



Assessing the case for in-country mobile consolidation

A report prepared for the GSMA

February 2015



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Executive Summary

There have been a number of recent mobile mergers and proposed mergers across Europe involving a reduction in the number of players in each market from 4 to 3. This has happened amid intense debates about the merits of mobile industry mergers in general. That debate extends beyond Europe; there was a 4-to-3 merger in Australia in 2009 and, in the US, the Federal Communications Commission (FCC) formally blocked a merger between AT&T and T-Mobile in 2009, and informally blocked a merger between T-Mobile and Sprint in 2014. In these debates, competition authorities have tended to focus on the short-term pricing implications of mergers, with a significant focus on the GUPPI¹ framework. However, mobile operators argue that more attention should be paid to the impact that such mergers could have on efficiencies or investment. This study examines these claims.

The GSMA has asked Frontier Economics to consider both the theoretical and empirical evidence for mergers, making use of the GSMA's extensive database on mobile metrics. We consider how competition authorities currently approach the task of assessing and modelling mergers in mobile markets, and suggest how this might be improved in order to produce better long term outcomes for consumers. However, the study has not been prepared in connection with any particular merger and does not attempt to predict the outcome of any specific merger. That requires competition authorities to undertake a detailed assessment based on the facts of each case.

We find that there are a number of ways in which the assessment of mobile mergers could be improved in future:

- **More focus on investment.** At present, the Commission generally starts by considering whether a merger will lead to short-term increases in prices, and then analyse whether the merger could also lead to efficiency gains and higher investment over the longer term to offset the price increases that it predicts. However, our analysis suggests that dynamic efficiencies from investment in mobile markets – which are not generally captured in GUPPIs – play a much larger role in determining outputs, including prices, in mobile than they do in many other industries. This is because major technology changes occur every 7-8 years in mobile, rather than every 30 or 50 years, as happens in many other industries. We find that the vast majority of the reduction in unit prices in Europe between 2004 and 2014 is explained by investments in new technologies.

Given this, the relevant question for merger analysis is whether a specific merger would result in higher investment levels than in the counterfactual. We find that there are certain circumstances in which mergers can increase the incentives of the merging parties to invest when compared to the pre-merger situation. Given that the potential benefits (including lower prices) for consumers from higher levels of investment are so significant in the mobile industry, it is important to evaluate carefully the impact that a merger will have on the incentives and ability of the affected parties to invest. To do this, the impact of the merger on market performance and, over a long time period, should be examined in a more holistic way.

1. GUPPIs attempt to capture the upward pricing pressure from mergers based on the closeness of competition (diversion ratios) between the merging parties and the margins of customers recaptured as a result of the merger.

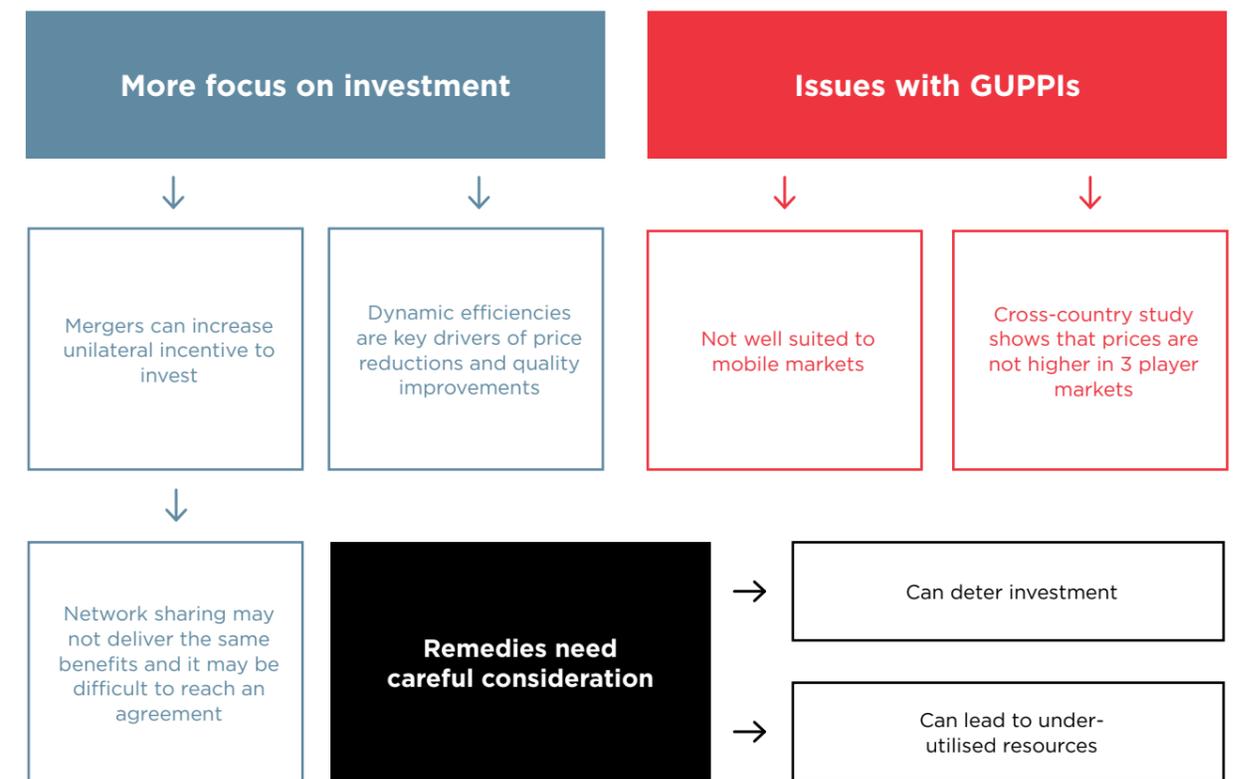
- Reconsider how GUPPIs are calculated and used.** We also find that the reliance on predicted price increases used by competition authorities, whilst providing a helpful starting point, needs further development in order to capture the complexities of the competitive process in mobile markets. These tools should not be expected to provide reliable predictions of the impact of mobile mergers on prices. We find no evidence that unit prices in 3 player mobile markets are systematically higher than those in 4 player markets, which is a fundamental prediction of the GUPPI framework currently used by competition authorities². This does not mean that no mergers will ever lead to higher prices, but it suggests that the tools and inputs being used by competition authorities today, do not adequately capture the drivers of mobile market performance.
- Give appropriate weight to differences between network sharing and full mergers.** We also find that the reliance on predicted price increases used by competition authorities, whilst providing a helpful starting point, needs further development in order to capture the complexities of the competitive process in mobile markets. These tools should not be expected to provide reliable

predictions of the impact of mobile mergers on prices. We find no evidence that unit prices in 3 player mobile markets are systematically higher than those in 4 player markets, which is a fundamental prediction of the GUPPI framework currently used by competition authorities. This does not mean that no mergers will ever lead to higher prices, but it suggests that the tools and inputs being used by competition authorities today, do not adequately capture the drivers of mobile market performance.

- More careful consideration of remedies.** Remedies are intended to address the competition problems which the authorities predict would arise as a result of a merger. If these problems are not specified accurately in the first place (as we suggest can occur with the use of GUPPIs in mobile mergers), then the remedies will be inappropriate. In addition, some remedies may prevent the realisation of the very benefits which might otherwise result from the merger. In the case of mobile mergers, remedies which may reduce either the incentive, or ability of the merging parties to increase investment, will harm consumers in the market in question and may deter beneficial mergers in other countries.

Figure 1

Summary of key conclusions of study



Source: Frontier Economics

2. Our analysis builds and improves on the evidence presented on this issue by the merging parties and the Commission in the context of the recent merger in Ireland.

1 Introduction

In recent years there has been substantial debate surrounding the subject of consolidation in the mobile market. The recent mergers in Europe (in the UK, Austria, Germany and Ireland) have been cleared by the European Commission, only with considerable remedies imposed on the merging parties. Concern regarding the impact of mobile mergers on competition and consumer welfare has led to increasing attention from the wider industry on the treatment of these mergers and the resulting market outcomes.

It is against this background that the GSMA has asked Frontier Economics to undertake this study. This report considers whether competition authorities' existing approaches, to assessing and modelling potential mergers, is appropriate for mobile markets. It challenges some of the pre-conceived assumptions about how mobile markets work and the impact of mergers on competition and performance in the market. The report highlights how the approach to assessing mergers in the mobile industry could be enriched to more appropriately reflect the nature of the

industry. We have considered both the theoretical and empirical evidence for mergers, largely informed by the GSMA database. This extensive database contains data from the mobile operators on many different metrics, including take-up, prices and investment since the year 2000.

In the rest of this introduction, we explain:

- the current approach to assessing mobile mergers; and
- the structure of this report.

1.1 The current approach to assessing mobile mergers

In recent mobile merger cases there has been significant overlap in how the Commission has assessed the mergers. In particular, the Commission has adopted the following approach:

- **Market definition** The Commission has defined a broad retail market including all mobile services. It also defined a market for wholesale access. In addition, it defined markets for call termination and international roaming, but it did not have any concerns for these two markets as they are regulated.
- **Anti-competitive effects.** The Commission has tried to understand the nature of competition in the market and how this could be affected by the merger, by considering several factors, including:

- market shares and growth rates;
- closeness of competition between the merging parties;
- spectrum holdings of the merging parties;
- role of mavericks;
- likely reaction of rival Mobile Network Operators (MNOs);
- competitive constraint imposed by Mobile Virtual Network Operators (MVNOs); and
- scope for co-ordination.

The Commission has attempted to quantify the upwards pressure on prices by using:

- the General Upwards Pricing Pressure Index (GUPPIs)³; and
- demand estimation which relies on econometrics.

3. GUPPIs attempt to capture the upward pricing pressure from mergers based on the closeness of competition (diversion ratios) between the merging parties and the margins of customers recaptured as a result of the merger.

- **Efficiency gains.** The Commission has considered whether the merger could lead to efficiency gains or increased investment. The Commission has tended to be sceptical of such claims, as it has argued that benefits are:
 - difficult to verify;
 - unlikely to be passed onto consumers as it has argued that any efficiency savings are mainly fixed cost savings; and
 - could largely be achieved under network-sharing deals instead.
- **Remedies.** In all of the four recent mobile merger cases (UK, Austria, Ireland, Germany) the Commission has imposed significant remedies.

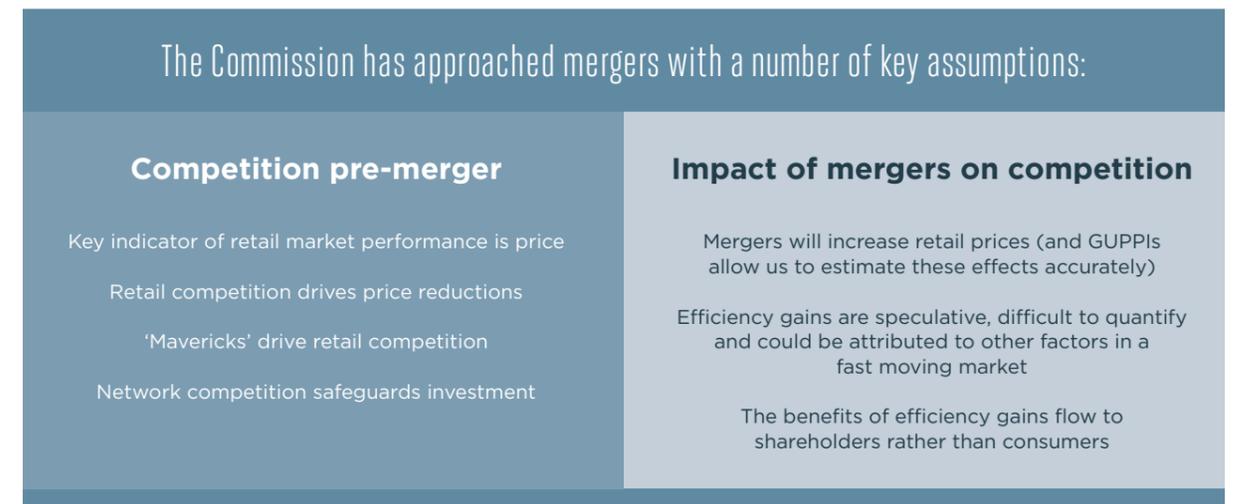
The Commission has tended to approach mobile mergers by predominantly focussing on the anti-competitive effects of the merger. In comparison, the assessment of efficiency gains, or the impact of the merger on investment, receives less attention. As a result, the burden of proof falls with the merging parties, and the issue is mainly considered after the anti-competitive effects of the merger have been identified by the Commission. When analysing mobile mergers, the Commission relies on a range of assumptions about how the mobile market works, namely:

- The Commission and many policymakers assume that markets with four network operators deliver superior outcomes to those with three network operators. They do not place much weight on the role of MVNOs as a competitive force in the market, and instead focus on ensuring adequate network competition to safeguard investment.
- The Commission focuses heavily on the role of maverick operators as a key driver of price reductions and service innovation. Mergers that are seen to threaten the position of mavericks are heavily criticised and stringent remedies to create the potential for new mavericks are imposed.
- The analysis focuses heavily on prices as the key determinant of consumer welfare and retail market performance. The Commission assumes that mergers will result in price increases and that GUPPIs can be used to accurately estimate such price effects.
- Efficiency gains and other dynamic impacts of mergers are often considered speculative and difficult to quantify. The Commission focuses more on price changes that are driven by changes in margins rather than changes in investment.

Figure 2

The historical approach to mergers

Source: Frontier Economics



1.2 Structure of this report

The report is structured as follows:

- In section 2, we explain that investment is a key driver of consumer outcomes in mobile and can be affected positively by consolidation;
- In section 3, we explain that competition authorities' approach to assessing mobile mergers may overstate post-merger price increases; and
- In section 4, we explain why network sharing deals may not always be commercially viable and may lead to lower benefits than mergers; and
- In section 5, we set out why significant remedies may undermine the potential benefits from mobile mergers.

2 Investment is a key driver of consumer outcomes in mobile and can be affected positively by consolidation

When assessing mobile mergers, the Commission pays substantial attention to the impact on mobile prices, based on a GUPPI analysis. However, the GUPPI framework focuses only on the short term impact of the merger on prices⁴. We show in this section that the evolution of mobile prices over time is likely to be affected more significantly by dynamic efficiencies driven by investment.

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In any market, prices can fall for the following reasons:

- Prices can fall as a result of firms being more productive when using the same technology and thereby reducing/minimising costs – for example by re-organising the operations of a company, or simplifying its procurement processes, etc. Alternatively, prices can fall due to a reduction in margins, which can lead to higher allocative efficiency.
- Prices can also fall due to dynamic efficiencies, which occur when firms invest in superior technologies and thereby reduce costs (and generally also improve the quality of existing services, as well as enabling new services which would otherwise not be produced).

In mobile markets, dynamic efficiencies due to technology developments are a key determinant of market performance and, therefore, consumer outcomes. Mobile markets follow technology cycles that last for 7-8 years. These short cycles in mobile markets look set to continue with the current roll-out of 4G and in preparation for 5G technologies. The short technology cycles in

mobile mean that the approach typically used to assess mergers in other industries may need to be modified when assessing mobile mergers.

We have performed an extensive empirical exercise to assess the relationship between investment and market concentration in mobile markets. We find that there is no clear evidence that investment is higher in markets with low HHIs⁵ or in markets with four players.

There are several ways in which mobile mergers can help to increase the operators' incentive and ability to invest. Firstly, they can lead to economies of scale, which can encourage investments that increase both capacity and coverage. Secondly, they can result in parties being able to combine complementary assets. For example, combining spectrum holdings can lead to benefits as a result of combining high and low frequency spectrum, earlier spectrum refarming and spectrum aggregation. Thirdly, they can help increase the opportunities to engage in commercial partnerships, which can deliver new innovative services, such as mobile money.

4. See also section 4.3 on the critique to the application of the GUPPI framework to assess mobile mergers.

5. Herfindahl-Hirschman Index – a measure of the size of firms in relation to the industry and an indicator of the intensity of competition among them.

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The Commission has considered network-sharing agreements as an alternative to mergers. In reality, network-sharing agreements are unlikely to offer the same incentive to invest as mergers do, because operators have less ability to differentiate products under a network-sharing deal, compared to unilateral investments following a merger. Network-sharing deals often do not involve the sharing of the whole network and do not offer any efficiencies at the retail-level. Finally, it may not always be possible for parties to reach a network-sharing agreement, particularly if the operators are asymmetric.

