In its measure of price, Ofcom includes both the price of tariffs and the price of handsets.

6 Ofcom concludes from its analysis that:

- a. prices are around 8% lower in countries that have one additional (non-disruptive) operator;
- b. prices are around 12% lower on average in markets where a disruptive firm is present than in those where one is not; and
- c. by combining these two findings, in countries with four operators, one of which is a disruptive operator, prices are 17% to 21% lower than in countries with three operators of which none is a disruptive operator.

#### Comments

7 As Ofcom itself notes, a significant drawback to its analysis of combined prices for handsets and tariffs is that it may capture customer's preference for handsets rather than tariffs. As tariff pricing is more clearly linked to the presence of a disruptor MNO or industry concentration than handset pricing, we would expect the impact of competition to be more pronounced in tariff prices. Instead, when Ofcom analyse the effect of industry concentration and the presence of a disruptive firm on

<sup>81</sup> Ofcom. (2016). *A cross-country econometric analysis of the effect of disruptive firms on mobile pricing*.

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- tariff charges alone, the effects diminish significantly. The price effect associated with an increase in the number of non-disruptive firms decreases from 8.2% to only 0.2% and becomes statistically insignificant. The price effect of a disruptive firm reduces from 12.3% to 2.9% and becomes far less statistically significant.<sup>82</sup> This indicates that the paper mainly captures the effect on handset prices, rather than the effect on tariffs. Ofcom does not comment on the very low pricing effects for tariffs alone.
- 8 Ofcom's analysis does not weigh its price data according to the frequency that each tariff was purchased. It treats every handset and tariff price equally, regardless of the frequency with which each was purchased. It also treats every MNO equally, regardless of their market share. Therefore, Ofcom's analysis reflects the determinants of the average tariff offered, as opposed to the average tariff purchased.
- 9 Ofcom's analysis uses a simplistic measure of network quality. Despite acknowledging that customers may broadly value "*the speed or coverage of a service*",<sup>83</sup> Ofcom's analysis only considers differences in network quality using a dummy variable that captures whether tariffs include 4G connectivity or not. However, there are many dimensions to network quality that are not captured by this dummy variable. For example, Ofcom note that examples of disruptive operators include Free in France and H3G in the UK; however, there is evidence that despite offering 4G connectivity, both of these operators have poor network quality and coverage as compared to their competitors.<sup>84</sup> Therefore, Ofcom's findings that countries with disruptive operators have lower prices on average could be driven by the fact that the low prices offered by disruptive operators reflect their low network quality beyond what is captured by the 4G dummy variable.
- 10 Ofcom's ad-hoc approach to identifying disruptive firms is subjective and not rigorously tested. As Ofcom itself notes, its classification of whether a firm is disruptive is subjective and a different classification may affect the findings of its analysis.<sup>85</sup> Ofcom tests the effect of re-classifying five operators from non-disruptive to disruptive (and vice-versa) and finds that the reclassification of these operators individually has no effect on its results. However, there are significant limitations to this test. First, it only considers the re-classification of these operators individually and not in combination, meaning that it is unclear whether the combination of these reclassification would change Ofcom's results. Second, Ofcom only tests the re-classification of five operators, in the context of 16 operators classified as disruptive and approximately 70 operators classified as not disruptive. A test of such a small proportion of the sample of operators is not convincing evidence of the robustness of Ofcom's results. Third, Ofcom always considers European operators belonging to the Hutchison Group and which have not merged with or acquired other operators in their market as being disruptive, without testing this assumption. Given the subjective nature of classifying operators, and the significant limitations of Ofcom's robustness test with respect to the classification of its operators, it cannot be ruled out that the results may be an artifact of the subjective classification of operations.

<sup>82</sup> Annex 4; Table 8.

<sup>83</sup> Page 10.

<sup>84</sup> For example, while much later than the period considered by Ofcom, Free Mobile is noted as having the lowest 'Consistent Quality' score, download speed, and upload speed, and its customers spent the greatest proportion of time connecting to 3G as compared to 4G, as compared to competing French operators in Tutela's 2020 ['France State of Mobile Networks'](#) report. A [2011 report commissioned by Ofcom](#) showed that the greatest proportion of H3G customers contacted their provider about an issue, and had the greatest proportion of customer contact about faults and repairs. A [2016 report](#) by Ofcom also showed that Three had the lowest satisfaction rating in terms of reception among all MNOs. Three's relative lack of quality has persisted, with Tutela's 2020 ['UK State of Mobile Experience'](#) report noting that H3G lags behind other operators across almost every KPI tested.

<sup>85</sup> Section 6, part (b).

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## Conclusion

- 11 Ofcom claims that its analysis shows that in countries with a disruptive MNO or with more MNOs, the combined prices of handsets and tariffs are significantly lower. However, its own robustness test indicates that its analysis has almost entirely captured the effect of market structure on the price of handsets, with little statistically significant effects on tariffs alone. Given that tariff prices are more clearly linked to the competition between MNOs, the results of Ofcom's analysis do not clearly show a link between market structure and MNO pricing. Additionally, Ofcom's analysis does not weight its pricing data according to the frequency that each tariff was purchased, uses a simplistic measure of network quality, and uses a subjective and untested classification of disruptive operators. These limitations significantly reduce the robustness of its results.

## Ofcom's Economics Discussion Paper "Market structure, Investment and Quality in the mobile industry" (2020)

### Summary of the paper

- 12 The main findings of the Ofcom paper<sup>86</sup> are set out below.
- 13 The article reviews five papers that have studied the impact of mergers on investment and three papers that have studied the impact of mergers on the quality of service. Ofcom finds that these studies suffer from various methodological issues. As a result, Ofcom considers that the evidence of these studies is either inconclusive or does not support their authors' conclusions.
- 14 Ofcom next estimates the relationship between market structure and industry investment as well as download speeds (as a measure of the quality of service), using a dynamic panel data model and quarterly data for 30 European countries covering the period 2000 to 2018. Ofcom concludes from its panel data analysis that industry investment and average download speeds are lower in more concentrated markets (albeit that there is no evidence of a direct impact of consolidation on speeds but an indirect impact via lower investment).
- 15 The study uses the SCG approach<sup>87</sup> to assess the effect of specific mobile operator mergers in Austria, Ireland and Germany on investment and download speeds. Ofcom claims that the results of its SCG analysis show that:
- a. The mergers in Ireland and Germany had a negative effect on industry investment. The effect of the Austrian merger on investment remains inconclusive.
  - b. The merger in Ireland had a lasting negative effect on average 4G download speeds. The merger in Austria reduced download speeds for two years before returning to a similar level as that which Ofcom predicts to have prevailed absent the merger. In Germany, the merger had no significant negative effect on download speeds.
- 16 Based on these findings, Ofcom concludes that there is no evidence that mobile consolidation has a positive impact on investment or quality (as measured by average download speeds), and that previous studies suggesting such an effect cannot be relied upon. Ofcom notes that their paper does not consider other dimensions of competition that are important to consumers, such as quality, price, or innovative tariffs.

<sup>86</sup> Available online [here](#).

<sup>87</sup> Ofcom uses SCG analyses to estimate the impact of mergers in Ireland, Austria and Germany on industry capex by reference to a constructed ('synthetic') control which can be thought of as the weighted average of outcomes in a sample of other countries that are chosen with the aim that the synthetic control will provide a good indication of what would have happened in Ireland, Austria and Germany had the mergers not occurred.

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- 17 Ofcom states its view that there “*is no magic number of MNOs for a well-functioning, competitive, mobile market*”, and that the consumer impact of any future consolidation would need to be assessed based on the specific transaction and market conditions.

### Comments

- 18 In this section, we set out the limitations of Ofcom’s (i) panel data analyses of investment and download speeds and (ii) SCG counterfactual analyses.