In the rest of this section, we explain why more weight should be attached to the potential positive impact of mobile mergers on investments.

- In section 2.1, we explain that the mobile industry is characterised by frequent technology cycles, which are likely to be shorter than the technology cycles in other industries, where competition authorities have carried out merger assessments;

- In section 2.2, we explain why investment is the main driver of consumer benefits in the mobile industry;
- In section 2.3, we show that cross-country analysis suggests, in general, that investment is no higher in 4 player, than in 3 player markets;
- In section 2.4, we set out why mergers will increase the incentive and ability of the merging parties to invest under certain conditions;
- In section 2.5, we explain that the precise impact of a merger on investment will depend on a number of factors; and
- In section 2.6, we present and assess the different mechanisms through which a merger affects investment incentives.

2.1 The mobile industry is characterised by frequent technology cycles

Innovation is a central feature of the mobile industry. Mobile operators determine how quickly and far to roll-out different generations of mobile technologies. The services now offered by the mobile sector on a global basis are unrecognisable compared to those of 30 years ago. The industry started off providing 1G services, which offered low quality voice services with poor security. During the early 1990s, 2G services were launched, which offered improved voice services alongside messaging capabilities. GPRS and EDGE represented upgrades to 2G services, which allowed low speed data usage. At the start of the new century, operators launched 3G services, which provided improved data speeds allowing a much wider range of services

to be offered over mobile networks. HSDPA and HSPA+ were two upgrades to 3G that further improved data speeds. The improved data speeds facilitated the exponential growth of applications that could be used on mobile phones.

There are more innovations to come. Countries are still in the process of fully rolling-out 4G and there are also upgrades to 4G, such as LTE-Advanced, now underway. This is essential as data usage is forecast to grow rapidly. For example, Cisco has predicted that data usage will grow by 61% per year at Compound Annual Gross Rates (CAGR) between 2013 and 2018⁶. Further down the line, operators will look to launch 5G services.

6. Cisco (see: http://www.cisco.com/c/dam/assets/sol/sp/vni/forecast_highlights_mobile/index.html)
 7. Such as radio (which introduced FM technologies about 50 years after AM, and DAB which was produced another 50 years after FM) or TV (which introduced colour in the 1960s, 30 years after television was first launched, and introduced DTT in the late 1990s, another 30 years later).

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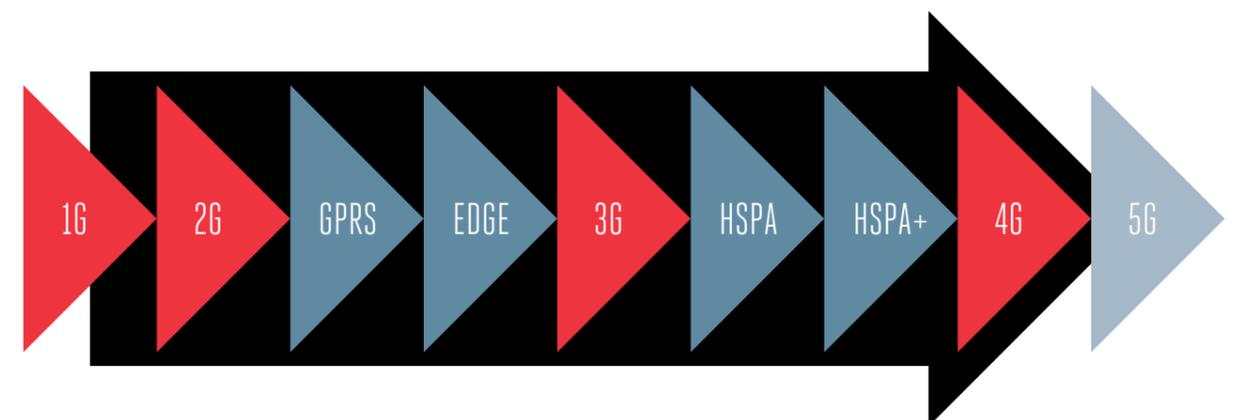
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Mobile markets follow short technology cycles with a new technology generation being launched every 7-8 years - see Figure 4 below. This compares to the 15-50 year cycles in many other industries⁷. These short cycles in mobile markets look set to continue with the current roll-out of 4G and preparation for 5G technologies.

Figure 3

Innovations in the mobile sector

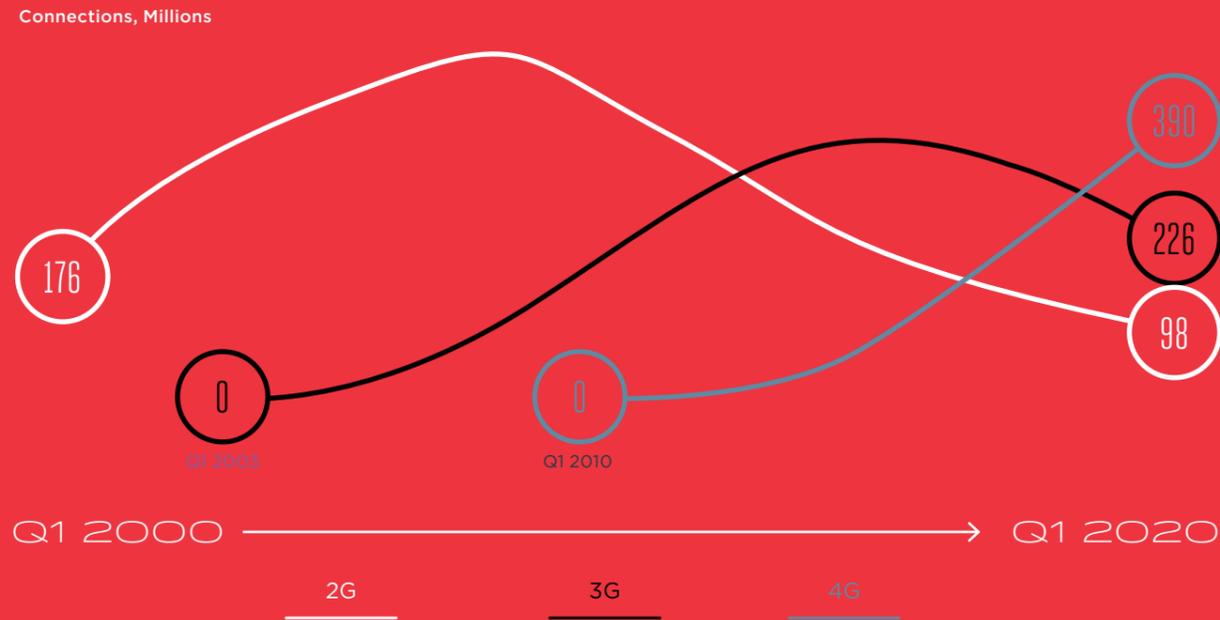
Increasing speeds and wider availability of services



Source: GSMA database

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Figure 4
Technology cycles in EU mobile markets



Source: GSMA intelligence

Note: analysis relates to EU28 countries except for 4G connections which does not include Cyprus due to lack of data availability

Market performance in an industry such as mobile therefore needs to be assessed across technology cycles, since these are periods during which large investments are made to deliver (a) significant increases in total capacity (both through investments in new infrastructure and through investments in new spectrum) and (b) significant improvements in the utilisation of capacity (i.e. the volume of data that can be supported over existing spectrum and network). New network technology cycles also unlock new cycles of innovation in services and devices along the supply chain (such as 3G and the iPhone), which then drive further growth in user demand for new services.

The non-telecoms industries in which the Commission has recently carried out Phase 2 merger assessments, mainly in the transport sector, do not exhibit the same rapid rate of technological innovation, capacity expansion, and consequent need to invest as the mobile sector does. This implies that the Commission may need to modify its approach to merger assessments

when addressing the mobile sector. As shown by the table below, where efficiency benefits have been assessed, these have tended to relate to savings to the existing fixed cost base. The Commission has typically argued that such cost savings do not get passed onto consumers. It has also ignored the impact of mergers on incentives to invest in new technologies, since this typically occurs over a 20-50 year time frame in other industries, and is therefore far beyond the time horizon normally adopted by the Commission. The mobile sector is different in that mergers can help incentivise investment in new technologies going forward, as well as reducing the existing cost base of current technologies. These technology investments can be contemplated within a much shorter time horizon – perhaps over the next 3-5 years. This means that even if some of the efficiencies relate to fixed cost savings for network roll-out, this can still benefit consumers if it also leads to greater investment in new technologies, which enable lower unit costs and higher levels of output.

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CASE	MERGING PARTIES	YEAR	INDUSTRY	COST SAVING EFFICIENCY ARGUMENTS	INCREASED INVESTMENT IN NEW TECHNOLOGIES
CASE M.7054	Cemex/ Holcim Assets	2014	Cement	No efficiencies argument mentioned	No discussion of investment in new technologies
CASE M.6905	INEOS/ SOLVAY/JV	2014	Chemicals	Annual variable cost savings mentioned. The Commission notes that these synergies are likely not to be merger-specific, since they are not achieved through the greater scale achieved by the JV and could be achieved by each party to the JV on stand-alone basis.	No discussion of investment in new technologies
CASE M.5830	Olympic/ Aegean Airlines	2011, reopened in 2013	Airline	According to the Parties, the transaction will allow the firms to enjoy savings from joint purchasing of inputs. The Parties also claim that the "the merger will allow the firms to benefit from network efficiencies i.e. savings through more efficient operation of network". The Parties also believe that the transaction may result in demand side (consumer) benefits. These include benefits to consumers of a larger network, in particular "greater choice of indirect routes due to larger network, greater choice in flight times due to the larger combined schedule and greater range of flights to earn and burn frequent flyer points". No Further details from 2013 case yet.	New routes/ direct flights involves investment but not new technology
CASE M.6360	NYNAS/ SHELL/HARBURG REFINERY	2013	Oil refinery	Nynas would be able to achieve production efficiencies [due to reorganization]. Based on the evidence, the Commission concludes that the transaction would result in a verifiable capacity increase. As a result, EEA production capacity will largely exceed EEA demand, and will be well above the capacity that would be available in the closure scenario. Furthermore, the capacity increase will lead to verifiable cost savings for Nynas. Importantly, Nynas has failed to verify that the notified transaction would generally lower Nynas' variable cost of EEA production of naphthenic base and process oils. Therefore, the Commission concludes that the cost savings are merger specific.	No discussion of investment in new technologies
CASE M.6663	Ryanair/ Aer Lingus III	2013	Airline	Ryanair claims that the Transaction brings about substantial efficiencies, which would benefit all customers as Ryanair applies its cost-cutting expertise to improve Aer Lingus' efficiency, lower its costs and air fares, and enhance its competitiveness against other airlines at primary airports while growing both its short-haul and long-haul traffic. Ryanair expects to generate synergies and savings in most cost categories, in particular staff costs, turnaround times, aircraft costs, fuel costs, maintenance costs, airport and handling costs, and distribution and other costs. Furthermore, a significant proportion of the efficiencies projected by Ryanair are derived from economies of scale, which are not available to Aer Lingus	Aer Lingus will also be in a position to expand its long-haul offering by, opening new routes. This is not investment into new technology however.
CASE M.6570	UPS/ TNTEXPRESS	2012	Freight transport/ courier	UPS claimed that the Merger was expected to give rise to significant efficiencies through the combination of the UPS and TNT's businesses. It pointed out the expected significant economies of density and of scope, improved service quality, and transactional efficiencies by combining their complementary networks.	No discussion of investment in new technologies
CASE M.6471	OUTOKUMPU/ INOXUM	2012	Manufacture of iron and steel	The Notifying Party claims that the proposed transaction will allow the Parties to harness the productive efficiency of their plants, which would lead to both fixed and variable cost savings.	Furthermore, the Commission notes that the alleged plan aimed at increasing capacity and improving the efficiency of the Swedish assets which is outlined in the documents submitted by the Swedish Consortium necessarily requires significant investments. There is no indication on how timely these investments would be
CASE M.6458	Universal Music Group/EMI music	2012	Sound recording and music publishing	The Notifying Party notes that the proposed concentration, to the extent that it leads to a reduction in the fragmentation of rights, would likely lead to efficiencies.	No discussion of investment in new technologies
CASE M.6410	UTC/Goodrich	2012	Manufacture of air and spacecraft and related machinery	No efficiency arguments mentioned	No discussion of investment in new technologies

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2.2 Investment is the main driver of consumer benefits

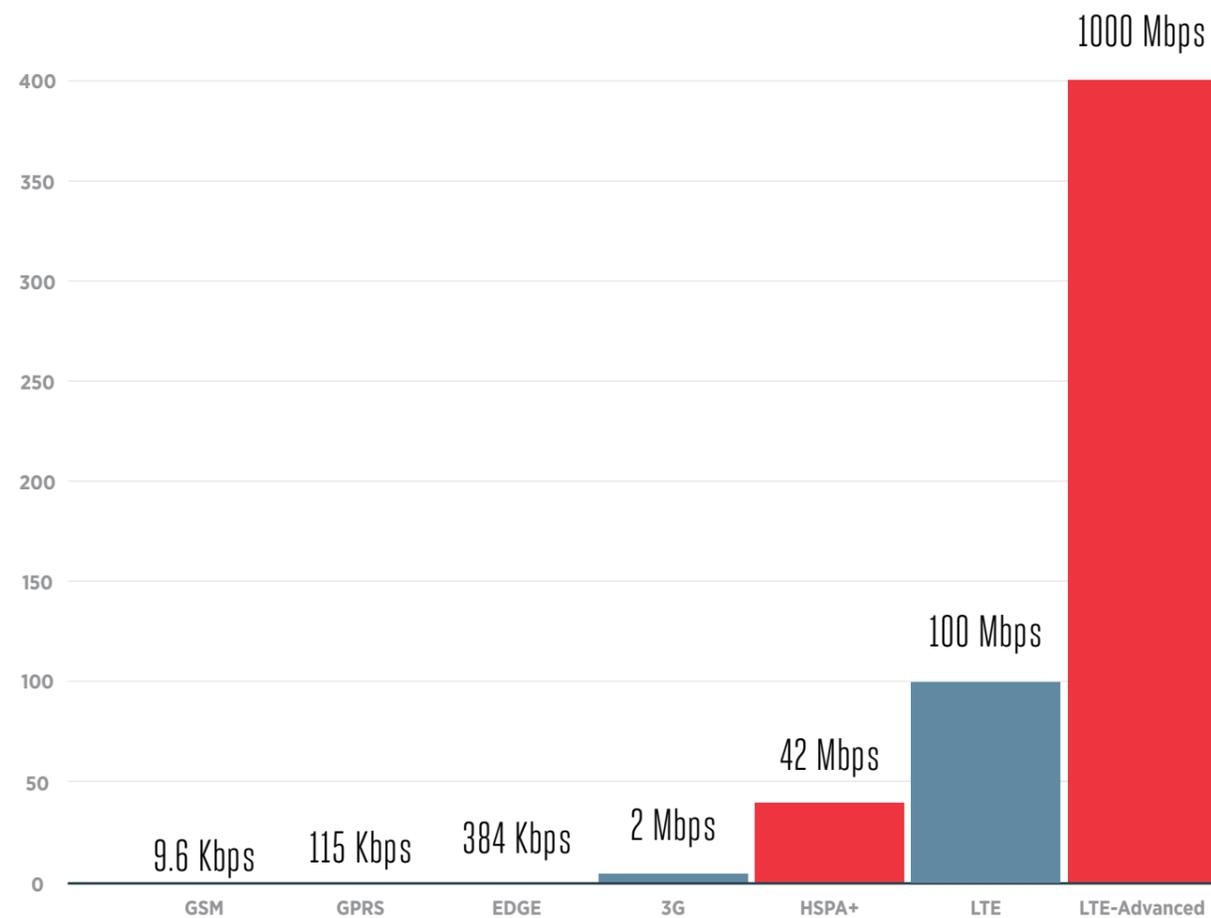
In the mobile sector, investment is likely to be the main driver of consumer benefits and social welfare. Investment in the mobile industry will benefit consumers in several ways:

- investment will impact the quality of existing products and services which the consumers receive,
- investment will enable innovation and the delivery of entirely new products and services and;

- investment will lead to improved efficiencies which will lower the unit prices that consumers pay for those products and services.

These are the key factors relevant for consumer welfare and each is highly dependent upon network investment in the mobile industry. Therefore, the impact of mergers on investment should be fundamental to any assessment of mobile mergers. We consider the impact of investment on quality and price below.