Ofcom’s panel data analyses suffer from methodological and data issues

### Ofcom’s analysis of investment

- 19 First, the GSMA industry capex data are not sufficiently reliable to be used in the sophisticated analyses done by Ofcom in which Ofcom’s conclusions are based on differences in the level and pattern of capex between countries and over time. These data are heavily based on constructed estimates using expected long-run relationships, rather than MNOs’ actual capex. When we cross-checked the GSMA estimates with actual data available for Ireland, we found that the GSMA estimate of industry capex substantially overstates actual capex with the extent of overstatement varying materially across years. As such, the evolution of capex in Ireland suggested by the GSMA estimates is not an accurate reflection of the evolution of actual capex. There is a case for assessing the impact on investment per connection by reference to operator data which is cross-checked with data reported by operators themselves.
- 20 Second, the panel data model Ofcom has used to estimate the impact of market concentration on industry capex assumes that a similar process determines industry capex per capita in each of the 30 countries in Ofcom’s dataset. However, when we tested this underlying assumption using the dataset we have created, it is clearly rejected. This is not surprising given the major differences in how capex per capita has evolved in these 30 countries. As the assumption underlying Ofcom’s capex panel data model does not hold, this model is mis-specified, so the results are not reliable and the conclusions about the effect of market structure on industry investment do not hold.
- 21 Third, Ofcom notes that it is primarily interested in the effect of increases in concentration. However, the vast majority of changes in the number of MNOs in its data are increases due to new entry (33/46 changes) rather than decreases due to mergers (12/46).<sup>88</sup> Ofcom correctly notes that its estimated average effect will therefore mostly capture the effect of entry.<sup>89</sup> Ofcom addresses this limitation by noting that, in the long run, what should matter for outcomes is the number of MNOs. Therefore, an increase in concentration from four to three MNOs should have the same (but opposite) effect on outcomes as a reduction in concentration from three to four MNOs.<sup>90</sup> However, when Ofcom tests whether the effects of entry and mergers are the same, it finds that while mergers have negative effects on investment, these effects are considerably smaller than the effects of entry and are much less statistically significant.<sup>91</sup>
- 22 Fourth, the model is estimated using data covering the period which includes the technological shift from 3G to 4G. Ofcom controls for the effects of this shift using a dummy variable which captures only the start of the investment cycle in 4G networks in each country. However, this variable fails to control for differences between countries in the speed of the rollout. Therefore, Ofcom’s analysis is likely to be distorted by failing to consider the extent to which differences in capex levels are due to

<sup>88</sup> Paragraph 4.13.

<sup>89</sup> Annex, Paragraph A4.12.

<sup>90</sup> Paragraph 3.2.

<sup>91</sup> Annex, Table A4.2.

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some countries having rolled out 4G faster. For example, faster rollout could lead to higher initial capex and lower later capex compared with countries with slower rollouts.

- 23 Fifth, the GSMA estimates of industry capex used by Ofcom are estimates of nominal, not real (i.e., the volume of) capex. Nominal investment depends on the price of investment goods and services at the time of the expenditure, and will therefore reflect changes in the prices of investment goods and services, as well as changes in real investment. It is changes in real investment (e.g., new sites and new equipment numbers) that is most relevant to considering potential consumer benefits from better quality and increased capacity. Because Ofcom's panel data analysis uses data covering 18 years (2000 to 2018), the price of investment goods and services purchased by the mobile sector is likely to have changed materially over the course of the period, and to have changed in a different manner in different countries. This is an issue as the panel data analysis uses both the variation in the data over time and across countries to estimate the effects of changes in market structure on industry capex.
- 24 Sixth, Ofcom focuses on investment per capita rather than investment per connection. Investment per connection would more directly capture differences between countries in investment levels which would impact mobile subscribers. Changes in investment per capita differ significantly from changes in investment per connection particularly in the early 2000s. When Frontier Economics sought to replicate Ofcom's analysis but using investment per connection, they found no impact of consolidation on investment.<sup>92</sup>
- 25 Seventh, Ofcom's preferred model uses 16 quarterly lags of investment. However, there are questions of whether such a model realistically captures the determinant of investment today and whether Ofcom's approach introduces bias into its estimation.

#### **Ofcom's analysis of download speeds**

- 26 Ofcom sets out that it believes that concentration can have an effect on download speeds as a result of two effects.
- a. *Direct effects* arising from changes in consumer usage (e.g., because of higher prices) and the way that mobile spectrum is utilised.
  - b. *Indirect effects* arising from changes in firms' ability and incentives to invest in network quality improvements.
- 27 Ofcom found no evidence of a statistically significant *direct effect* of market concentration on download speeds.<sup>93</sup>
- 28 Ofcom infers there was an *indirect effect* based on combining their findings that: (i) market concentration had a negative effect on industry capex; and (ii) industry capex had a direct effect on download speeds. However, as noted above, Ofcom's first finding (i.e., that market concentration has a negative effect on industry capex) is not reliable. As such, Ofcom's finding of an indirect effect of market concentration on download speeds is also not reliable.

#### **Ofcom's SCG analyses of mergers in Austria, Ireland and Germany suffer from methodological and data issues**

- 29 Fundamentally, the robustness of an SCG analysis depends on the synthetic control providing an accurate estimate of what industry capex or download speeds would have been absent the merger.

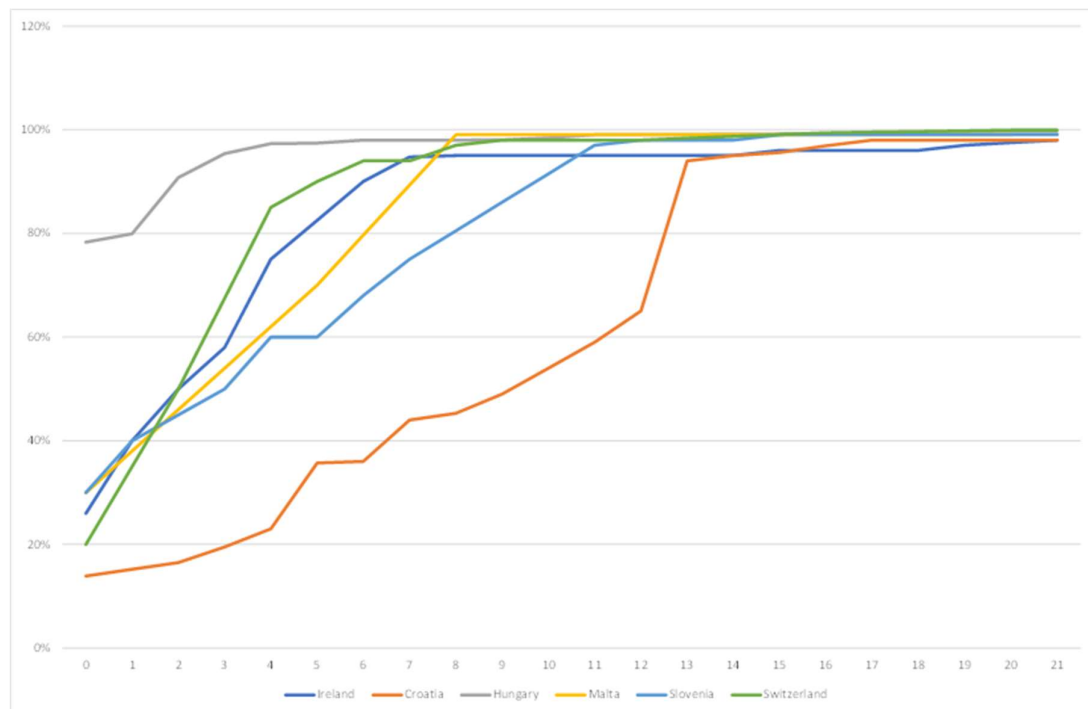
<sup>92</sup> Frontier Economics, [The impact of mobile market consolidation on quality](#), December 2021, p.11.

<sup>93</sup> Paragraph 6.11.