Figure 5
Data speeds have increased significantly with each technology cycle



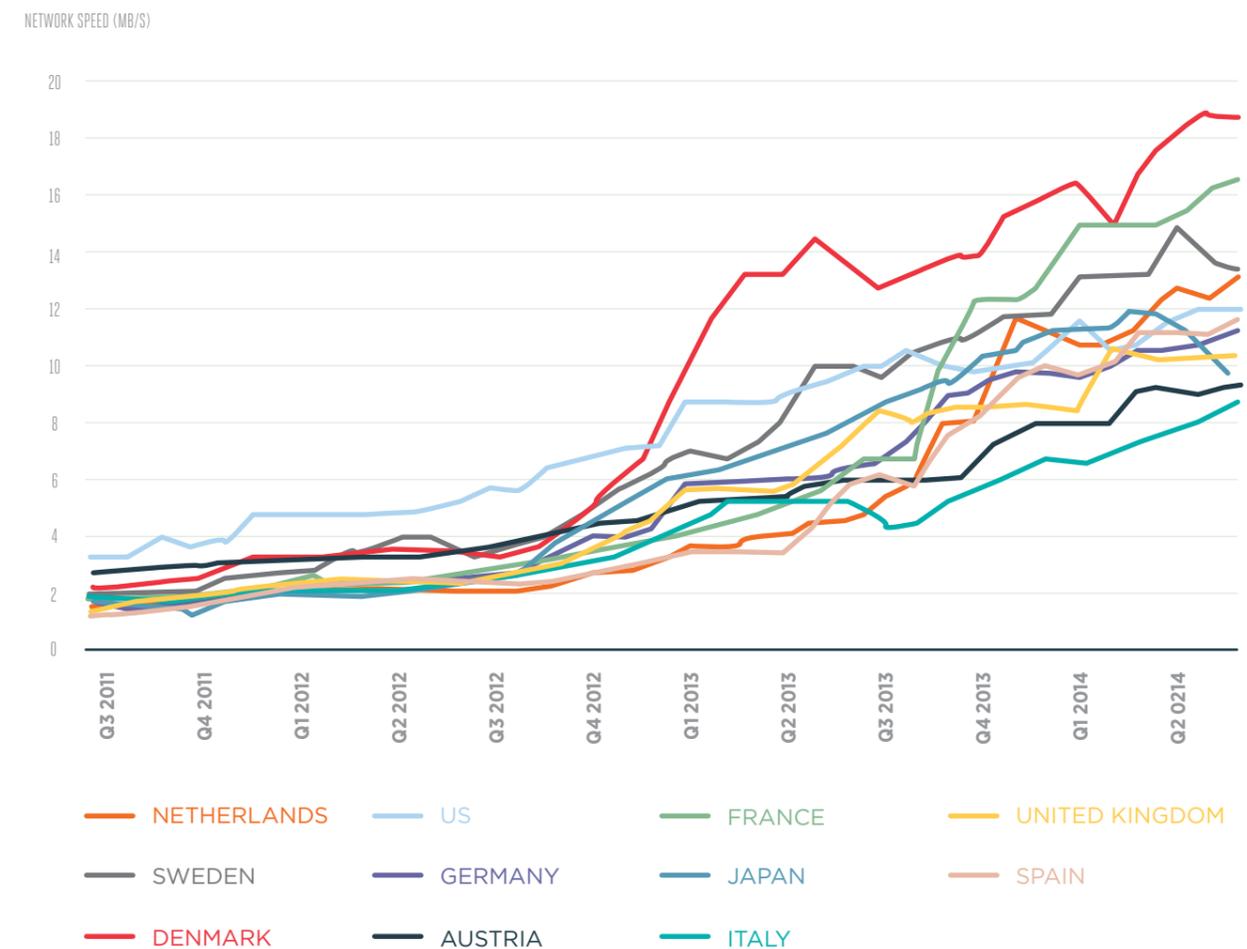
Source: Frontier based on ITU data

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In the past few years, operators have been rolling out 4G services, which have again improved data speeds and increased the range of applications that can be offered. The improved capabilities of the new technology has led to consumers across Europe experiencing higher quality services, as download speeds have increased significantly

over time and new services have been introduced, particularly video over mobile. The speeds that consumers now experience were not possible under the old technologies and therefore the investment into new mobile technology has been vital for achieving the level of quality customers now experience and have come to expect.

Figure 6
Download speeds in a number of European countries⁸



8. Average speed will be determined by both the capacity of the network and the amount of usage, which is why average speeds can go down in some periods if the increase in capacity is outweighed by an increase in the amount of usage.

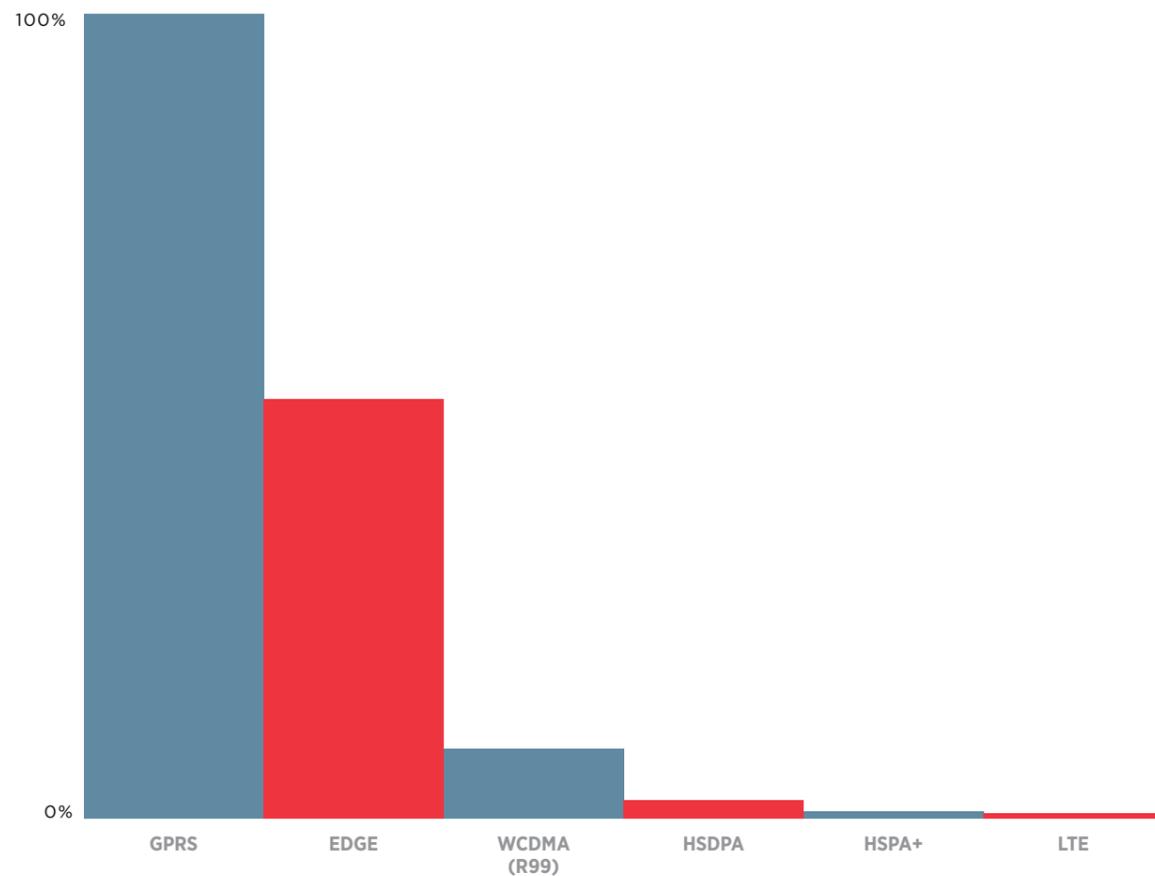
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2.2.2 Impact of investment on prices

As explained above, dynamic efficiency and investment in new technology has led to increases in quality. The cost of higher quality has also fallen, as new mobile technologies deliver significant increases in capacity and enable the launch of innovative new services which drive consumer demand to fill that capacity.

This growth in volume allows the unit costs of supplying both existing and new services to fall dramatically. Thus, as shown by the figure below, new technology cycles in mobile markets, produce dynamic efficiencies which translate into very large reductions in unit costs (often by a factor of 5 or more).

Figure 7
Cost per MByte as a % GPRS⁹



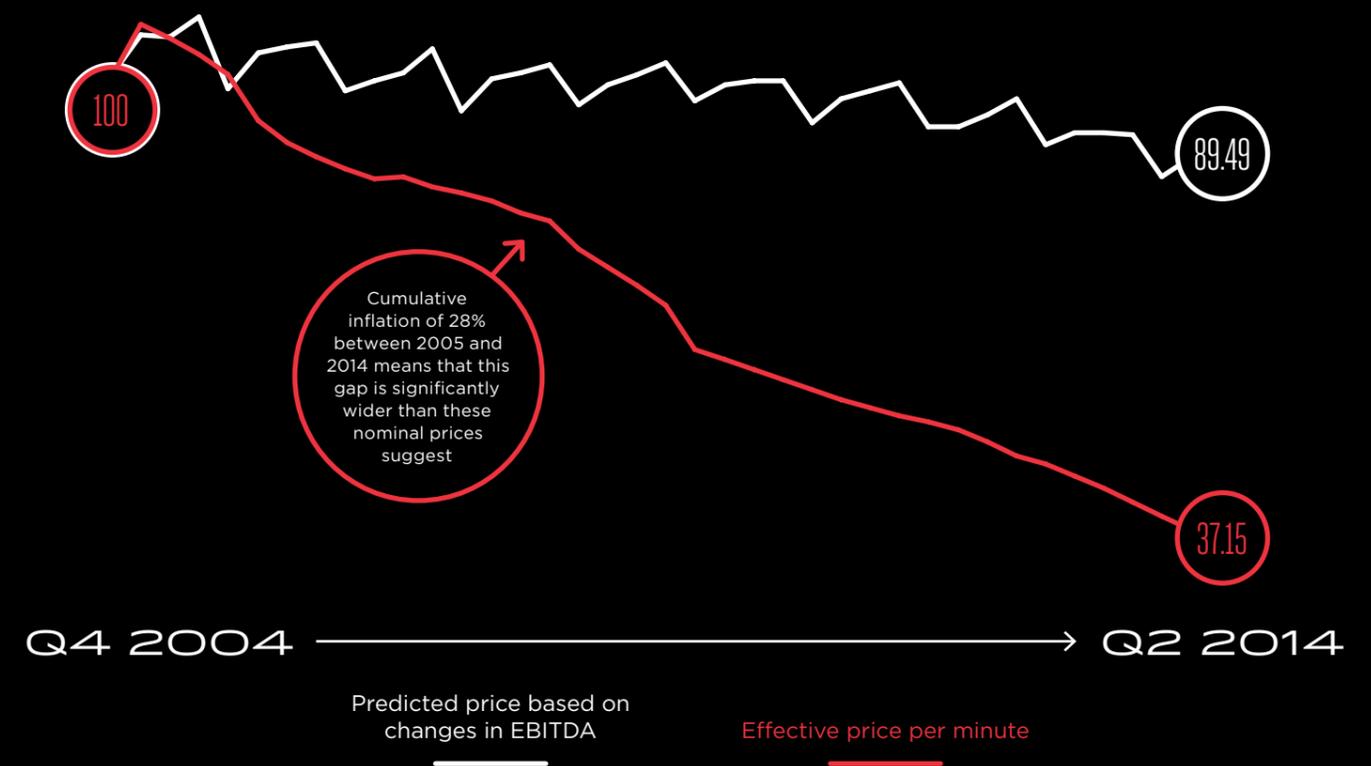
9. GPRS and EDGE are 2.5G technologies. WCDMA R(99) is a 3G technology. HSDPA and HSPA+ are 3.5G technologies. LTE is a 4G technology.
 10. There are different ways in which 'prices' can be measured. To be able to obtain the most comprehensive series, we have used country-level data on average revenue per minute.
 11. We note also that the later period is associated with a significant economic slowdown compared to the earlier period, hence the reduction in EBITDA margins may not reflect any structural change in the intensity of competition in mobile markets.

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The drastic falls in unit costs that arise from rolling-out new technologies would suggest that dynamic efficiencies related to such technology developments are the main driver of price reductions. We can see this by examining the trend in EBITDA margins and unit prices in Europe¹⁰ from 2004 to 2014. We find that voice unit prices have fallen significantly over time, although the fall in

EBITDA margins has been much smaller. The fall in EBITDA margins between 2004 and 2014 would suggest that unit prices should have fallen by 10%. However, in reality, unit prices fell by 63%. This suggests that the vast majority of unit price reductions arose from dynamic efficiencies due to the transition from 2G to 3G technologies during this period¹¹.

Figure 8
Unit price reductions compared to changes in EBITDA margins in EU markets



Source: Frontier Economics based on GSMA database

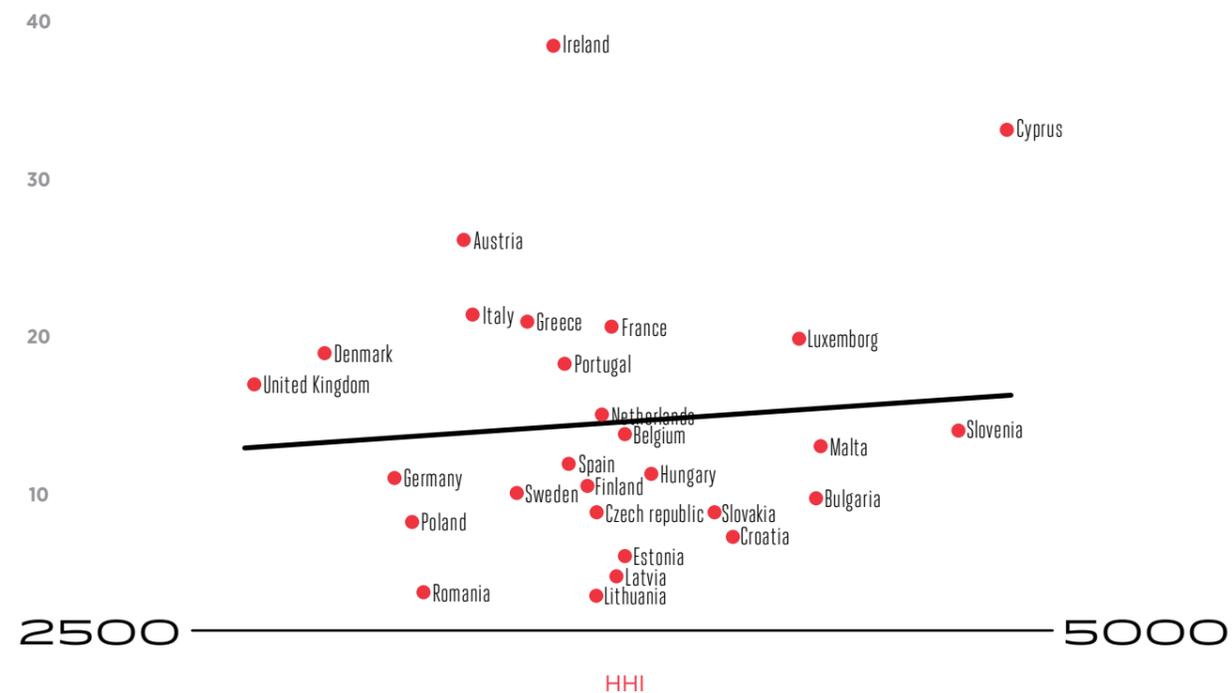
Note: analysis does not include Cyprus, Estonia, Luxembourg, Malta or Slovakia due to lack of data availability. The expected prices due to changes in EBITDA margins have been calculated as Price = Unit cost / (1-EBITDA margin) assuming that unit costs have stayed constant over time.

The above argument is supported by our econometric analysis included in section 3.1, which casts further doubt on the existence of a relationship between mobile unit prices and competition in three versus four player mobile markets.