Whether the synthetic control provides an accurate estimate of the counterfactual depends upon a range of factors.<sup>94</sup>

- 30 The reliability of Ofcom's synthetic controls is called into question for the following reasons:
- 31 Industry capex was affected by the rollout of 4G during the period of the analysis, and differences in the timing and speed of the rollout of 4G in different countries are likely to result in industry capex evolving differently in these countries, and the analysis does not control for the large differences in the speed at which 4G was rolled out between countries (see Figure 16). Even after rebasing time to when rollout commenced, there are significant differences in the speed of the rollout between Ireland and several of the control countries. In particular, the speed of the rollout in Croatia (the country with the largest weight in the synthetic control) was much slower than in Ireland. Slovenia (which has a weight of 18.5%) also had a significantly slower 4G rollout than in Ireland. Therefore, the reliability of the synthetic control is questionable.
- 32 There are large differences between the level of industry capex in Ireland, Austria and Germany and several of the control countries which are effectively ignored because the synthetic control is based on averaging out these large differences. Such differences suggest that the process driving industry capex significantly differs between the countries so that they do not provide a reliable control.
- 33 Our review of the SCG analysis for Ireland shows the synthetic control becomes a less accurate and reliable estimate of industry capex within 18 months, and if a five year pre-merger period is used to construct the synthetic control then the estimated effects of the merger are not significant.

Figure 16: Speed of 4G rollout for Ireland and donor countries (rebased time)



Source: Compass Lexecon analysis based on data from GSMA.

<sup>94</sup> Other factors include how the control countries and their weights are chosen (the latter includes factors such as the length of the pre-merger period, the method used to select the control countries and weights, etc.).



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34 The robustness of Ofcom’s SCG analysis of download speeds is questionable, as (i) the predictor variables used in the analysis are not important or relevant to download speeds; (ii) industry capex (which is an important determinant of download speeds) is not used as a predictor variable; and (iii) differences in the timing and speed of the rollout of 4G mean suggest download speeds are not being determined by the same process in these countries in the analysis.

### Conclusion

35 Ofcom’s paper sets out to analyse the effects of market concentration on industry-level capex and download speeds. However, its analysis fails to critically review the fundamental assumptions underlying its models, and the input data it uses are not sufficiently robust for the purpose of the analyses. Therefore, the reliability and robustness of the evidence that industry concentration have reduced industry investment or download speeds is questionable.

### RTR’s “Ex-post analysis of the merger between H3G Austria and Orange Austria” (2016)

#### Summary of the paper

36 The RTR paper<sup>95</sup> analyses the effect of the 2013 Austrian 4-to-3 merger of H3G and Orange Austria (Orange) on prices.

37 The study constructs a nationwide measure of average price for Austria and other ‘control’ countries by:

- a. using data on the number of minutes, SMS and data (MB) consumed by the average user (called the “smartphone user”) in each country;
- b. using tariff data to estimate the monthly cost for the average smartphone user; and
- c. taking the average of the four cheapest calculated tariffs for every operator.

38 It also calculates the price paid by the average “traditional user” in each country, who RTR assumes uses only half of the minutes and SMS of the smartphone user and does not consume any data.

39 It then estimates the effect of the Austrian merger using two methods, a DiD model and a SCG approach.

40 Applying both models to the data, RTR conclude that their results indicate that:

- a. prices for the average smartphone user rose by 24% in the first year after the merger, and by between 50% - 90% (depending on the estimation method used) in the second year; and
- b. prices for the average traditional user did not change in the first year after the merger, and increased by between 22% - 31% in the second year.

<sup>95</sup> Austrian Regulatory Authority for Broadcasting and Telecommunications. (2016). *Ex-post analysis of the merger between H3G Austria and Orange Austria*. [https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/Ex\\_post\\_analysis\\_merger\\_H3G\\_Orange\\_RTR.pdf](https://www.rtr.at/TKP/aktuelles/publikationen/publikationen/Ex_post_analysis_merger_H3G_Orange_RTR.pdf)



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## Comments

### **RTR's calculation of average prices is flawed**

- 41 There are several limitations to RTR's calculation of prices, which mean that its estimates of price changes should be treated with caution.
- 42 First, RTR makes a miscalculation with regard to its calculation of the average MB per user. RTR uses data on average data usage, which includes the use of data-only mobile broadband services (e.g., dongles). RTR removes the data usage associated with mobile broadband services by using Ericsson's Mobility 2014 Report, and incorrectly calculate mobile broadband services to account for half of all mobile data. Ericsson's Report<sup>96</sup> indicates that data-only devices account for only around 30% of mobile data in 2013. Hence, RTR understates average mobile phone data use and places too little weight on changes in prices for data compared to SMS or minute prices.
- 43 Second, RTR uses significantly different baskets of consumption across different countries, which means that changes in average prices may be distorted by changes in relative prices for different services. For example, if data prices fell by the same percentage and voice prices rose by the same percentage in each country, then a country whose 'average' price is based on a basket weighted more heavily to data may show a relative price decrease while a country whose price basket is weighted more heavily to voice will show a price increase. This effect would occur mechanically even though consumers in the different countries would face the same prices for the same services throughout.
- 44 Third, the data on average usage per country is based on usage in 2013, which will greatly underestimate data usage for most customers from 2014 onwards. Therefore, to the extent that RTR's methodology seeks to capture the change in the usage-weighted average, this methodology will significantly underestimate the weight given to the price of data.
- 45 Fourth, RTR calculates the simple average of the four cheapest tariffs for every MNO, with no analysis of how many customers take up these cheap tariffs as compared to other tariffs. RTR state that its dataset of tariffs contains an average of 27.1 tariffs per operator per quarter, and 99.7% of MNOs had more than four tariffs available.<sup>97</sup> Therefore, RTR's analysis only captures a small proportion of all tariffs, and it does not present any analysis of the extent to which these cheap tariffs were representative of other tariffs.

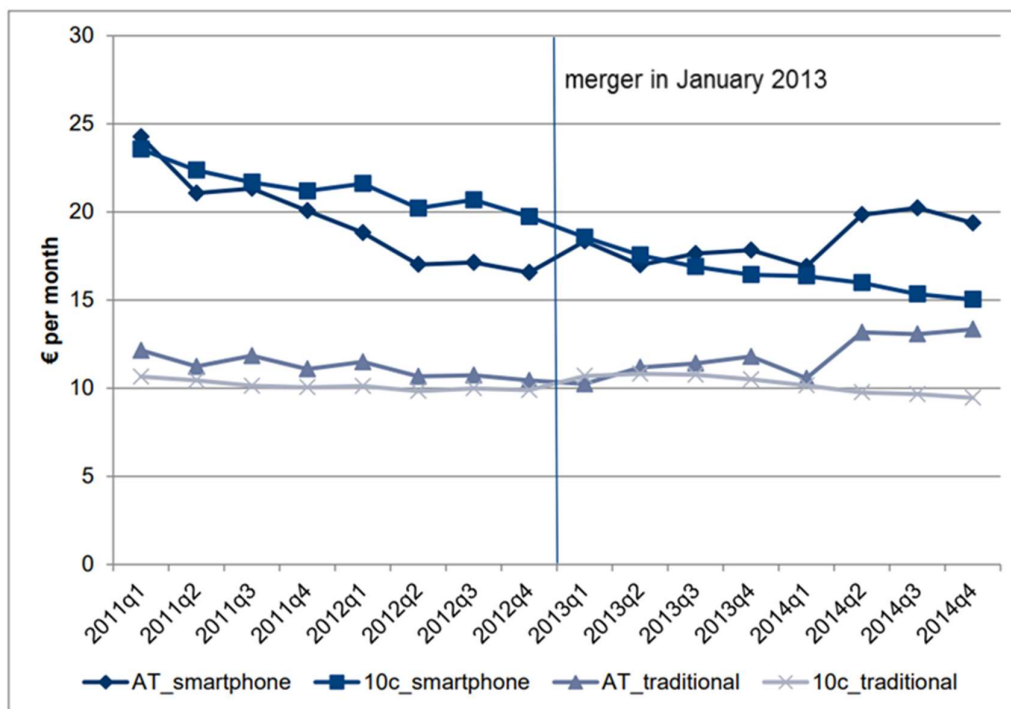
### **RTR's analysis of smartphone prices likely captures the fact that Austria had low prices to start with**

- 46 Figure 1 of the RTR paper sets out its estimated average 'smartphone' and 'traditional' prices for Austria and the 10 control group countries (see Figure 17).

<sup>96</sup> Available online [here](#). Page 2 of Ericsson's Mobile Report November 2014 shows that there were 1,900 million smartphone subscriptions with monthly data traffic per smartphone of 700 MB/month and 250 million mobile PC, tablet and mobile router subscriptions with monthly data traffic per mobile PC of 3,300 MB/month and per tablet of 1,400 MB/month.

<sup>97</sup> RTR Report, page 20.

Figure 17: RTR's (2016) estimation of average prices for Austria and 10 control countries



47 Figure 17 shows that prior to the merger, average smartphone prices in Austria were significantly lower than the average price in the 10 control countries, a result of its faster fall in prices between 2011 and 2012 Q4. Therefore, the 'merger effect' in the immediate quarters after the merger which the RTR paper allegedly captures for smartphone prices is likely to be driven, in large part, by the fact that pre-merger Austria had low prices for smartphone customers to start with. The RTR's price series does show an increase in Austrian prices in quarter 2 of 2014 but it questionable whether this is due to the merger which completed in January 2013 given that any change in price incentives would be expected to apply from the date of completion.

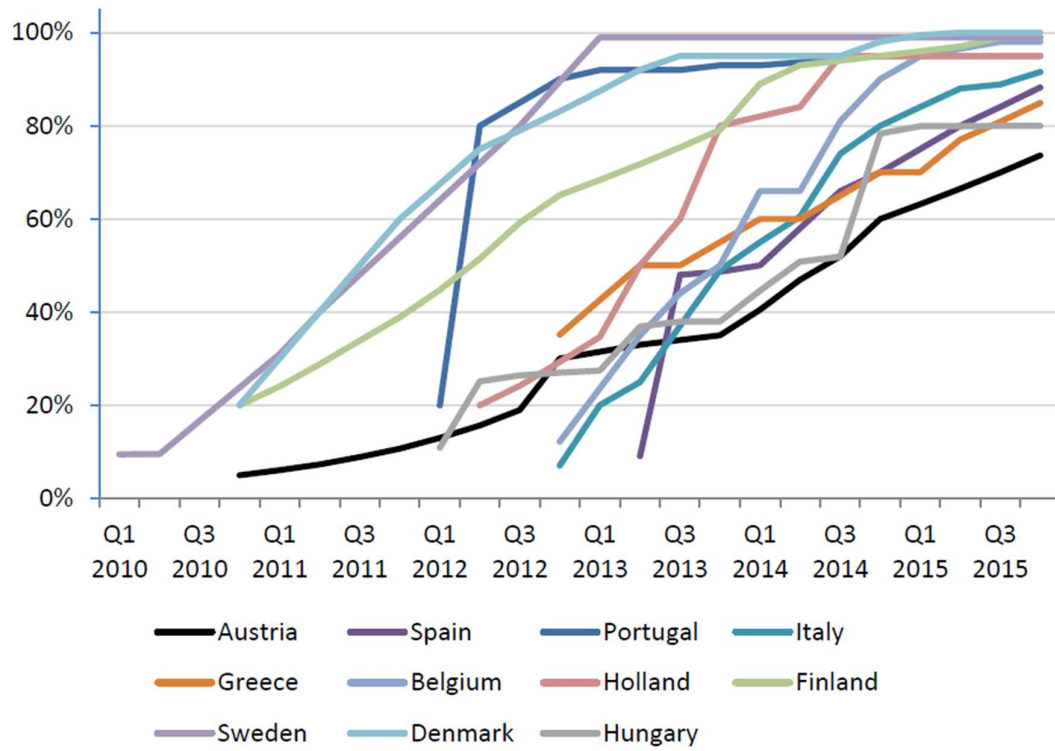
**RTR's control variables**

48 It is crucial for a DiD analysis to properly control for all relevant price influences that may have evolved differently across the countries in the sample, which have driven the observed differences in price evolution, and that have nothing to do with the merger. RTR only included two control variables in its DiD specification; GDP growth and termination rates.

49 It seems unlikely that the two control variables that the RTR has included in its DiD specification sufficiently control for these influences. In particular, there are several other factors that are likely to have evolved differently across Austria and the countries in the control group which could bias RTR's results. These include the following.

- a. Figure 18 shows that 4G population coverage growth was slow in Austria in the pre-Transaction period when compared to control countries, with growth increasing significantly after 2014. In comparison, in some of the control countries, 4G seems to have been rolled out fully by the time of the transaction.

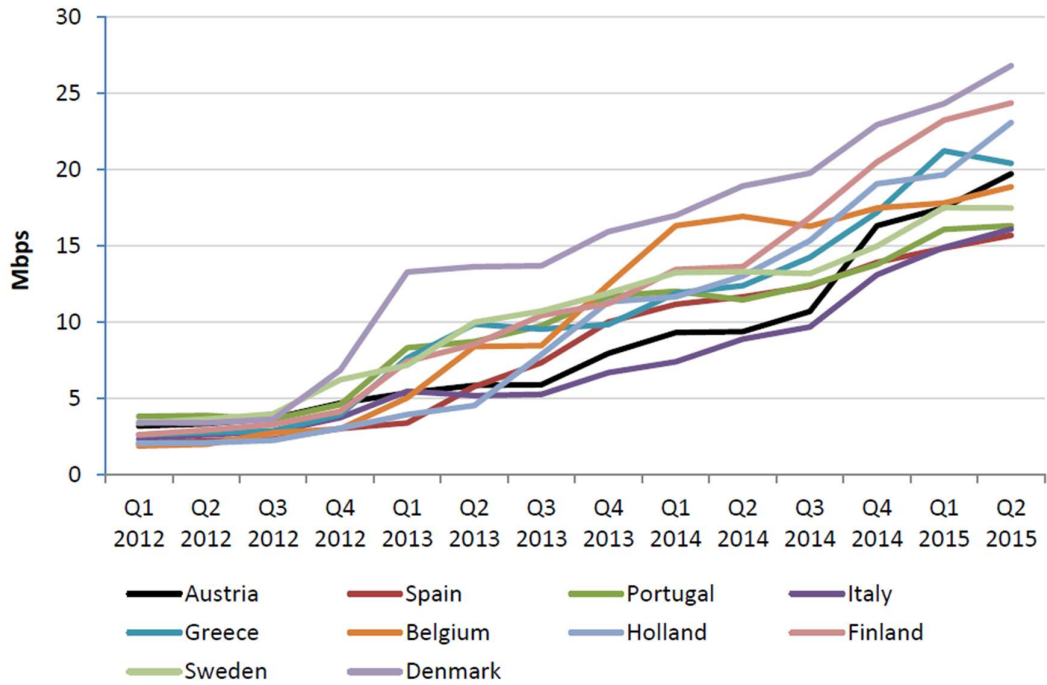
Figure 18: 4G network coverage (by population) in Austria and benchmark countries (2010 - 2015)



Source: Compass Lexecon analysis based on data from GSMA.

b. Figure 19 shows that average mobile download speeds in Austria were slow as compared to the control countries shortly after the merger in Q2 2014, but its download speeds started increasing significantly only a year later. By Q2 2015, Austria had overtaken four control countries.