2.3 Cross-country analysis suggests that investment is not higher in four player markets

Figure 9 suggests that there is not a strong direct link between average investment and competition in EU countries as measured by the HHI over the last 15 years.¹²

Figure 9
Relationship between capex per subscriber and HHI in EU countries



Source: Frontier Economics based on GSMA database

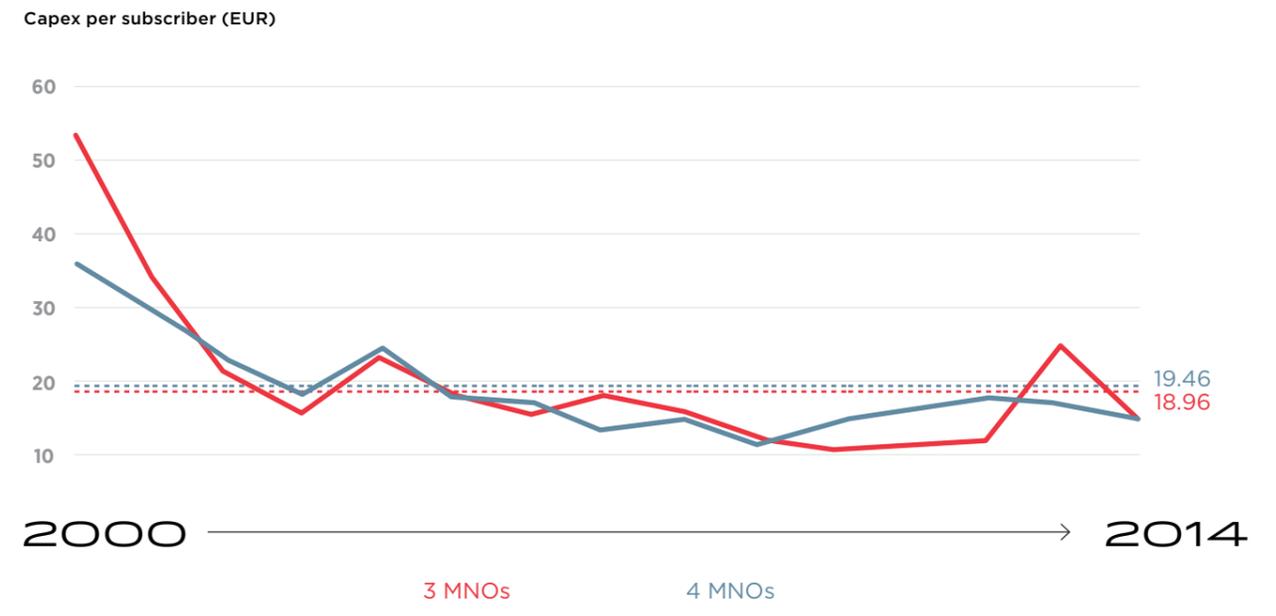
Note: data points are averages between 2000 and 2014 for three and four player markets

Moreover, Figure 10 shows that there is not a significant difference in investment in three and four player EU markets over the past 15 years.¹³

12. HHI is a rudimentary but commonly used measure of the intensity of competition, which is calculated as the sum of the squares of the MNOs.
13. We define an MNO as an operator with a market share of at least 5%.

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Figure 10
Capex per subscriber in EU countries



Source: Frontier Economics based on GSMA database

Note: (1) annual capex per subscriber calculated as the mean quarterly value for each MNO; (2) we include MNOs with a market share of at least 5%

We have also carried out a more sophisticated statistical analysis (based on econometrics) which suggests that the level of competition does not have a clear influence on investment. In particular, we used quarterly GSMA data between 2000 and 2014 for EU MNOs in three and four player markets to determine the key factors that influence capex per subscriber. This provides further evidence to support the results from our graphical analysis, which shows that there is no clear link between investment and competition in three versus four player markets.¹⁴

We have focussed on the difference between three and four player markets. We define a “player” as an MNO with a market share of at least 5%.¹⁵ We measure investment as capex/subscriber, which we consider is likely to be a superior measure of investment to capex/revenue, as this measure is also influenced by the level of prices. We do, however, also include results based on capex/revenue in annexe 2.

We note that finding a perfect measure of capex is challenging. The GSMA data that we have used is based on data from the mobile operators. In some cases, capex may have been measured using different methodologies. However, we have no reason to believe that this would bias our results, as there would only be a bias if operators in markets with a high level of competition tended to use a different methodology for measuring capex to operators in countries with a low level of competition. Moreover, capex data is generally volatile, making trends harder to distinguish. To address this issue, we present the results of our analysis using annual data in Annexe 2.

We have estimated a number of different models of capex to ensure that our results are robust. Table 2 provides the detailed results of our analysis for six such models. Relationship (1) is our preferred specification, which we sensitivity test through relationships (2) to (6).

14. Given that we find no difference in investment across three and four player markets, it is likely that there is more efficient investment in network infrastructure in three player markets. In three player markets, there will be less duplication of coverage-driven infrastructure. This means that the otherwise duplicative resources of a potential fourth player can be used for capacity-driven investment.

15. In Annexe 2, we have run various sensitivities, including considering the impact of relaxing this assumption by including operators with more than 2.5% market share, as well as including all markets regardless of the number of players in our sample.

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Table 2. Econometric analysis of the relationship between competition and investment

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	log(capex per subscriber)	log(capex per subscriber)	log(capex per subscriber)	capex per subscriber	log(capex per subscriber)	log(capex per subscriber)
HHI	-0.14 (0.31)	-0.44 (0.32)	-	0.01 (0.00)	0.14 (0.11)	-
4 player dummy	-	-0.12** (0.06)	-0.07 (0.06)	-	-	-0.06* (0.03)
Auction dummy	0.09** (0.04)	0.09** (0.04)	0.09** (0.04)	3.70*** (1.22)	0.08* (0.05)	0.08* (0.05)
3G network dummy	0.22*** (0.08)	0.24*** (0.09)	0.24*** (0.09)	2.46 (1.88)	0.15** (0.07)	0.15** (0.08)
4G network dummy	0.34*** (0.09)	0.33*** (0.10)	0.33*** (0.10)	5.79*** (2.19)	0.16** (0.07)	0.16** (0.07)
% prepaid connections	-0.38*** (0.11)	-0.40*** (0.12)	-0.40*** (0.12)	-12.87* (7.52)	-0.03 (0.02)	-0.03 (0.02)
GDP per capita (in PPP terms)	0.06 (0.46)	0.03 (0.48)	0.17 (0.44)	0.00*** (0.00)	0.35*** (0.05)	0.36*** (0.05)
Lagged capex per subscriber	0.18*** (0.05)	0.18*** (0.05)	0.18*** (0.05)	0.22* (0.11)	0.47*** (0.03)	0.47*** (0.03)
Number of observations	2,293	2,293	2,293	2,293	2,293	2,293
R²	0.22	0.23	0.23	0.15	0.40	0.40
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
MNO FE	Yes	Yes	Yes	Yes	No	No
Methodology	FE	FE	FE	FE	OLS	OLS

Source: Frontier based on GSMA database
 Figures in parentheses indicate robust standard errors
 *** p<0.01, ** p<0.05, * p<0.1; † R² values are not comparable between FE and OLS models
 Relationships (1), (2), (3), (5) and (6) are log-log models with all non-dummy variables in logarithmic form

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To determine the impact of competition on investment, we control for a range of other factors that may impact investment. These include the timing of 3G and 4G auctions, the launch of 4G services, the percentage of prepaid connections, GDP per capita and year dummies.

We also include the lag of capex per subscriber, as we would expect capex to adjust slowly in response to changes in other factors because the costs of doing so are high.¹⁶ Moreover, operators are likely to follow long-term investment plans, so we would expect a degree of path dependency in investment. Including lagged capex per subscriber also allows us to estimate the long-run impact of competition on investment, as outlined in more detail in annexe 2. Performing statistical tests on this impact suggests that competition does not materially influence investment in the long-run.

Overall, the results of our econometric analysis suggest the following conclusions:

- There is no evidence that more intense competition increases investment in the mobile markets we analysed, as indicated by the fact that the intensity of competition does not have a statistically significant or positive impact in any of our regression models.

- This conclusion is robust to the relationship that we assume about capex and its explanatory factors, as illustrated by the sensitivity tests carried out around our preferred specification.

- Several other factors appear to be important for determining capex. While not the focus of this study, and recognising that capex is generally volatile, our analysis suggests that past capex influences current capex. Increases in the share of post-pay subscribers may increase capex per subscriber, as post-pay subscribers tend to utilise 3G and 4G services more than pre-pay users. In contrast, increases in GDP per capita may result in increases in capex per subscriber, as increasing wealth increases users' budgets for mobile services. As expected, capex is higher in auction years and also for MNOs rolling out 3G and 4G networks.

16. The FE estimator is biased in autoregressive models, which is known as the "Nickell-bias" (<http://fmwww.bc.edu/ec-c/S2004/771/NickellEM81.pdf>). However, this bias disappears in datasets with many time periods. In our analysis we have 15 years of quarterly data.

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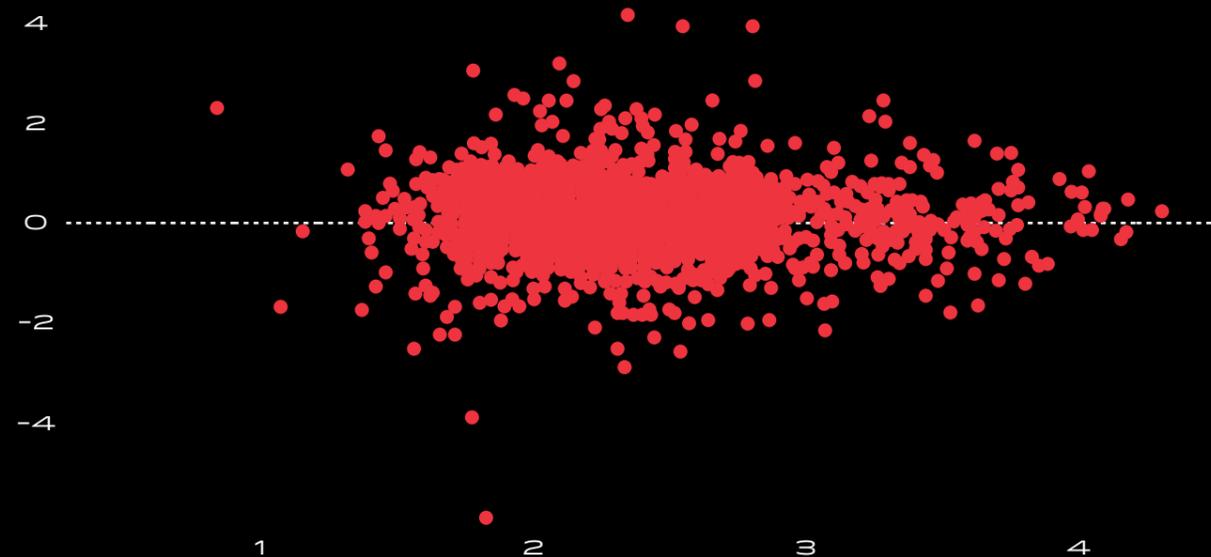
Preferred investment relationship

Relationship (1) is the preferred specification for the following reasons:

- Statistical tests suggest that the Fixed Effects (FE) model provides a better fit than Ordinary Least Squares (OLS) or random effects models, as shown in more detail in annexe 2. The FE model controls accounts for unobserved differences across countries and MNOs. This means that the estimated relationships solely rely on variations in competition over time and not across countries.
- In this situation, we consider HHI to be a more appropriate measure of the level of competition than a four player dummy. This is because HHI reflects the competitive landscape more accurately than an indicator of the number of players. Moreover, in an FE model, the dummy captures the effect of a change in the number of players within a country only.
- Converting data into logarithmic form reduces the impact of outliers on the results and is a common approach to econometric analysis.

Moreover, analysis of the residuals produced under relationship (1) suggests that there are no obvious outstanding systematic factors that influence investment. In particular, Figure 11 suggests that these residuals fluctuate randomly around zero.

Figure 11
Residuals under our preferred relationship (1)



Source: Frontier Economics

We have also carried out additional sensitivity tests on our preferred relationship (1), which provide consistent results. We provide details of these sensitivities in Table 3 below and in annexe 2. The results of these sensitivities imply that the results of our preferred specification (1) are robust to a wide range of factors.

Table 3. Sensitivities carried out on the preferred relationship between competition and investment

SENSITIVITY	CONCLUSION
Use instrumental variables to control for potential endogeneity	Results are similar to main specification, suggesting that endogeneity is not a significant issue
Use alternative measures of investment	Using capex/revenue or capex with subscribers as an explanatory variable provides results that do not differ significantly from main specification
Include spectrum as an explanatory variable	Results do not differ significantly from main specification
Use alternative definition of the number of MNOs	Applying a definition of 2.5% for the minimum market share to be considered an MNO does not provide significantly different results from the main specification
Include observations from markets with fewer than three or more than four operators	Results do not differ significantly from main specification
Use country level data instead of operator level data	Results do not differ significantly from main specification
Consider data from the past ten years	Results do not differ significantly from main specification
Remove outliers	Results do not differ significantly from main specification

Source: Frontier Economics

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2.4 Mergers are likely to increase the incentive and ability of the merging parties to invest under certain conditions

The greater significance of dynamic efficiencies from investment in new technologies in mobile markets (compared to many other sectors of the economy) suggests that particular attention needs to be paid to the impact that mergers may have on the ability and incentive of operators to invest, both in terms of investment in existing technologies within the technology cycle, and in terms of the capacity of the market to move from one cycle to another.

It is useful to start by distinguishing between the potential impact of a merger on the incentives of the merging parties to invest (which we call 'unilateral' incentives) and the potential impact of a merger on the incentives of all of the operators in the industry to collectively invest (which we refer to as 'multi-lateral' incentives).

In this section, we explain different ways in which mergers could impact individual operator's incentive and ability to invest. When operators merge, they are able to pool together their assets and customers. In previous merger cases, there has been much focus on the extent to which this allows operators to remove costs from their business. The Commission has concluded that it should, in general, place limited emphasis on efficiencies as it considers that the claimed efficiency gains may not be verifiable, and may not benefit customer and could be gained through network-sharing.

In light of the evidence outlining the benefits that

technology developments deliver to consumers of mobile services, we have focussed on the impact that the merger has on the merged firm's incentive and/or ability to make new investments. There are three mechanisms that mean that the merged firm may decide to increase investments:

- Economies of scale;
- Access to complementary assets; and
- Access to commercial partnerships to deploy innovative services.

In some cases, the merger increases the incentives of the merged operator to undertake certain investments by making the investment profitable. This is, for example, the case with coverage investments when the merger allows the merged party to reach the minimum scale necessary to cover certain areas. In other cases, the merger also provides the ability for the merged operator to undertake certain investments. For example, deploying Long Term Evolution (LTE) requires a minimum amount of spectrum in certain bands. By merging, two operators that could not deploy an effective LTE service on a stand-alone basis, may have the ability to do so by pooling their spectrum holdings. The table below summarises the different ways in which mergers may lead to a greater ability and incentive to invest.

Table 4. Unilateral ability and incentives to invest by the merged entity

Mechanism	Example	Ability to invest	Incentives to invest	Notes
Scale economies	Coverage	Yes/No ?	Yes	Particularly relevant when transiting to new technologies or in countries with coverage problems
Access to complementary assets	Spectrum	Yes	Yes	
Access to commercial partnerships	Mobile money	Yes	Yes	

Source: Frontier Economics

Consumer benefits may be greatest when the entity created by the merger enjoys cost or quality advantages, which the pre-merger entities lacked, and which its rivals will find difficult – but not impossible – to match.¹⁷ These would enable such a merged entity to serve customers, who are not economic for other operators to serve (for example, because coverage is unprofitable for those other operators), or to provide a higher level of quality (and hence better retail price) for the same underlying costs (for example, because the new merged entity can deliver network speeds which rivals cannot match).

A merger will need to produce (and any application of remedies will need to maintain) significant advantages if the merged entity is to alter its behaviour (relative to a non-merger

situation), but at the same time competition authorities will wish to ensure that a merger does not produce advantages which are so significant as to allow the merged entity to enjoy an unmatchable position.

We explain why operators may have a greater ability and incentive to invest following a merger than under network sharing in Section 4.

In the rest of this section, we explain how mergers can lead to increased investment due to:

- Economies of scale (section 2.4.1);
- Access to complementary assets (section 2.4.2); and
- Access to commercial partnerships to deliver innovative services (2.4.3).

17. This may be more likely to be the case if the merger leads to the creation of a market leader to the extent that such operators could be expected to have strong incentives to invest sufficiently to preserve a network and cost advantages once they have established them.