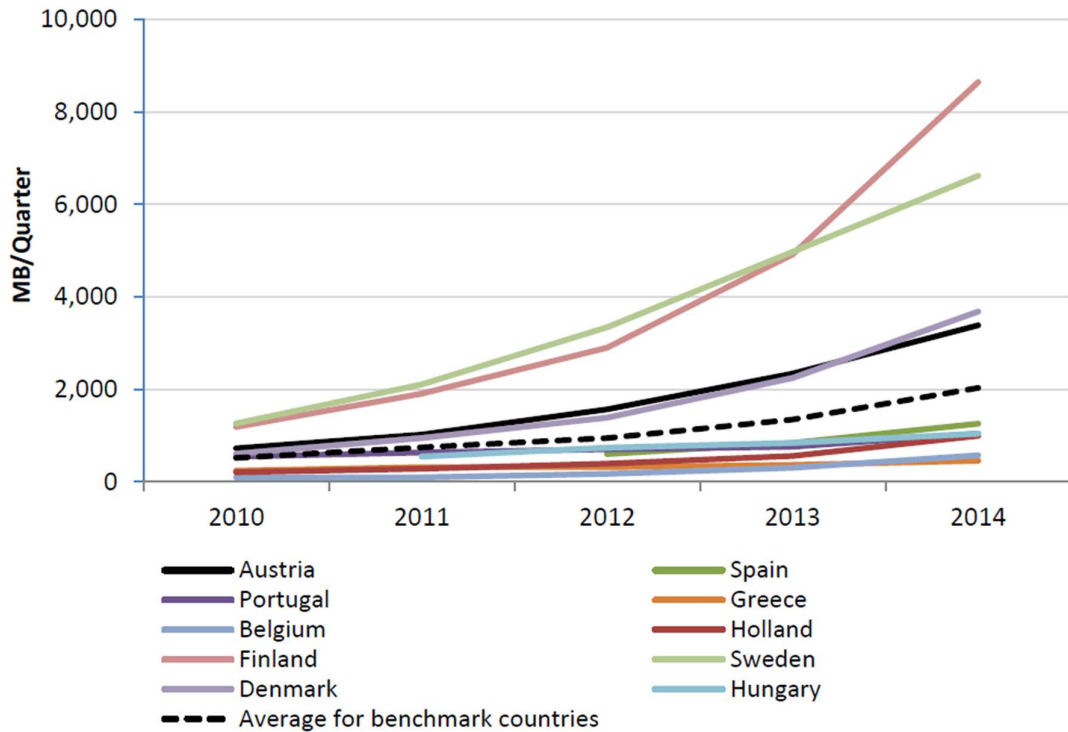
Figure 19: Evolution of average mobile broadband download speed in Austria and benchmark countries (2010 - 2015)



Source: Compass Lexecon analysis based on data from GSMA.

c. Figure 20 shows that usage (voice, SMS, and data) per subscriber grew considerably faster in Austria compared to the average of the 10 control countries.

Figure 20: Evolution of quarterly usage (SMS/voice/data) per subscriber, yearly average, (2010 - 2014)



Source: Compass Lexecon analysis based on data from GSMA.

50 All three of these factors may have caused prices in Austria and the control countries to develop differently over time. This is particularly the case for Austria's higher growth in download speeds and usage as compared to the control countries, as it would be expected that as these grew, *ceteris paribus*, prices in Austria would have increased relative to prices in the control countries. These price effects cannot be interpreted as a result of the merger, and therefore must be controlled for in a DiD analysis. However, the two control variables included by RTR are unlikely to capture these effects, and therefore RTR's analysis incorrectly overestimates any effect of the merger on prices.

### Conclusion

51 RTR attempts to analyse the effect of the 2013 Austrian 4-to-3 merger of H3G and Orange on prices, using a constructed estimate of average prices. However, there are significant limitations to the results of this study.

- a. RTR significantly underestimates the usage of data for customers (and therefore its estimation will not place an appropriate amount of weight on changes in the price of data).
- b. RTR's compares prices for baskets which differ between countries.
- c. RTR's result of strong merger-induced price effects in the first year after the merger are likely distorted by Austria having low prices pre-merger (and thus less scope to reduce prices than control countries) while the price increases six quarters after the merger seem unlikely to be caused by the merger.

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- d. The analysis fails to control for important drivers of prices that could have caused the evolution of prices to differ between Austrian and the control countries even in the absence of the merger. Factors not controlled for include the speed of the 4G roll-out, the evolution of download speeds, and the evolution of usage.

## **BEREC, “Report on Post-Merger Market Developments - Price Effects of Mobile Mergers in Austria, Ireland and Germany” (2018)**

### Summary of the paper

- 52 BEREC’s report<sup>98</sup> examines the effect of prices and quality of three four-to-three mergers:
- a. the H3G/Orange merger in Austria completed in January 2013;
  - b. the H3G/O2 merger in Ireland conditionally cleared in May 2014; and
  - c. the O2/E-Plus merger in Germany completed in October 2014.
- 53 BEREC uses two methods to estimate the mergers’ price effects.
- a. A DiD approach which compares the difference in price levels between the country experiencing the merger and a set of benchmark countries before and after the merger; and
  - b. An SCG approach.
- 54 The study uses prices based on IDATE/Tarifca data on the average of the cheapest four tariffs per operator in each market. The authors calculate a national price as the average of these averages weighted by operators’ market shares. The medium user basket is based on the average usage in each country in 2013, the low user basket is defined as half the usage of the medium user basket and excludes data altogether, and the high user basket is defined as double the usage of the medium user basket.<sup>99</sup> BEREC follows the RTR’s approach in underestimating average data usage in Austria in 2013 by assuming that Ericsson had estimated half of data volumes relate to data-only devices rather than only around 30%.
- 55 BEREC’s study also provides some limited data on potential effects of the mergers in Austria and Germany on quality of service. In particular, the study considers scores assigned by the German magazine ‘connect’ of quality of service for the main Austrian and German operators over the period 2011/2012 to 2017. The scores are designed to reflect several quality parameters related to voice quality, speed and reliability of data transfer and network coverage.
- 56 BEREC’s results offer evidence of, at best, partial and time-limited effects of 4-to-3 mergers.
- a. The country for which the study produces the strongest evidence of merger effects is Austria, where both the DiD and the SCG approaches estimate that prices increased because of the merger for low- and medium-use baskets in 2014 and 2015. The results suggest no effect on prices in 2013 compared with control countries<sup>100</sup> (although the merger had been concluded in

<sup>98</sup> Available online [here](#).

<sup>99</sup> Prices are adjusted for inflation and PPP exchange rates. Prices are also considered for a basket using 2014 average usage. The prices of MVNOs and MNO sub-brands are excluded except for tele.ring in Austria. Handset subsidies are not considered in the pricing baskets. The only other potential factors impacting on prices that BEREC tests for are GDP growth and mobile termination.

<sup>100</sup> While there is a statistically significant effect for the high-use basket under the DiD approach for 2013H2, BEREC believes that the results for this basket are likely to be overestimated, since Austrian prices were already very low and could not be expected to follow the downward trend of other countries. (BEREC (2018), *Report on post-merger market developments – Price effects of mobile mergers in Austria, Ireland and Germany*, p.18.)

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January 2013) and no effect on prices from 2016 onward, which BEREC attributes to increased competitive pressure from MVNOs as a result of the MVNO remedy. The finding of no long-run effect is especially significant because Austria is the only country for which BEREC have data long enough to test for such an effect. The SCG results are less robust to changes in methodology (i.e., BEREC's robustness checks) than the DiD results.

- b. In Ireland, there are no statistically significant effects under the SCG approach, which BEREC favours over the DiD approach. Under the DiD approach, there is an effect for the high-use basket but no reliable evidence of an effect for the low- or medium-use basket beyond the first half year. The effect for the high-use is also not robust, as demonstrated in the robustness checks in Appendix A.
- c. In Germany, there are no statistically significant effects under the SCG approach, except for 2016 H1 for the low-use basket (i.e. a year and half after the merger). The DiD estimation finds an effect for the low-use basket in each period, but there is no reliable evidence of an effect for the medium- and high-use baskets beyond the first half year. In one of the robustness tests (using 2013 and 2014 usage and considering the cheapest two tariffs), there is a statistically significant price decrease for the medium-use basket for one half year.<sup>101</sup>
- d. In relation to potential effects on quality, there appears to be a small short-term decrease in average quality for the merging parties in Austria. However, quality subsequently increased, and average quality for the merging parties appears to reach a higher level post-merger than pre-merger. In Germany, the available data shows a decrease in quality to 2017. with the study noting that the integration process was still ongoing in 2017. In any event, given the increasing data volumes over time, which strained all operator's networks, it is not clear that any change in quality can be attributed to the mergers.

## Comments

### H3G/Orange merger in Austria, 2013

57

In relation to the H3G/Orange merger in Austria, which was completed in January 2013, BEREC's analysis shows no reliable effect on prices in 2013, a potential effect in 2014 and 2015 and then no effect from 2016. BEREC attributes the finding of no effect from 2016 onwards to increased competition from MVNOs. However, there are reasons to question whether the merger impacted prices even in 2014 and 2015.

- a. The finding of a price effect in the years 2014 and 2015 under the SCG approach, which BEREC favours, is not robust. Considering the cheapest two tariffs and usage based on the years 2013 and 2014 instead of 2013 alone, there is no statistically significant effect on any price, except for a supposed effect limited only to the second half of 2015.<sup>102</sup> Given that the merger was completed in January 2013, this does not seem like a credible merger effect. The fact that the results change so dramatically under a small change to the assumptions of the model cast doubt on the reliability of the estimation.
- b. The problem of 2013 usage underestimating usage over the study period is less with respect to BEREC's high use basket. BEREC finds no statistically significant effect on prices for the high use basket in any of its tests using the SCG approach. Concerning the alternative DiD method, BEREC notes that this approach is not reliable in the Austrian case because of the low pre-

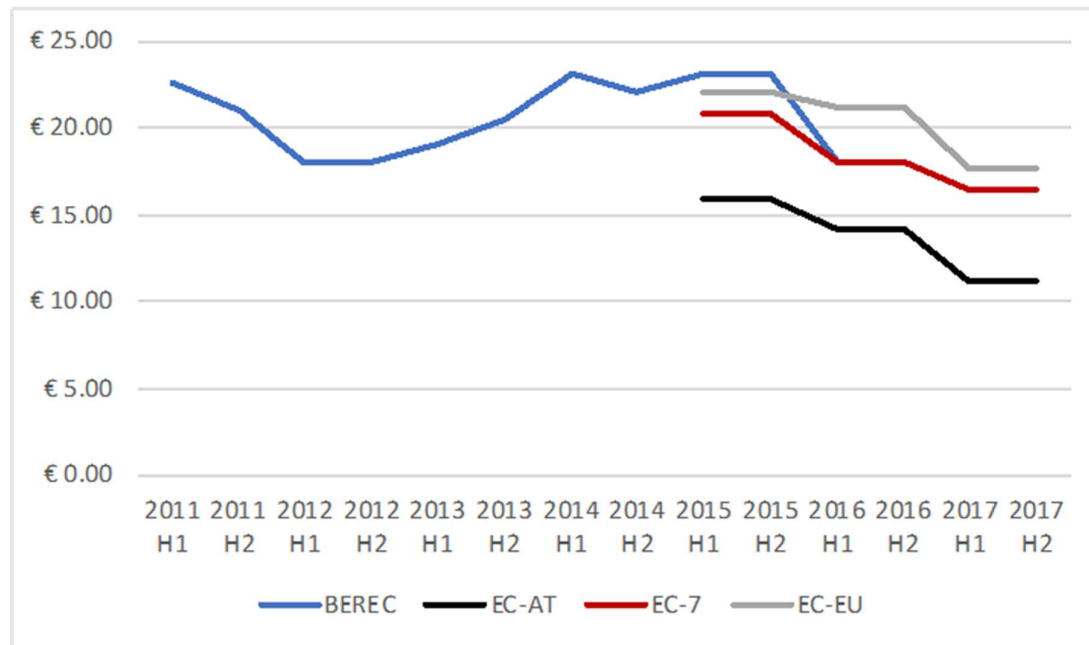
<sup>101</sup> See BEREC Report, Table 34.

<sup>102</sup> See BEREC Report, Annex 5.

merger prices in Austria, which imply that “it cannot be expected that Austria (without the merger) would follow the significant downward trend of the control group”.<sup>103</sup>

- c. BEREC’s pricing data for Austria is also inconsistent with data from the European Commission. Whereas BEREC’s data suggests that Austrian prices increased to be around and even higher than an average of European countries, the Commission’s data shows that Austrian customers could acquire a basket with more service volumes at a price significantly below that of other European countries.

Figure 21: BEREC’s and EC price data for Austria, 7 comparator countries (“EC-7”) and the EC average



Note: EC averages for 7 comparator countries and EU-28 are unweighted averages of prices in each country.  
Source: BEREC, EC.<sup>104</sup>

- d. BEREC’s pricing data ignores handset prices and MVNO prices. As such, it fails to account for deflationary effects reported in the market at the time including higher handset subsidies and additional data volumes for existing customers.<sup>105</sup>

### H3G/O2 merger in Ireland, 2014

58 There is also no reliable evidence of a price increase from the H3G/O2 merger in Ireland in 2014, for the following three reasons.

<sup>103</sup> See BEREC Report, section 5.2.

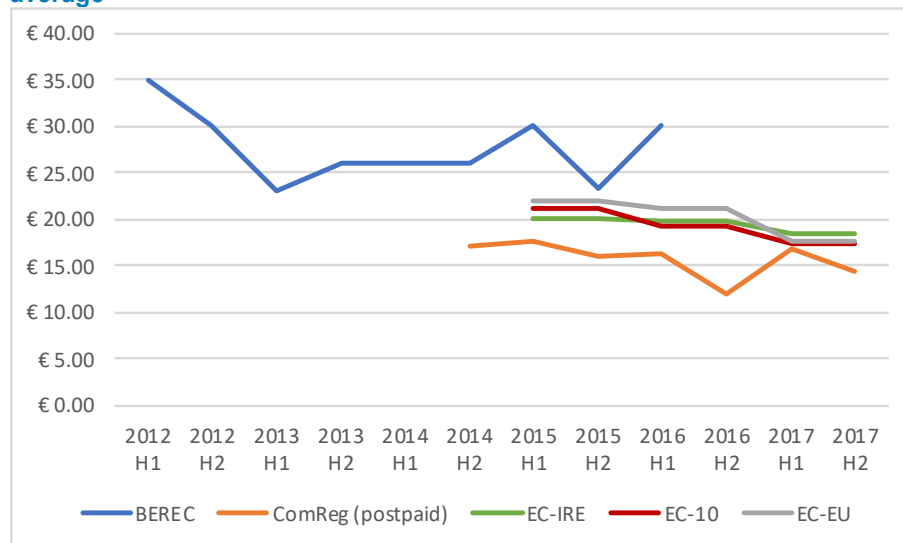
<sup>104</sup> The EC has published three mobile broadband price studies: Van Dijk Management Consultants, Mobile Broadband Prices, 2015 and 2016 and Empirica Mobile Broadband Prices in Europe, 2017. The studies use 6 different price baskets to benchmark mobile broadband prices across Europe. For each country, we have chosen the EC basket closest to the usage bundle used by BEREC for a medium user in that country. The BEREC analysis assume a medium Austrian user has the following usage pattern: 140 minutes, 37 SMS and 361 MB (see Table 9 of the BEREC report). The EC bundle used in our analysis for Austria is Basket 2 comprising 200 minutes, 512MB data and 140 SMS.

<sup>105</sup> As noted in the Telekom Austria Annual Report 2015, p.7.; “In Austria, new mobile virtual network operators (MVNOs) entering the market increased competitive pressure, particularly in the no-frills and SIM-only segments. To secure the premium customer business, the subsidy level was again raised significantly and tariffs for existing and new customers were enriched to include additional data volumes and bandwidths in 2015.”



- a. BEREC's SCG estimation shows no statistically significant effect on Irish prices.
- b. The finding of an effect beyond the initial first half year under BEREC's DiD approach (i.e., for high use baskets) is shown to be not statistically significant once BEREC takes 2014 usage into account.
- c. The finding of a short-term price effect under some of BEREC's approaches seems to arise from BEREC's data suggesting a price rise between 2014H2 and 2015H1 (see BEREC's Figures 7-9). However, this price rise is not found in ComReg's price data<sup>106</sup> which shows stable then falling prices (see Figure 22). BEREC's data also suggests that Irish prices rose to be significantly above prices in other European countries. The EC's data<sup>107</sup> for the basket that is closest to BEREC's medium use basket instead suggests that, post-merger, Irish prices have remained around the European average (EC-EU) and the average of BEREC's 10 comparator countries (EC-10). ComReg's and the Commission's data of low and falling prices in Ireland calls into question whether BEREC's price series is reliable.