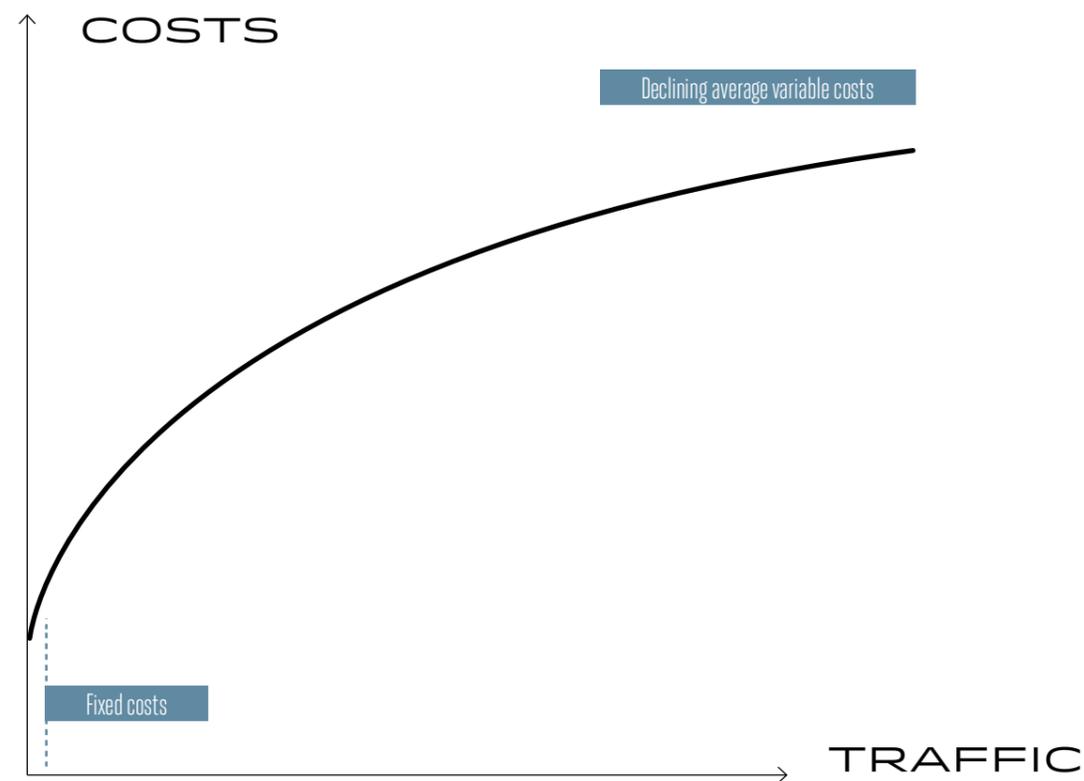
2.4.1 Economies of scale

Economies of scale mean that average costs fall at higher levels of output. They can arise for two reasons. Firstly, there are fixed costs associated with mobile networks that do not depend on the level of output. As output increases, these fixed costs can be spread over more units of output. Secondly, average variable costs may fall with higher output. For example, this could be the case if the cost of equipment is not directly

proportional to its capacity, meaning that a piece of equipment with double the capacity does not cost double the amount. We would expect the main source of economies of scale to stem from the spreading of fixed costs over more subscribers, rather than declining average variable costs.

The following Figure 12 illustrates both potential sources of economies of scale.

Figure 12
Economies of scale



Source: Frontier Economics

In the rest of this section, we consider the implications of economies of scale for investment decisions on coverage, network refreshment and product innovation.

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Coverage investments

There will be a fixed cost associated with rolling-out coverage to a new area. Therefore, the investment case will depend on whether there are sufficient subscribers over which to recover these fixed costs. The following Table 5 shows how it may be profitable for a merged operator to expand coverage into a new area, even though

it is not profitable for the individual operators to expand coverage in the absence of the merger.

The fixed costs associated with providing coverage comprise, among others, the costs of deploying the required base stations to cover a given area, including the necessary equipment, software licenses and installation costs.

Table 5. Impact of economies of scale on coverage investments

	Individual operator 1	Individual operator 2	Merged operator
Revenues	25	25	50
Fixed cost (constant)	20	20	20
Variable cost (no falling average variable cost)	10	10	20
Profit	-5	-5	10

Source: Frontier Economics

While consumers would always benefit from increased coverage by the merging party, the biggest impact on consumer welfare will be attained when the merger leads to an increase in overall coverage. That is, when the merging party takes the lead in covering areas which would

remain uncovered without the merger, instead of just matching the coverage of its competitors. This scenario is most likely to happen when the merger creates a market leader which is able to go beyond its rivals.

Network upgrades

As technology evolves, mobile operators upgrade their networks in order to benefit from lower costs and deploy new services. For example, vendors have introduced what is called "Single Radio Active Service (RAN)" equipment, which allows mobile operators to support multiple

communications standards (e.g. 3G and 4G) and services on a single network. Upgrading the network to Single RAN not only results in cost reductions (by requiring fewer base-station units) but also facilitates the introduction of higher quality services (such as LTE).

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Upgrading a mobile network incurs fixed costs, including installation costs, the cost of acquiring new equipment, etc. These costs can be significant. This is why the transition to new technologies takes some time. As in the case of coverage investments, the investment case will depend on whether there are sufficient

subscribers over which to recover the fixed costs required to upgrade the network. The table below shows how it may be profitable for a merged operator to upgrade its network in a given area, even though it isn't profitable for the individual operators to do it in the absence of the merger.

Table 6. Impact of economies of scale on network upgrades

	Individual operator 1	Individual operator 2	Merged operator
Incremental profit from upgrading the network (excluding investment cost)*	25	25	50
Fixed cost (constant) per operator	30	30	20
Incremental profit - cost of investment	-5	-5	10

Source: **Frontier Economics**

* The incremental profit may be due to lower variable costs or to a higher ARPU (as a result of the higher quality provided with the upgraded network).

Product innovation

A significant amount of the innovation which occurs in the mobile sector is 'complementary innovation', enabled but not performed by, the mobile network operators themselves. Thus, smartphones became attractive to consumers

once 3G networks were of sufficient scale and quality to deliver acceptable mobile data services. Today's rise in mobile video services, including Netflix, is being enabled by the roll out of 4G.

2.4.2 Access to complementary assets

In many cases, the merger allows the merging parties to pool complementary assets, which increase the ability of the merging party to undertake investments. This is, for example, the case when the merger results in improved spectrum holdings or when the merger provides access to a greater number of base-station sites. As a result of a merger, the new entity will be able to combine the spectrum holdings of the

two merged firms. This could increase investment for the following reasons:

- the merged operator can re-farm spectrum earlier; and/or
- the merged party is able to reach an efficient combination of low and high frequency spectrum.

Spectrum aggregation

There are some benefits that can be gained from aggregating spectrum, particularly when the starting point is below 2x10MHz, and particularly for LTE/4G. In certain cases, spectrum aggregation becomes necessary in order to deploy new services. Thus, the deployment of LTE services ideally requires a minimum amount of spectrum (2x10 MHz) within a given band to function properly.

Under a scenario where neither of the two parties involved in the merger hold the amount of spectrum necessary to deploy a new technology, the merger may provide the ability to the merged entity to invest in the new technology, by allowing the aggregation of spectrum. The spectrum aggregation resulting from a merger will also increase the incentives of the merged party to improve its capacity and, therefore, lower unit prices. This is because of the substitutability between network equipment and spectrum commented above. In addition, the merged party may be able to launch services using the aggregated spectrum which rivals may find hard to immediately match. This would be the case if the merger creates or increases the asymmetry in spectrum holdings between parties in the market.

Although the timing of spectrum auctions clearly has a bearing on the level of 4G take-up, the US appears to be an example where some asymmetry in spectrum holdings has contributed to a high level of 4G take-up. Asymmetries in spectrum holdings may encourage investment, as it may be more difficult for rivals to immediately

match the investments made, which may increase the potential return from investing in the first place.

Spectrum caps were introduced in the US during the 1990s by the FCC (Federal Communications Commission) with a view to promoting competition. However, they were gradually eliminated during the following decade.¹⁸ Caps were replaced by an approach of making case-by-case reviews of the aggregation of spectrum during auctions.¹⁹ During the 700MHz spectrum auction in 2008, 80% of the total revenue raised came from AT&T and Verizon.²⁰

Unlike in the EU, where spectrum caps are still used to minimise asymmetries, there is more asymmetry in the spectrum holdings of US mobile network operators. Two market leaders have emerged as a result, namely AT&T (31% market share) and Verizon (33% market share).²¹ Of the remaining main players, Sprint holds 15% and T-Mobile holds 16% market share.²²

The US 4G take-up figures are consistent with large players helping to lead the way in technology advancements. By the end of 2014, the number of 4G connections in the US was equal to 40.9% of the population. The weighted average across EU countries, on the other hand, was 12.3%.²³

These observations may suggest that mobile mergers can make it both feasible and worthwhile for them to make large investments, such as in new technology and infrastructure.

Spectrum re-farming

Different spectrum bands can be used for different technologies. When launching a new technology, operators may have to re-farm existing spectrum. For example, at present in Europe, 800MHz, 1800MHz and 2.6MHz is used for 4G services. However, 1800MHz is also used for 2G services. Therefore, 1800MHz will have to be re-farmed before it can be used for 4G services.

There are several obstacles that need to be overcome before spectrum, currently used for other services, can be re-farmed to allow the use of other technologies, such as 3G for voice, or LTE for packet data traffic:

- newer technologies require or produce optimal performance with sizable contiguous allocations of spectrum (2x5MHz for 3G and 2x10MHz for LTE) which may not be available through re-farming;
- a certain level of capacity and coverage will need to continue to be provided to offer service to customers who do not have handsets capable of using later technologies;
- re-farming requires additional spectrum or increased cost during the process as existing traffic needs to be carried in other frequency bands in order to clear spectrum prior to re-farming; and,

- re-farming requires incremental investments which may be difficult to justify unless there are large and demonstrable benefits of re-farming.

A merger may lower these barriers to re-farming and thus enable quicker re-farming compared with the counterfactual because:

- the combined spectrum holding may allow a merged operator to clear a sufficient amount of spectrum to provide advanced services;
- the (fixed amount) of spectrum required to provide services for legacy users will be a smaller proportion of the overall spectrum holdings for the merged entity; and
- the greater overall spectrum holding, and the greater capacity of the merged network, would enable spectrum to be cleared more easily with proportionately lower cost of migrating traffic to other bands.

A merger that allows operators to re-farm spectrum earlier will accelerate the deployment of new technologies as the merged operator will be able to deploy the new services at an earlier date.

18. <http://www.gsma.com/spectrum/wp-content/uploads/2012/07/Spectrum-Mobile-broadband-competition-and-caps-report-2009.pdf>

19. We do, however, note that the FCC is once again considering using spectrum caps in the upcoming 600MHz auction.

20. <http://www.gsma.com/spectrum/wp-content/uploads/2012/07/Spectrum-Mobile-broadband-competition-and-caps-report-2009.pdf>

21. GSMA database

22. GSMA database

23. GSMA database

By facilitating re-farming, a merger is likely to accelerate the deployment of new technologies

The UK case

After the merger between Orange and T-Mobile in the UK in 2010, the merged entity, Everything Everywhere (EE), announced a £1.5 billion investment into their 'Network Evolution Programme' to upgrade their existing hardware and prepare for the new 4G rollout.

The merger allowed EE to roll-out LTE faster than either Orange or T-Mobile would have been able to do, prior to the merger. This was because EE had sufficient spectrum holdings at 1800MHz to launch LTE before the auction of further

spectrum (in the 800 MHz band). Today, EE remains the market leader in LTE, both in terms of subscriber numbers and population coverage (in March 2014, EE already had 73% population coverage compared to 41% for O2 and 36% for Vodafone). EE's investments in LTE have prompted its rivals to roll-out 4G as quickly as possible, with both Vodafone and O2 aiming to have 98% population coverage by the end of 2015. In October 2014, EE became one of the first operators in Europe to launch LTE-Advanced services.

2.4.3 Access to commercial partnerships to introduce innovative services

In many cases, product innovations introduced by mobile operators are implemented through commercial partnerships with companies in other sectors. For example, the implementation of mobile banking is taking place via partnerships between mobile networks and banks. Other examples include the introduction of 'smart car' technologies in association with car manufacturers. In such cases, the chances of finding a successful partner to deploy an

innovative service may be higher for larger operators, as the new service is offered to a larger customer base, which makes the investment more attractive. By creating a larger operator, the merger will increase the ability of the merged party to participate in innovative partnerships. Ultimately, in a highly fragmented mobile market, consolidation may be the only way to adopt certain product innovations.

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Importance of operator's size in the deployment of mobile banking services

The successful deployment of mobile money services requires having a strong and reputable agent network.²⁴ Having a large customer base and an extended retail distribution network facilitate the introduction of mobile banking services. This suggests that it will be easier for a large operator to introduce mobile banking services compared with smaller ones.

GSMA's data on the introduction of mobile banking services over the world²⁵ shows that, indeed, these services have been introduced by leader mobile operators in 67% of the cases. In 81% of the cases, the operator leading the introduction of mobile banking services held a market share above 30% in terms of subscribers.²⁶

24. See for example: <http://blog.eservglobal.com/2010/12/09/the-central-role-of-agents-in-mobile-money/>

25. <http://www.gsma.com/mobilefordevelopment/programmes/mobile-money-for-the-unbanked/insights/tracker>

26. Market share data comes from Globalcomms.

2.5 The precise impact of a given merger on investment will depend on a number of factors

Although mobile mergers have the potential to have a positive impact on investment, the magnitude of the investment benefits from a particular merger is likely to depend on several factors.

- Timing.** Investment in the mobile sector has been driven by the launch of subsequent technological generations, including: the introduction of GSM or 2G communications in early 90s; the launch of 3G services in the late 90s; and, the launch of 4G services, which is a process taking place now in most countries. The impact on investment will be largest in transition periods between different generations of technologies. It is in these periods where the most investment is at stake and where first mover advantages can be established. Given that many operators are still rolling-out 4G networks, the next few years represent a time during which mergers could have a particularly beneficial impact on investment and therefore consumer benefit. This is consistent with the observed trend for mobile mergers in Europe, as the region moves from one technology cycle to another.
- Pre-merger position of merging parties.** The impact of the merger on investment may be largest when the merger creates a new 'leader' in the market.²⁷ The possibility of

differentiating from competitors creates an additional incentive for the merged entity to improve the quality of its services and seek to become a leader (e.g. increasing the speed of LTE deployment).²⁸ A merger that involves two players that do not create a 'leader' will also lead to consumer benefits by allowing the operators to catch up with competitors. However, the benefit may not be as great as that achieved when a leader launches better quality services than anyone else in the market.

- Post-merger asset holdings.** As spectrum is an essential asset for mobile operators, access to complementary spectrum assets is one of the key benefits from mobile mergers. However, the impact of the merger will be different depending on the post-merger position of the parties with regards to spectrum assets. A merger that allows the merged party to hold superior spectrum assets than its rivals will have a larger impact on investment than a merger which enables the parties to simply catch up with existing rivals. Having access to superior asset holdings may enable the merged entity to take the lead in the introduction of new services and/or improve the quality of existing ones. The possibility of taking a leadership position becomes a key investment driver.

27. We use the term 'leader' to denote a merged entity with an advantage that none of the pre-merger entities had and none of the rivals would be able to easily replicate. Such an entity may have the largest market share but this is not necessary.

28. This is not generally possible under a network sharing agreement between two or more operators as the possibility of differentiation would be reduced (at least in relation to the sharing partner).