**Figure 22: BEREC, ComReg and EC price series for medium use for Ireland and EU average**



Source: Compass Lexecon analysis based on data from BEREC, ComReg, EC.

59 When considering high use baskets, BEREC's data is also inconsistent with that of ComReg and the EC although there are significant differences in the allowances of each basket. BEREC 'high user' usage profile for Ireland is based on 330 mins, 288 SMS and 652 MB. ComReg's business basket is the closest ComReg basket to the BEREC 'high-user' profile for Ireland. ComReg's business usage profile is 300 calls (569 mins), 225 SMS, 1GB data. ComReg's data shows prices

<sup>106</sup> ComReg's data compiled by Strategy Analytics using an OECD-approved methodology shows prices of 3 mobile phone usage baskets: (1) Prepaid Residential 30 calls (50 mins), 100 SMS and 0.1GB data; (2) Postpaid Residential: 100 calls (182 mins), 140 SMS and 2GB data; and (3) Business: 300 calls (569 mins), 225 SMS and 1 GB data. ComReg states that these baskets were selected given they are the most closely related to the average mobile voice usage patterns in Ireland. The prices are advertised prices of the largest operators. Prices are converted using Euro Purchasing Power Parities and exclude VAT charges. ComReg regularly updates its methodology to take account of changing usage profiles. Between Q3 2014 and the end of 2017, ComReg used the 2010 OECD methodology and the selected baskets described above. This is the data range that is presented in this paper.

<sup>107</sup> The EC has published three mobile broadband price studies: Van Dijk Management Consultants, Mobile Broadband Prices, 2015 and 2016 and Empirica Mobile Broadband Prices in Europe, 2017. The studies use 6 different price baskets to benchmark mobile broadband prices across Europe.

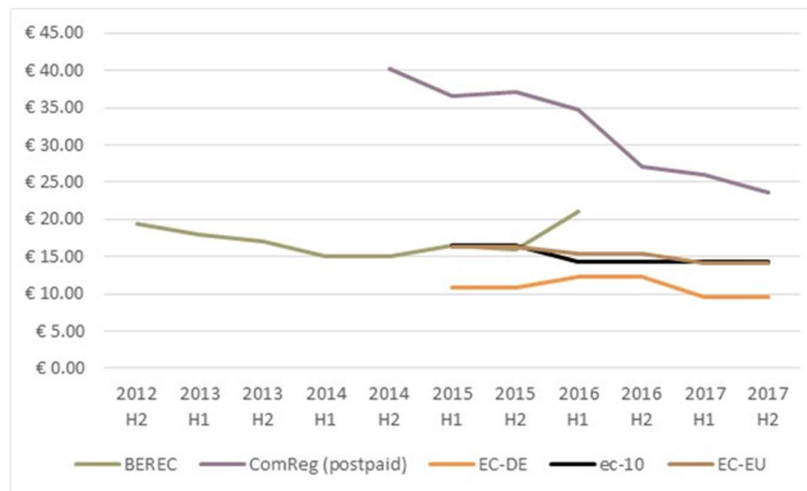
falling from 2014H2 onwards whereas BEREC finds a price rise between 2014H2 and 2015H1. The European Commission's Basket 2 is the most closely aligned price basket to the BEREC 'high-user' profile for Ireland and has 200 mins, 140 SMS and 512MB and is significantly cheaper than BEREC's price data.

### O2/E-Plus merger in Germany, 2014

60 BEREC's finding of a price effect for the O2/E-Plus merger in Germany is also not reliable, for three reasons:

- a. BEREC's SCG estimation only finds a single statistically significant price effect (for the low use basket in the first half of 2016), and this is not confirmed by 4 out of the 5 robustness checks applied by BEREC.
- b. The finding of a price effect under BEREC's DiD approach for the low-usage basket seems to be an artifact of BEREC's pricing data, which suggests a significant price increase in Germany in 2015 and 2016. This price increase is not found in data from other sources: pricing data from ComReg indicate that German prices for tariffs with a similar usage fell over this period. The European Commission's data shows a small price increase in 2016, followed by a price reduction in the following year, such that prices were lower in 2017 than 2015 (see Figure 23 and Figure 24). A study of prices for Canadian regulator found price decreases in Germany for seven out of eight baskets over 2014 to 2016, with the price increase for the remaining basket being only 1.4%.<sup>108</sup>

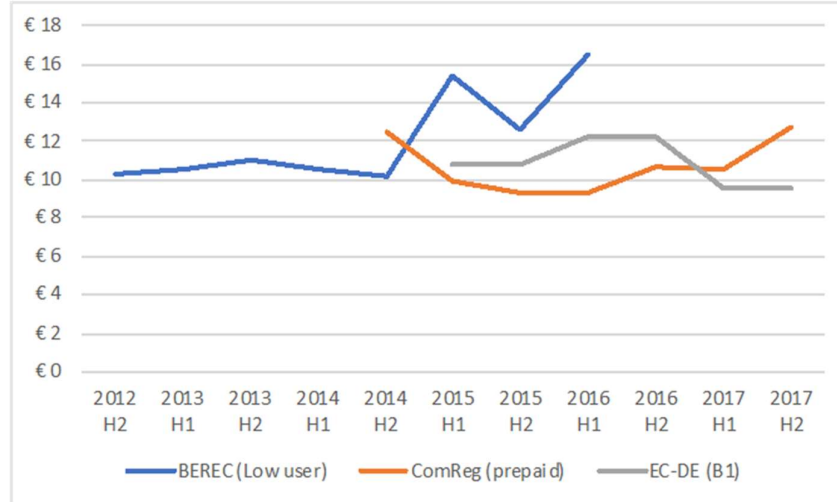
Figure 23: BEREC, ComReg and EC price data for medium use in Germany and EC-10 and EU average



Source: Compass Lexecon analysis based on data from BEREC, ComReg, EC.

<sup>108</sup> Nordicity, [2016 Price comparison study of telecommunications services in Canada and select foreign jurisdictions](#), p.96-201.

Figure 24: BEREC, ComReg and EC price data for low use in Germany



Source: Compass Lexecon analysis based on data from EC, BEREC, ComReg.

- c. The reliability of the analysis of the low-usage segment is also questionable given BEREC's omission of MVNO prices. MVNOs account for 14% of subscribers in Germany<sup>109</sup> and undercut operators particularly in the low-usage segment.<sup>110</sup>

## Conclusion

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In summary, the significant inconsistencies between BEREC's price series and that of other regulators suggests that BEREC's study cannot be relied upon to make conclusions as to the general effects of the three mergers. Of most concern is BEREC's assumptions of price increases when other price series (for similar usage baskets) show price decreases. Even with respect to BEREC's price series, BEREC's own tests do not consistently find significant price increases. This is particularly the case with BEREC's preferred SCG approach, which either finds no statistically significant price increase or finds an increase only in some specifications but not others, which indicates a lack of robustness.

<sup>109</sup> Moody's Investors Service, *Deutsche Telekom AG*, 30 April 2018, p.6.

<sup>110</sup> Ovum, "MVNO consolidation in the German market creates a strong fourth player", 7 July 2017; and Warburg Research, Drillisch, January 2018, p.11.

## Appendix B

# Econometric analysis of revenue per GB

62 This Appendix describes our own econometric analysis to assess whether four-to-three mergers have resulted in significant changes in revenue per GB consumed, our proxy for quality-adjusted prices. The analysis covers six countries in which a four-to-three merger has taken place since 2010, namely Austria, Ireland, Germany, Italy, the Netherlands, and the US. We have found that the post-merger decline in revenue per GB was statistically faster than pre-merger in two out of the six countries, and unchanged in three of the countries.

### Data sources and processing

63 We calculated revenue per GB as mobile service revenue divided by mobile data consumed in the market, using data collected from publicly available sources. Detailed information on data sources and metrics used for each country is presented in Table 7.