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2.6 The positive impact on the merging parties' incentive and ability to invest is likely to outweigh any industry-wide impact on investment incentives

In addition to affecting the incentives to invest by the merged entity, a merger may affect the wider industry's ('multi-lateral') incentives to invest by leading to a more concentrated market. In the mobile industry, mergers are in general likely to have an ambiguous impact on the wider industry's incentives to invest. Therefore, it appears reasonable for authorities to focus on the impact that the merger has on the merging parties' ability and incentive to invest. The impact of mergers on the wider industry's incentive to invest depends on two opposing effects:

- **A Schumpeterian effect.** Firms with market power are likely to be able to extract greater profits from their customer base following a new investment. This is because it is less likely

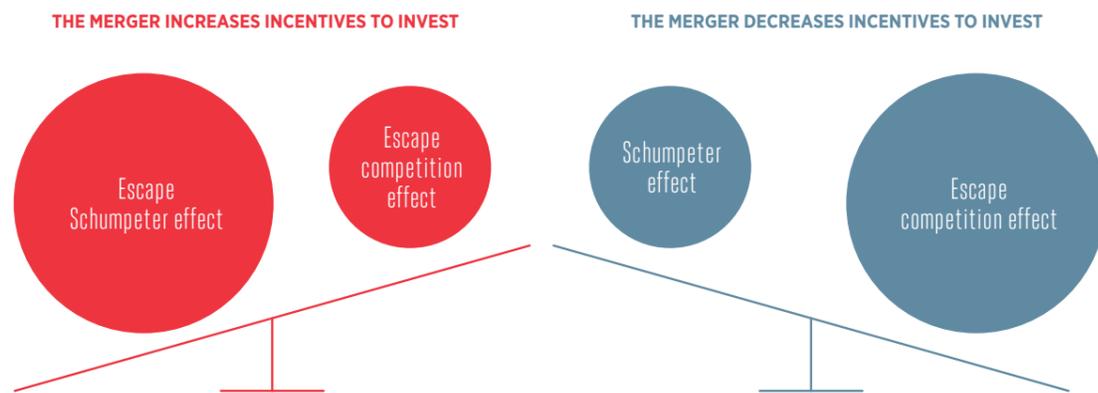
that higher margins from an investment will be competed away. This suggests mergers could increase incentives to invest.

- **Escape competition effect.** With a higher level of concentration, firms will have a weaker incentive to try to leapfrog their rivals to gain higher profits (since profits will be higher before the investment is made). The strength on this effect will depend on the extent to which rivals are able to match investments. If all players invest at the same rate, then the gain in market share from investing is likely to be limited.

Depending on which of the two effects dominates, a merger may increase or reduce the incentives to invest.

Figure 13

Impact of concentration on investment



Source: Frontier Economics

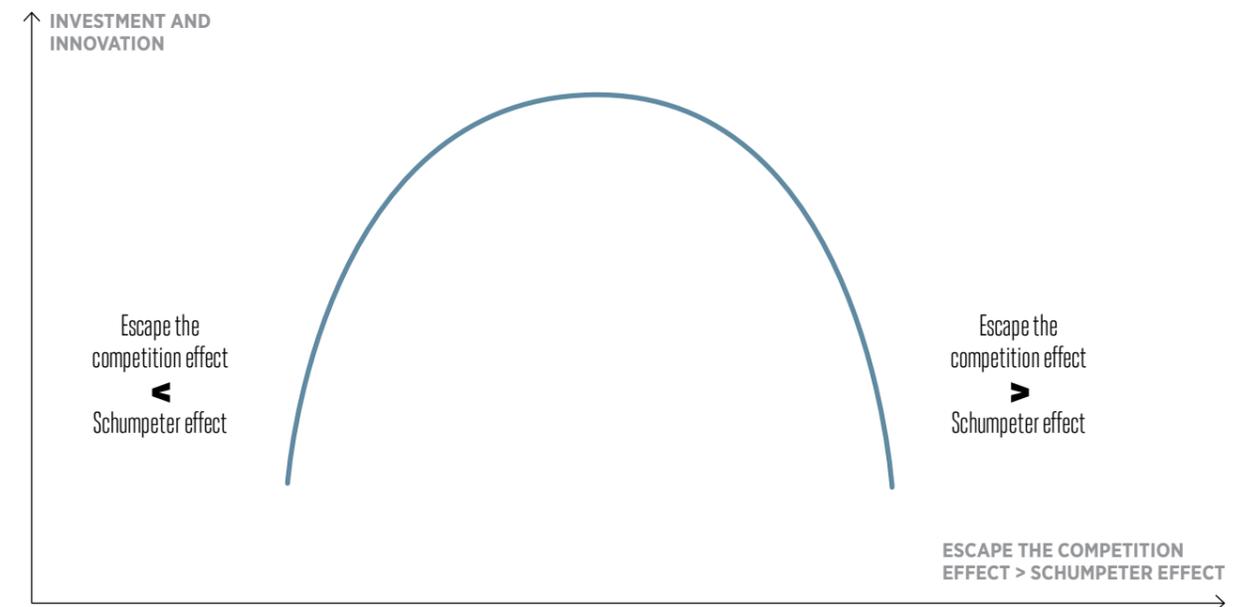
INVESTMENT IS A KEY DRIVER OF CONSUMER OUTCOMES IN MOBILE AND CAN BE AFFECTED POSITIVELY BY CONSOLIDATION

In the academic literature, there is no consensus on the relationship between investment and concentration. More recently, it has been

suggested that there may be an inverse U-shape relationship between investment and concentration,²⁹ as shown by Figure 14.

Figure 14

Inverted U-shape relationship between concentration and investment



Source: Frontier analysis based on Aghion et.al. (2005)

It is difficult to make general statements about which effect will dominate, as it will depend on the characteristics of the specific industry. It may be possible to make conclusions about which effect will dominate for extreme industry structures. For example, most (though not all) economists would agree that monopoly provision of most services would produce lower investment than competitive provision. But the position is more difficult if we consider smaller differences in the level of competition, as we might find when comparing a four player with a three player mobile market.

Our empirical analysis (section 2.3) supports the view that the identification of a 'generalised' significant and conclusive relation between the level of competition and operator's investment is challenging. We would, therefore, conclude that the incentives of a merged entity to invest, which are likely to trigger investments under some conditions, should be the focus of the analysis. Rivals may then be forced to increase their investment in order to be able to compete with the merged operator, leading to wider industry investment and consumers being better off.

29. Aghion et.al. (2005) suggested that the link between innovation and concentration may exhibit an inverted U-shape, depending on which of the two effects dominates. "Competition and Innovation: an inverted-U Relationship" (Aghion, Bloom, Blundell, Griffith and Howitt 2005).

INVESTMENT IS A KEY DRIVER OF CONSUMER OUTCOMES IN MOBILE AND CAN BE AFFECTED POSITIVELY BY CONSOLIDATION

3 Competition authorities' approach may overstate post-merger price increases

In merger cases, competition authorities will conduct an assessment of the anti-competitive effects of mergers, with a particular focus on the impact on prices. In recent cases, competition authorities in both Europe and the United States have used an analytical framework known as the Gross Upwards Pricing Pressure Index (GUPPI) analysis to predict what might happen to unit prices in mobile markets following mergers. In these cases, this type of analysis often predicts considerable price increases.

- In Germany, the Commission predicted price increases of 26% to 37% in the prepay segment³⁰;
- In Austria, the Commission predicted price increases of 10% to 20% in the post-paid segment³¹; and
- In Ireland, the Commission predicted price increases of 6% in the post-paid sector and 4% market wide (which is arguably not large).³²

These price predictions appear to be inconsistent with cross-country empirical evidence, which suggests that there is no clear link between concentration and unit prices. Evidence from Austria also suggests that unit prices are not higher than what they would have been absent the merger.

There are several reasons why a GUPPI analysis may provide misleading predictions for mobile markets. Firstly, the Commission has tended to use high margins, which ignores the fact that costs may be more variable in the context of rapid increases in data usage, which mean that frequent investment is required. Secondly, there are a number of reasons why the GUPPI model may not accurately capture the way that competition works in mobile markets, given that GUPPIs ignore capacity constraints, efficiency improvements and supply-side re-positioning.

Competition authorities and regulators in Europe have also attached considerable importance to the role of mavericks. Many of these mavericks entered around the time of the 3G auctions, at which time mobile operators were significantly more optimistic about the potential profits that could be made in the mobile sector. Given the current outlook for the sector, mavericks may in future be more cautious about investing in significant capacity and competing aggressively on price, and many have sought to exit (via mergers). Maverick returns on investment have tended to be poor, so they may now become more focussed on increasing their returns, rather than competing aggressively for new customers. Many mavericks have failed to acquire any 800MHz spectrum in the recent wave of 4G auctions, which suggests they may be a much less significant competitive force in 4G, or that they may also seek to merge.

30. <http://www.telecompaper.com/news/ec-fears-price-increases-from-o2-e-plus-merger-report--999139>

31. http://ec.europa.eu/competition/mergers/cases/decisions/m6497_20121212_20600_3210969_EN.pdf

32. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.264.01.0006.01.ENG

In the rest of this section, we explain in more detail why the existing approach of competition authorities is likely to overstate post-merger price increases. In particular, the rest of this section is structured as follows:

- In section 3.1, we describe our cross-country analysis that indicates that prices are not higher in markets with only three players or in markets with a higher HHI;

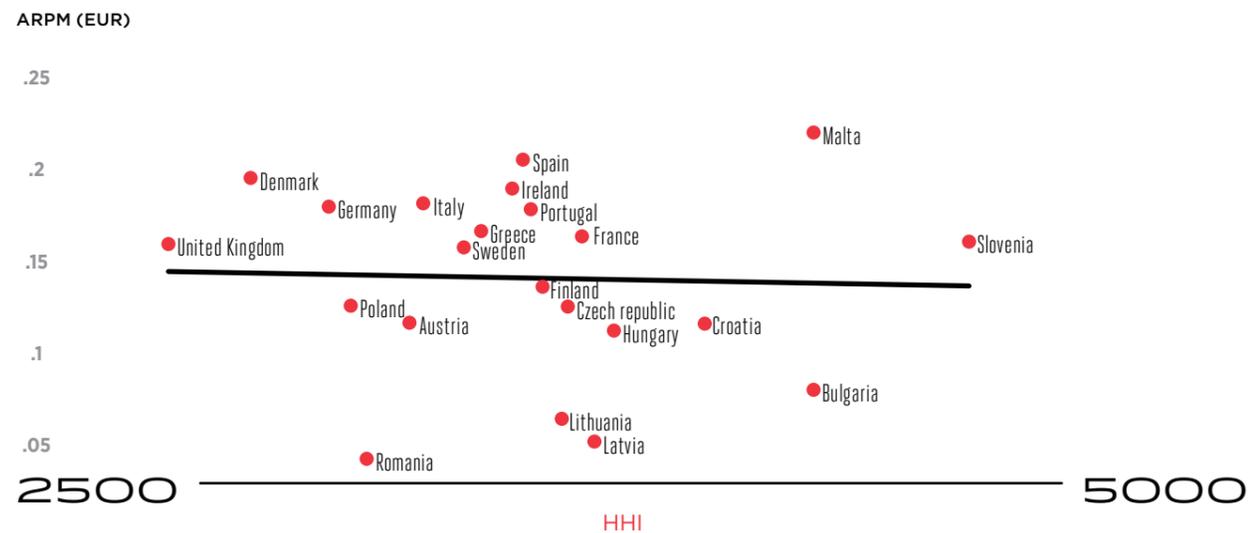
- In section 3.2, we set out the empirical evidence from Austria and show that there is no evidence that prices increased following the merger;
- In section 3.3, we explain why the price predictions implied by the GUPPI approach are not consistent with the empirical evidence; and
- In section 3.4, we discuss the outlook for mavericks.

3.1 Cross-country analysis suggests that prices are not higher in three player markets

The Commission's GUPPI approach suggests that all mergers should result in an increase in prices. We have assessed this claim by analysing the link between prices and competition using the GSMA's extensive database. Our analysis suggests that there is no clear evidence for a link between measures of competition and prices. This conclusion is robust to a range of different sensitivities. We have considered both a graphical analysis and more sophisticated statistical techniques.

A graphical analysis of both HHI and the number of players shows that there is no clear relationship between prices and measures of competition. Figure 15 shows that there is no obvious relationship between average prices, as measured using Average Revenue Per Minute (ARPM), and the level of HHI in EU countries over the last 15 years.

Figure 15 Relationship between ARPM and HHI



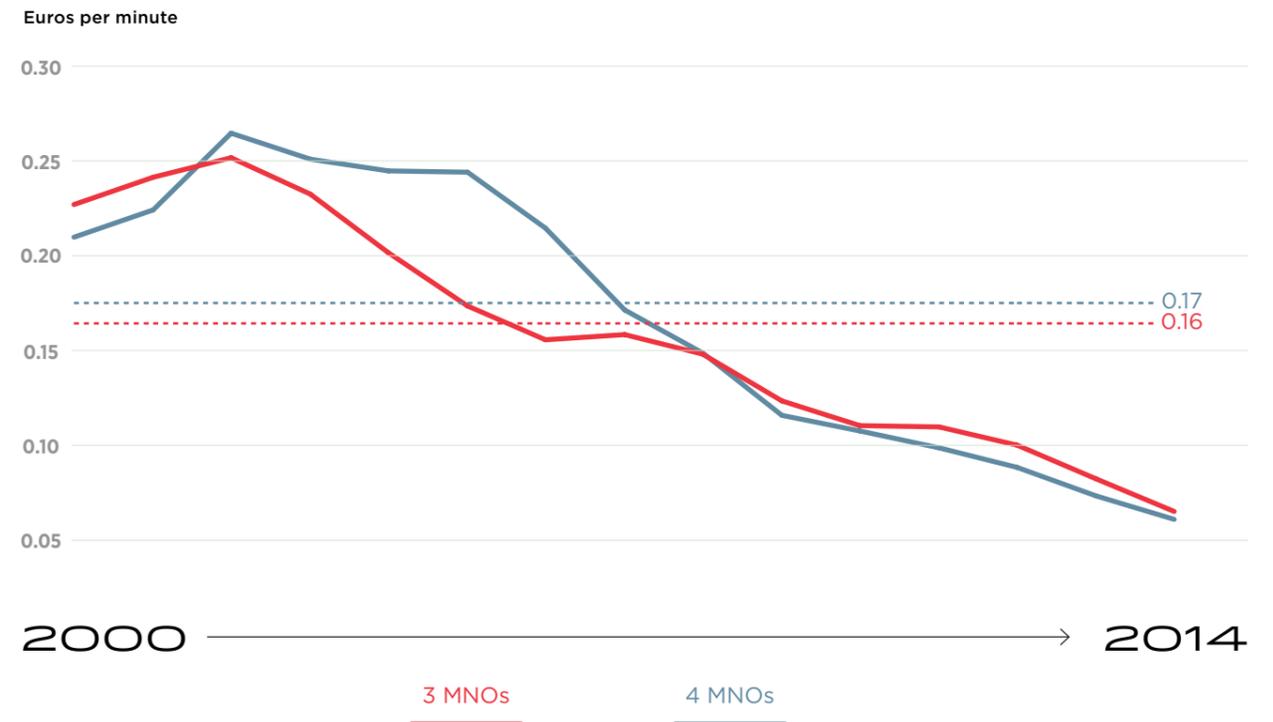
Source: Frontier Economics based on GSMA database

Note: data points are averages between 2000 and 2014 for three and four player markets

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

Furthermore, Figure 16 shows that there is no clear evidence supporting a link between competition and prices when we compare three and four player EU markets over time.

Figure 16 ARPM in EU countries over time



Source: Frontier Economics based on GSMA database

Notes: (1) we consider only those MNOs that have a market share of above 5%, and we do not include MVNOs (2) analysis does not include Cyprus, Estonia, Luxembourg or Slovakia due to lack of data availability (3) these prices are nominal (putting the data in real terms would not change the conclusions)

In addition to the above graphical analysis, we have also carried out a sophisticated econometric analysis which provides further evidence that there is no direct link between the level of competition and prices. In particular, we used quarterly GSMA data between 2000 and 2014 for EU MNOs. To focus on the difference between three and four player markets, we have restricted our sample to three and four player markets. We define a "player" as an MNO with a market share of at least 5%. However, in Annexe 2, we also consider the impact of relaxing this assumption, as well as including all markets regardless of the number of players in our sample.

We have measured prices using ARPM data. We consider that this is likely to be a superior

measure of prices to Average Revenue Per User (ARPU), given that ARPU does not take into account differences in usage. However, we do note that an ideal measure of prices would take into account data usage, particularly given that it has rapidly increased in recent years. Unfortunately, such information is not readily available, so we consider ARPM to be the best measure possible given these limitations.

We have estimated a range of different models to ensure that our results are robust. Table 7 provides the results of our analysis for six potential relationships between prices and its explanatory factors. Relationship (1) is our preferred specification, which we sensitivity test through relationships (2) to (6).

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

Table 7. Econometric analysis of the relationship between prices and competition

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	log(ARPM)	log(ARPM)	log(ARPM)	log(ARPM)	log(ARPM)	log(ARPM)
HHI	0.03 (0.06)	0.03 (0.06)	-	0.00 (0.00)	0.02 (0.02)	-
4 player dummy	-	0.00 (0.01)	0.00 (0.01)	-	-	-0.01* (0.00)
3G network dummy	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
4G network dummy	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	-0.00 (0.00)	0.00 (0.01)	0.00 (0.01)
% prepaid connections	0.00 (0.02)	0.00 (0.02)	0.00 (0.02)	-0.01 (0.01)	0.00 (0.00)	0.00 (0.00)
GDP per capita (in PPP terms)	-0.11** (0.05)	-0.11** (0.05)	-0.11** (0.05)	0.00 (0.00)	0.04*** (0.01)	0.04*** (0.01)
Subscribers	0.01 (0.03)	0.01 (0.03)	0.01 (0.03)	-0.00** (0.00)	0.00 (0.00)	0.00 (0.00)
Lagged ARPM	0.89*** (0.02)	0.89*** (0.02)	0.89*** (0.02)	0.83*** (0.02)	0.97*** (0.01)	0.97*** (0.01)
Number of observations	2,340	2,340	2,340	2,340	2,340	2,340
R²†	0.95	0.95	0.95	0.93	0.98	0.98
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
MNO FE	Yes	Yes	Yes	Yes	No	No
Methodology	FE	FE	FE	FE	OLS	OLS

Source: Frontier Economics based on GSMA database
 Figures in parentheses indicate robust standard errors
 *** p<0.01, ** p<0.05, * p<0.1; † R² values are not comparable between FE and OLS models
 Regressions (1), (2), (3), (5) and (6) are log-log models with all non-dummy variables in logarithmic form

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

We control for a range of factors that may impact the level of prices. These include the launch of 3G and 4G services, the share of prepaid connections, GDP per capita and subscriber numbers. We also include year dummies in our models, as prices have tended to show a strong trend over time, as shown in Figure 16. We also take into account the approach taken by the European Commission in its analysis of the recent mobile merger in Ireland.

We also include the lag of prices because we might expect it to react slowly to changes in other factors, given that doing so could incur significant costs.³³ Including lagged prices also allows us to estimate the long-run impact of competition on prices, as outlined in more detail in annexe 2. Performing statistical tests on this impact suggests that competition does not materially influence prices in the long-run.

Overall, the results of our econometric analysis suggest that:

- **There is no clear relationship between the level of competition and prices**, as illustrated by the fact that the level of competition is not significant in the vast majority of specifications. This challenges the GUPPI approach (in so far as it is applied to mobile markets), which would imply that prices would typically be higher in more concentrated markets.
- **This conclusion is robust to the assumptions that we make about the relationship between price and its explanatory factors**, as illustrated by the sensitivity tests carried out around our preferred specification.
- **Other factors appear to be important for determining prices**. In particular, past prices are an important determinant of current prices. In some relationships, GDP per capita and the availability of 4G services also have an impact on prices. However, we cannot conclude from this evidence that these factors systematically influence prices.

33. The FE estimator is biased in autoregressive models, which is known as the "Nickell-bias" (<http://fmwww.bc.edu/ec-c/S2004/771/NickellEM81.pdf>). However, this bias disappears in datasets with many time periods. In our analysis we have 15 years of quarterly data, so it is unproblematic to include lagged capex.

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

Our preferred price relationship

Relationship (1) is our preferred specification for the following reasons.

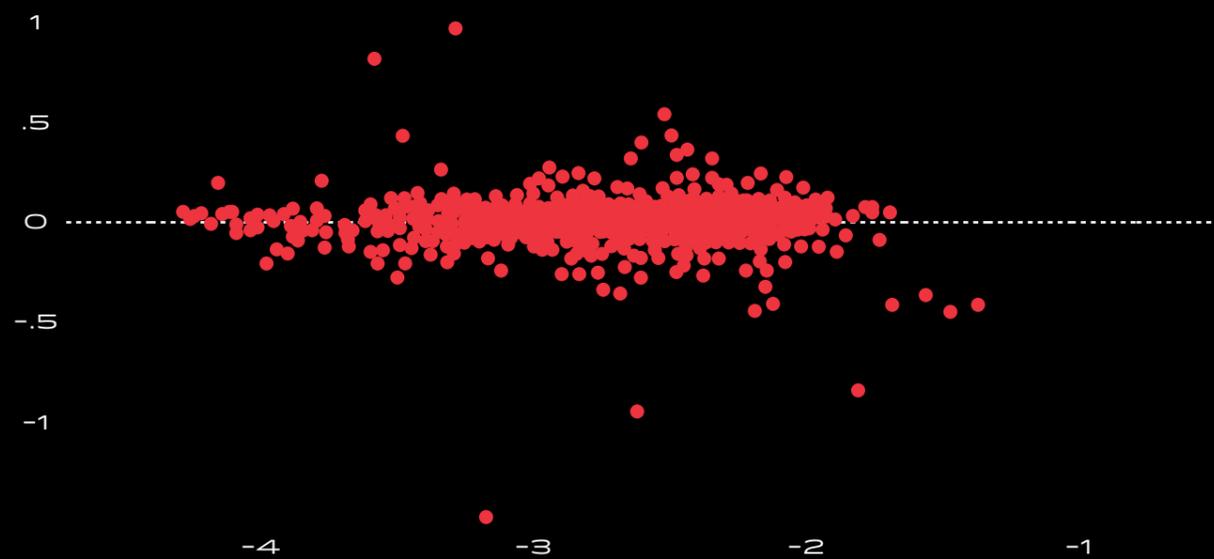
- Statistical tests suggest that the Fixed Effects (FE) model provides a better fit than Ordinary Least Squares (OLS) or random effects models, as shown in annexe 2. The FE model controls for unobserved differences across countries and MNOs. This means that the estimated relationships solely rely on variation in competition over time and not across countries.
- As set out in our analysis of the relationship between competition and investment, we consider HHI to be a more appropriate measure of the level of competition than a four player

dummy. This is because HHI reflects the competitive landscape more accurately than an indicator of the number of players. Moreover, in an FE model, the dummy captures the effect of a change in the number of players within a country only.

- Converting data into logarithmic form reduces the impact of outliers on the results and is a common approach to econometric analysis.

Analysis of the residuals produced under relationship (1) suggests that there are no obvious outstanding systematic factors that influence prices. In particular, Figure 17 suggests that these residuals fluctuate randomly around zero.

Figure 17
Residuals under our preferred relationship (1)



Source: Frontier Economics

We have carried out further sensitivity tests on our preferred relationship (1). These are summarised in Table 8 below and in annexe 2 in more detail. The results of these sensitivities suggest that our results are robust to a range of factors.

Table 8. Sensitivities carried out on the preferred relationship between competition and investment

SENSITIVITY	CONCLUSION
Use instrumental variables to control for potential endogeneity	Results are similar to main specification, suggesting that endogeneity is not a significant issue
Use alternative price measures	Using ARPU provides results that are not significantly different from our main specification
Include opex as an explanatory variable	Results do not differ significantly from main specification
Include spectrum as an explanatory variable	Results do not differ significantly from main specification
Use alternative definition of the number of MNOs	Applying a definition of 2.5% for the minimum market share to be considered an MNO does not provide significantly different results from the main specification
Include observations from markets with fewer than three or more than four operators	Results do not differ significantly from main specification
Use country level data instead of operator level data	Results do not differ significantly from main specification
Consider data from the past ten years	Results do not differ significantly from main specification
Remove outliers	Results do not differ significantly from main specification

Source: Frontier Economics

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

3.2 The available evidence from Austria does not suggest that three to four mobile mergers should in general be expected to lead to higher prices

In this section we look at the recent MNO merger in Austria (2012) to determine the effects of the mergers on consumer outcomes, particularly prices.³⁴ When the merger was considered by the Commission, the GUPPI approach predicted significant increases in prices following a reduction in players in the market, but there is little evidence to support that prediction in Austria.

It is challenging to isolate the exact impact of a merger on prices. This is because there are a number of factors that are unrelated to the merger that will also affect prices. However, given the magnitude of the price predictions implied by the GUPPI approach, then it should be possible to observe a notable difference in the price trend, unless there are other significant developments to the market at that point in time.

In 2012, the Commission cleared the proposed acquisition of Orange in Austria by Hutchinson 3G (H3G) subject to remedies, including the divestment of spectrum and wholesale access agreements and potential roaming agreement with a new entrant. The Commission was concerned that the market was characterised by

high barriers to entry and high concentration. The Commission found sizable GUPPIs, given the use of high prices and material diversion ratios. The parties were considered close competitors, when considering pricing and tariff structures for smartphones and data. H3G was viewed as an important driving force of competition in the market and the Commission was concerned that their incentive to continue this would be reduced as a result of the merger.

The GUPPI tests performed by the Commission indicated that the merger may lead to predicted price increases in the region of 10-20% for post-pay tariffs, which they considered to be a high price increase. The Commission was also conscious that second round effects could lead to further price rises, although these effects were not quantified in the Austria case.³⁵

The Commission considered that MVNOs were unlikely to offer a competitive constraint on the merged entity. Furthermore, the Commission argued that efficiency gains were unlikely to mitigate its competition concerns. The remedies required aimed to allow the entrance of a new MNO into the market to maintain competition.

Following the merger, BWB (the Austrian competition authority) has recently launched an investigation into the Austrian mobile market due to alleged price increases published by the RTR (the Austrian Regulatory Authority). The price indices published by the RTR contain a number of characteristics, which may not present an accurate reflection of consumer welfare for the market as a whole because:

- The price indices solely focus on new tariffs;
- There is no weighting of the different tariffs based on take-up; and
- The usage for the different consumption baskets increase over time, so consumers will be getting more for their money.

34. Lack of sufficient data has prevented us considering other mergers (the Netherlands (2007), the UK (2010) and Australia (2009)).

35. In contrast the Commission did attempt to quantify them in the German and Irish cases.

There has also been a recent study by the Vienna Chamber of Labour,³⁶ which suggested there have been significant price increases. Again, this study relied on an analysis of different tariffs, so may not be reflective of the prices actually paid by consumers.

The Austrian evidence relates to a short time period, whilst mobile market performance (in terms of consumer welfare measures such as the quality, availability and price of mobile services) should be judged over a much longer time period to accommodate changes in technology cycles. As indicated by Figure 18, the long-run pricing evidence that we have examined is not consistent with prices being higher or falling less rapidly in three compared to four player markets. With this in mind, we have analysed the underlying data from the RTR on the Austrian mobile sector to

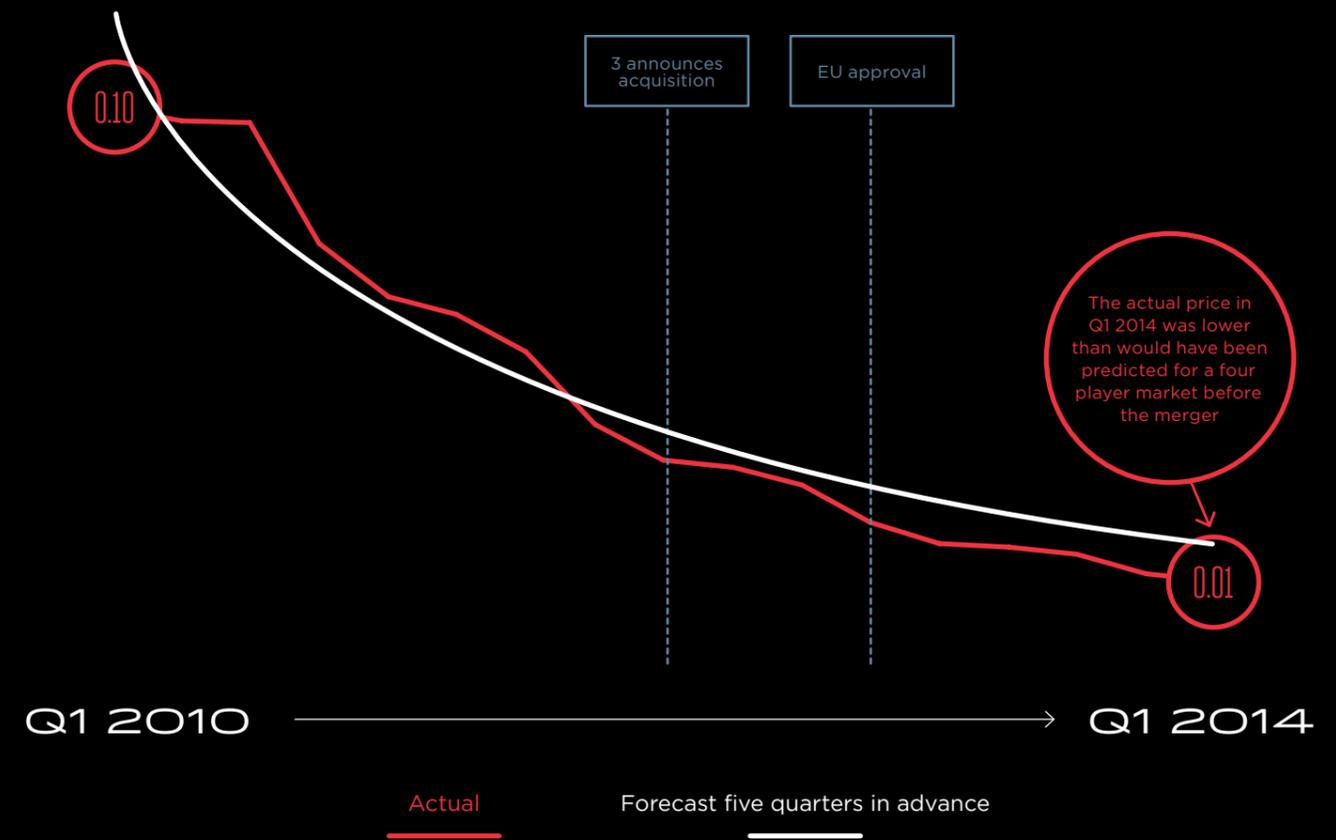
assess trends in unit prices in the short period since the merger.

Post-merger, the Average Revenue Per User (ARPU) in Austria has remained relatively flat and in line with the pre-merger trends, contrary to the predictions of the GUPPI approach. This occurs despite trends in usage. The number of minutes per SIM card has remained constant since the merger, SMS per SIM has declined slowly, but mobile data usage per SIM has increased dramatically since 2010. This does not appear to suggest that consumers are worse off as a result of the merger in Austria. The price per average MB of voice, SMS and data in Austria has fallen since 2010. In Q2 2014, the unit price was lower than the pre-merger trend would have predicted. Figure 18 shows this trend and the forecast which is based on a logarithmic trend.³⁷

36. http://media.arbeiterkammer.at/PDF/Analyse_Handytarife_2013-2014.pdf
 37. We use a logarithmic trend as a linear trend would predict that prices would eventually reach zero, which is unrealistic.

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

Figure 18
Price per average MB of voice, SMS and data in Austria



Source: RTR

Notes: (1) price calculated based on conversion factors of 12.2 kbps for 3G voice and 150 bytes for SMS, which is in line with what Ofcom used in its Mobile Termination Rate model (2) forecast based on a logarithmic trend (3) prices are in nominal terms.

Although we present results based on the RTR data available, we do not consider that any robust conclusions should be drawn one way or the other from the performance of the Austrian mobile market at this stage, although we do note that the period after the merger is of particular interest given that the remedies had not been fully implemented by this point.