64 For each country except Italy, we compiled a series for total mobile traffic consumed, which comprises data, voice, and text messages. We converted voice minutes and number of text messages into GB based on the approach suggested by Abdirahman et al. (2020), which assumes that 1 minute = 480 kilobyte and 1 SMS = 140 byte.<sup>111</sup> For Italy, information on traffic volume is only available for data usage.<sup>112</sup> To calculate revenue per GB, market revenues were divided by total usage for countries other than Italy and by data usage for Italy.

65 Data is available on a quarterly basis for Austria, Ireland, Italy and the Netherlands, and on an annual basis for Germany and the US.

**Table 7: Summary of data sources by country**

Metric	Country	Provider	Description of source
Revenue	Austria	Rundfunk und Telekom Regulierungs-GmbH (RTR)	Retail revenues from mobile communications from annual reports and Open Data database
	Ireland	Commission for Communications Regulation (ComReg)	Total mobile retail revenues from quarterly reports
	Germany	Bundesnetzagentur	Retail external revenue from mobile services (excluding terminal equipment) from annual reports
	Italy	GSMA	Recurring cellular revenue
	Netherlands	GSMA	Recurring cellular revenue

<sup>111</sup> Abdirahman, M. et al. (2020). A Comparison of Deflators for Telecommunications Services Output. *Economie et Statistique*, 517-518–519, Table, p. 114. Unit prefixes in the calculations are understood as powers of 10.

<sup>112</sup> AGCOM communications market report 1/2023 (<https://www.agcom.it/documents/10179/6176015/Allegato+5-5-2023/d739f475-1bf6-499f-b370-5e3b3e51a129?version=1.0>).

**Table 7: Summary of data sources by country**

	US	GSMA	Recurring cellular revenue
Usage	Austria	Rundfunk und Telekom Regulierungs-GmbH (RTR)	Data volume, call minutes, text messages in the retail market from annual reports and Open Data database
	Ireland	Commission for Communications Regulation (ComReg)	Voice, SMS and other data volumes from quarterly reports
	Germany	Bundesnetzagentur	Mobile data volumes, SMS messages, call minutes from annual reports
	Italy	AGCOM	Data traffic from quarterly reports
	Netherlands	Netherlands Authority for Consumers & Markets	Mobile data, minutes and SMS usage from Telecom Monitor
	US	CTIA	Wireless data, minutes and text usage from Annual Survey Highlights

### Econometric model

66 To evaluate the post-merger deviation of revenue per GB from the pre-merger rate of decline, we estimated the following regression model:

$$\text{Log}(P_t) = \alpha + \beta \cdot t + \sum_i \delta_i \cdot D_i$$

Where:

- $\text{Log}(P_t)$  is the natural logarithm of revenue per GB;
- $t$  denotes time, defined as either quarters or years;
- $D_i$  is a set of dummy variables, each indicating a post-merger period  $i$ .<sup>113</sup>

67 The coefficient of each dummy variable shows how revenue per GB in the period deviates from the logarithmic time trend based on pre-merger revenue per GB. For example, a negative statistically significant coefficient  $\delta_i$  implies that the rate of decline in revenue per GB in the period  $i$  is statistically lower than the pre-merger rate of decline; in other words, revenue per GB fell faster after the merger than before the merger.

68 We tested the joint significance of the post-merger dummy coefficients using Wald test. The null hypothesis is that the coefficients are jointly not different from zero:

$$\delta_1 = \delta_2 = \delta_3 = \dots = \delta_i = 0$$

<sup>113</sup> Post-merger periods are defined as those which follow the period in which the merger was approved. The first post-merger period is Q1 2013 for Austria, Q3 2014 for Ireland, 2015 for Germany, Q4 2016 for Italy, Q1 2019 for the Netherlands and 2020 for the US.

69 If the null hypothesis is rejected, this implies a statistically significant deviation from the pre-merger trend in revenue per GB. Conversely, if the null hypothesis is not rejected, this implies that revenue per GB continued to fall after the merger in the same rate as before. We infer whether the post-merger decline is steeper or shallower than the pre-merger trend based on the sum of the deltas.

## Results

70 For each country except Italy, we have considered multiple time windows to estimate the pre-merger trend and post-merger deviations in revenue per GB:

- a. 3 years before and after the merger approval.
- b. 4 years before and after the merger approval.<sup>114</sup>
- c. 5 years before and after the merger approval.<sup>115</sup>

71 For Italy, we have considered two sets of models. In the first set of models, the post-merger period always ends with Iliad's entry (and hence last from Q4 2016 to Q2 2018). In the second set of models we drop this restriction, i.e. consider post-merger periods of 3, 4 or 5 years. Both sets of models estimate the pre-merger trend using data from the 3, 4 or 5 years before the merger.

72 Results considering four years before and after the merger are presented in the main body of the paper. This reflects evidence that mobile network integration may take three years or longer<sup>116</sup> and hence the full benefit of the additional capacity created by network integration may not be evident until four years after the merger. Sensitivities considering either three or five years before and after the merger to estimate the pre-merger trend and post-merger deviations confirm the baseline results, with two exceptions. In Austria, the sensitivity considering three years before and after the merger shows that the decline in average revenue per GB was unchanged post-merger. In Italy, the sensitivity analyses with the post-merger lasting 3, 4 or 5 years (as opposed to ending in Q2 2018) show a faster decline in average revenue per GB post-merger.

73 Table 8 presents the results for each country and time window.

**Table 8: Results of econometric analysis by country and time window considered**

Country	Metric	+/- 3 years	+/- 4 years	+/- 5 years
Austria	Summary of findings	No statistically significant difference in rate of decline	Faster decline in average revenue per GB post-merger (**)	Faster decline in average revenue per GB post-merger (***)
	P-value of Wald test	0.428	0.043	0.001
	N	24	32	40
Ireland	Summary of findings	Faster decline in average revenue per GB post-merger (*)	Faster decline in average revenue per GB post-merger (**)	Faster decline in average revenue per GB post-merger (*)

<sup>114</sup> For the US, data is available up to 2022, so the post-merger period only lasts 3 years. For Ireland, information on data usage is available starting Q2 2011, so the pre-merger period only lasts 13 quarters.

<sup>115</sup> For the US, data is available up to 2022, so the post-merger period only lasts 3 years. For Ireland, information on data usage is available starting Q2 2011, so the pre-merger period only lasts 13 quarters. For the Netherlands, data is available up to Q2 2023, so the post-merger period only lasts 18 quarters.

<sup>116</sup> Arthur D Little (2015), "Creating value in telecoms consolidation", p.2.

**Table 8: Results of econometric analysis by country and time window considered**

	P-value of Wald test	0.062	0.043	0.051
	N	24	29	33
Germany	Summary of findings	No statistically significant difference in rate of decline	No statistically significant difference in rate of decline	No statistically significant difference in rate of decline
	P-value of Wald test	0.988	0.994	0.879
	N	6	8	10
Italy (post-merger period ending Q2 2018)	Summary of findings	No statistically significant difference in rate of decline	No statistically significant difference in rate of decline	No statistically significant difference in rate of decline
	P-value of Wald test	0.546	0.699	0.737
	N	19	23	27
Italy (post-merger period lasting 3/4/5 years)	Summary of findings	Faster decline in average revenue per GB post-merger (**)	Faster decline in average revenue per GB post-merger (***)	Faster decline in average revenue per GB post-merger (***)
	P-value of Wald test	0.036	0.006	0.003
	N	24	32	40
Netherlands	Summary of findings	Slower decline in average revenue per GB post-merger (***)	Slower decline in average revenue per GB post-merger (***)	Slower decline in average revenue per GB post-merger (***)
	P-value of Wald test	0.000	0.000	0.000
	N	24	32	38
US	Summary of findings	No statistically significant difference in rate of decline	No statistically significant difference in rate of decline	No statistically significant difference in rate of decline
	P-value of Wald test	0.595	0.534	0.358
	N	6	7	8

Note: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

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