What evidence we have on prices suggests no immediate grounds for concern, but the impact of the merger on other aspects of market performance, notably, quality, innovation, speed of roll-out and therefore long term prices, would require consideration of the merger impact on investment across technology cycles. This is a task for a future study

3.3 The GUPPI approach may require improvements to be used in mobile markets

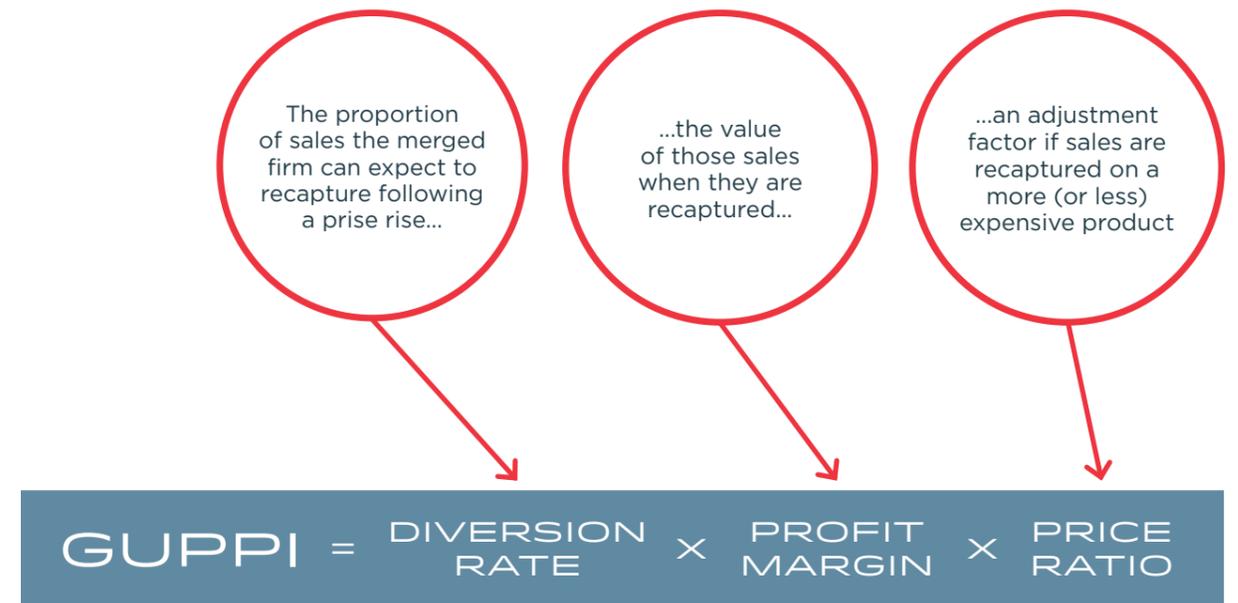
When considering a potential merger, competition authorities will pay close attention to the likely impact of competition. Authorities tend to be concerned that a merger may result in unilateral effects and a worsening of competitive offerings by the firms in the market. The extent of the impact on competition will depend on how intensively the merging firms compete with each other, and the extent to which customers view their products as substitutes. Worsening competitive conditions can result in higher prices, reduced quality, or reduced innovation

in the market. Since the price effect is easiest to measure, the Commission (and other competition authorities) often focuses on this.

The GUPPI³⁸ (Gross Upward Pricing Pressure Index) is a simplistic tool for indicating the pricing pressures resulting from a merger. The GUPPI considers the incentives to raise prices after the merger by considering the diversion ratio, profit margin and relative prices, as shown in the figure below.

Figure 19

The GUPPI calculation



Source: Frontier Economics

The greater the GUPPI, the more likely that the proposed merger will lead to a significant price increase.³⁹ It is worth noting that the GUPPI itself does not directly provide the predicted price increase, but the two measures are closely

related. Figure 20 shows that higher diversion ratios and larger profit margins give rise to higher GUPPIs.⁴⁰ Diversion ratios attempt to capture the closeness of competition between the merging parties.

38. The GUPPI approach is based on Farrell and Shapiro's (2010) upward pricing pressure (UPP) concept which is based on a Bertrand Nash differentiated products framework. See annex for more details.

39. A GUPPI below 10% is typically considered to not be a cause for concern.

40. The price ratio is often considered to be around one when the products of both firms are similar, so tends to "drop out" of the calculations.

Figure 20
GUPPIs under different diversion ratios and variable margins⁴¹

		VARIABLE MARGIN							
		20%	30%	40%	50%	60%	70%	80%	90%
DIVERSION RATIO	5%	1%	2%	2%	3%	3%	4%	4%	5%
	10%	2%	3%	4%	5%	6%	7%	8%	9%
	15%	3%	5%	6%	8%	9%	11%	12%	14%
	20%	4%	6%	8%	10%	12%	14%	16%	18%
	25%	5%	8%	10%	13%	15%	18%	20%	23%
	30%	6%	9%	12%	15%	18%	21%	24%	27%
	35%	7%	11%	14%	18%	21%	25%	28%	32%
	40%	8%	12%	16%	20%	24%	28%	32%	36%
	45%	9%	14%	18%	23%	27%	32%	36%	41%
	50%	10%	15%	20%	25%	30%	35%	40%	45%

Source: Frontier analysis

When competition authorities have applied the GUPPI approach to mobile markets, they have typically found high GUPPIs because they have used:

- High margins. Competition authorities have argued that the majority of MNOs' costs are fixed in nature, as they do not vary with the level of output. This has therefore led to the use of high margins.

- High diversion ratios. Many mobile markets, at least within the EU, have three to four players. This implies that there is likely to be significant switching between merging parties. Competition authorities have typically measured the degree of switching, and thereby the diversion ratios, by using mobile number portability data.

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

The way in which competition authorities have applied GUPPIs to mobile market to date suggests that the majority of potential mobile mergers in Europe would be considered as problematic. We undertook an analysis to show the proportion of all potential mobile mergers in the EU that would cause concerns if the Commission relied heavily on a GUPPI analysis.

In sections 3.1 and 3.2, we explained that the price predications implied by a GUPPI analysis are not consistent with the empirical evidence. There are several reasons why the way in which competition authorities apply the GUPPI approach to mobile markets is likely to overstate the upward pricing pressure from mergers. Firstly, the GUPPI approach does not take into account efficiency improvements which could more than offset any short-term price pressures. These were discussed in Section 2.4. Secondly, the GUPPI approach ignores the significance of capacity constraints. Thirdly, the diversion ratios used ignore any supply-side repositioning of operators. Fourthly, the GUPPIs are calculated for narrow segments. Fifthly, the margins used are likely to be too high as they do not take into account that costs will be more variable given the continuous investment that takes places in the mobile sector. An alternative approach to using GUPPIs is to undertake demand estimation and perform a merger simulation. This involves estimating consumer demand based on estimates of cross

price elasticities and switching rates. Whilst this removes the reliance on margins and diversion ratios, it is complex to calculate accurately, and is likely to be sensitive to the exact approach used. The Commission has undertaken demand estimation in some recent cases. This has generally produced lower pricing pressure results than the GUPPI analysis – highlighting some of the weaknesses in relying solely on GUPPIs, however, is also subject to calculation issues. Replacing the use of GUPPIs with demand estimation may not be appropriate, as in some cases the results from demand estimation models can be quite sensitive to the exact approach used.

Given the lack of a strong alternative to the GUPPI approach, we consider that, at a minimum, competition authorities should reduce the margins used in the GUPPI analysis and place less weight on the results. The rest of this section explains how the GUPPI approach could be improved and the limitations that are still likely to be present once such improvements have been made. In particular, we discuss why,

- The approach to calculating margins could be improved; and
- Less weight should be attached to the GUPPI approach even if the calculation of margins is improved.

3.3.1 The approach to calculating margins could be improved

The calculated GUPPIs will be affected by the way in which competition authorities estimate margins. The current approach to GUPPIs is likely to lead to excessive margin estimates and subsequently inflated GUPPIs. By considering a short time horizon and small changes in output, they underestimate the proportion of costs that

are variable. In addition, historical margins may not provide an accurate indication of future margins, given the increasing growth of OTT services. The above effects contribute to higher GUPPIs which will lead to more potential mergers appearing to result in competition concerns relating to upward pricing pressure.

41. The GUPPIs would be even higher if considering the second round effect of price rises, which the Commission calculated for the recent mergers in Ireland and Germany.

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

The impact of margins on GUPPIs

The margin used in the GUPPI calculation can have a significant effect on the result. For example, if we assume the prices of each operator are equal and 20% of the lost sales resulting from a price increase would be recaptured by the other merging party, then doubling the margin would double the GUPPI.



This implies that it is important to carefully consider the appropriate approach to estimating margins when calculating the GUPPI.

Considering the longer term nature of decisions is more realistic and takes account of the impact on the customer in the longer run, rather than immediately after the merger. This is important given the dynamic nature of the mobile industry where constant improvement and development is critical for customers. The customers' welfare must be considered in the longer run given the significant investments required to keep up with increasing usage and demand for quality improvements.

In the following sections, we explain why the current approach to measuring margins could be improved. In particular, we explain that:

- a greater proportion of costs should be considered as being variable; and
- using historical margins may be misleading.

A greater proportion of costs should be considered as being variable costs

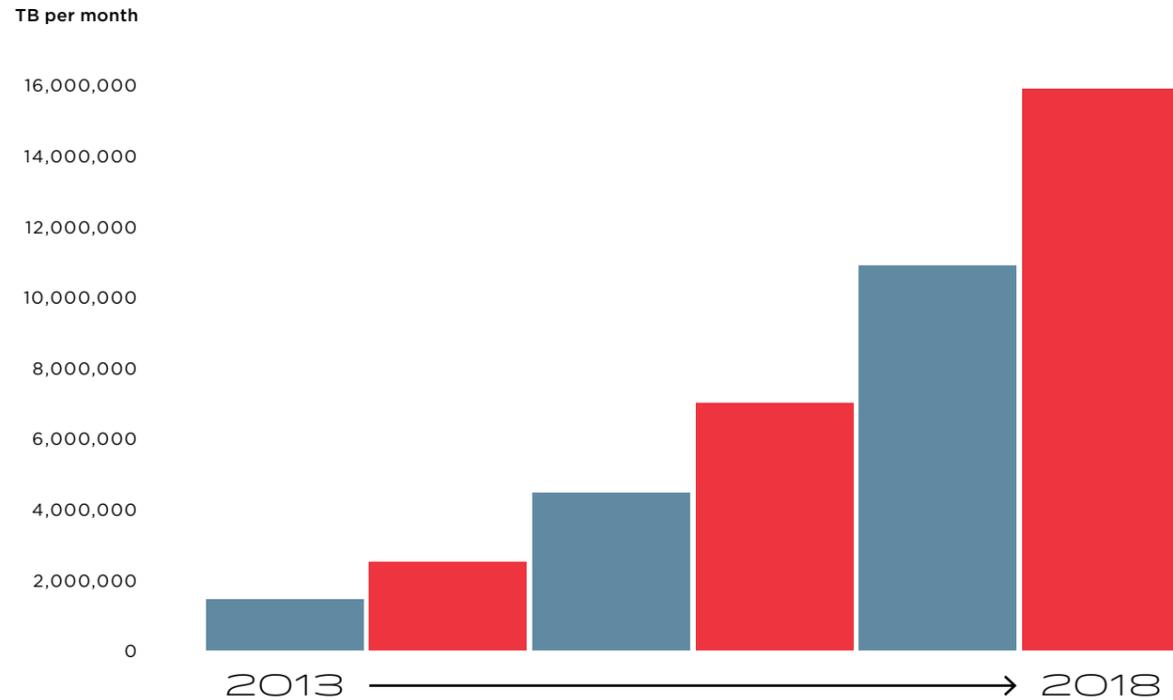
Depending on the time period considered and the size of the change in output, the classification of mobile operator costs as 'variable' (i.e. changing with output) will alter. The Commission uses a short term approach, which leads to the conclusion that there are low variable and marginal costs. Under such an approach, the costs that vary in line with output may include:

- per minute termination/roaming charges,
- per unit production costs,
- merchandise costs,
- bad debt,
- customer acquisition costs,
- handset subsidies,
- commission fees etc.

This leads the Commission to use high margins in its GUPPI estimates. Since the mobile market requires significant investments on an ongoing basis, there is a case for considering a broader range of costs as being variable. One of the main drivers of this investment need is the rapid rise in data usage, which is forecast to continue, as shown by the following figure.

Figure 21

Given forecasted increase in data usage, investment going forward is crucial



Source: Frontier Economics based on Cisco

When considering slightly longer time horizons and more significant changes in output, then other costs may be considered to be variable, for example:

- marketing and advertising expenditure which may be indirectly related to output and revenues and adjustable over a given timeframe;
- spectrum – where this can be traded or contracts renewed then the costs related to this can be varied over a longer timeframe;
- investments into network (network costs) and the associated operating costs – which will be influenced by the expected customer base and usage;
- rental agreements and other assets; which may be sold, ended or increased in size or number in the medium run; and

- staff costs – which can be flexed in the medium run.

The treatment of network costs is critical. Since spectrum is inevitably limited, infrastructure investment drives capacity. As demand for data grows, so ‘peak hour’ capacity/speed matters more compared to basic coverage. Therefore, increased usage will impact on infrastructure investment. Winning more customers will require higher capacity in the congested areas of the network. This suggests that these costs are at least partially variable in the medium run.

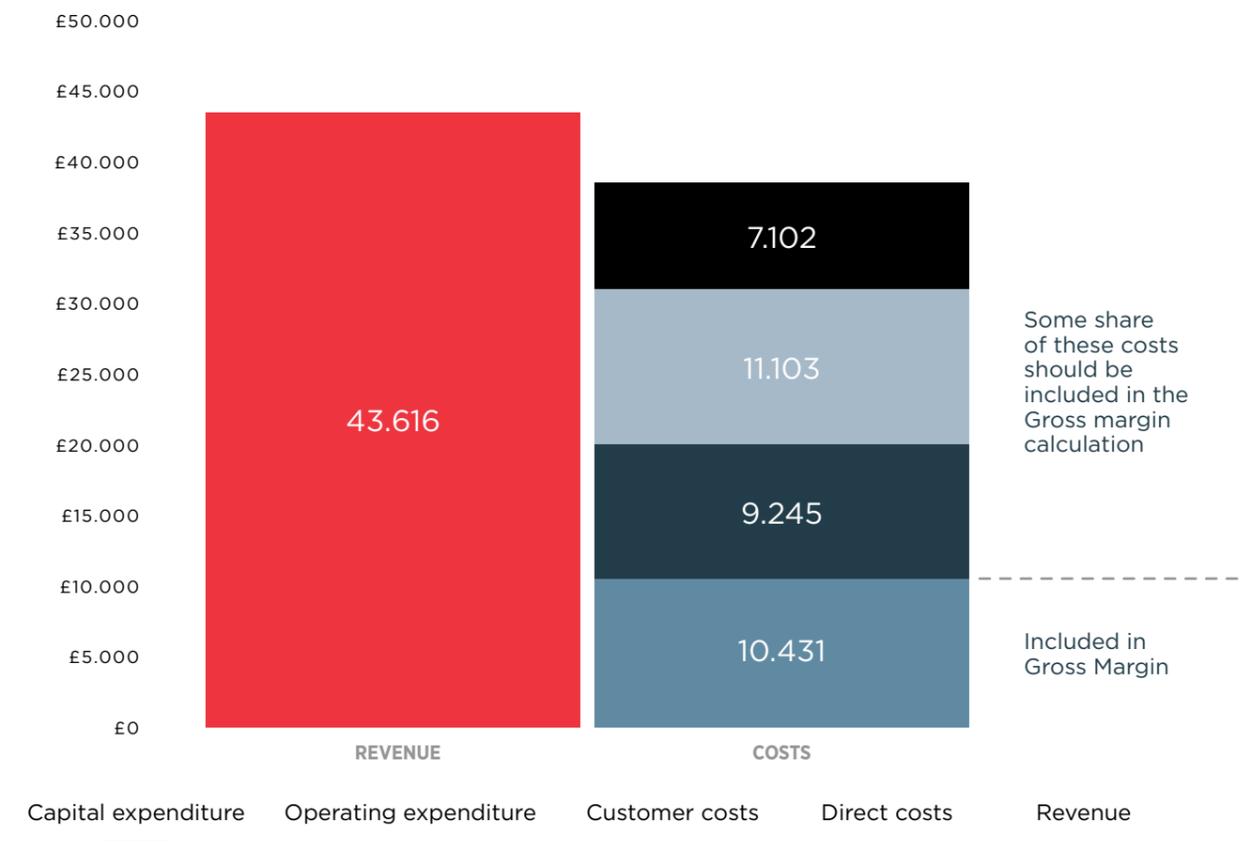
Therefore, it would be appropriate to use lower margins (for example, using EBITDA-CAPEX for the margin calculation).

The Commission's approach has typically been to only include direct costs. This means that reclassifying some costs as variable costs could have a significant impact on the margins used in the gross margin for the GUPPI calculation. For example, the figure below shows the revenues for Vodafone Group relative to its costs. Some share

of customer costs, operating and capital costs should be included in the gross margin, which would lead to considerably lower margins and as a result, lower GUPPIs. This would take account of the costs operators actually consider when making pricing decisions.

Figure 22

Including a share of other costs in the gross margin is more realistic



Source: Frontier Economics based on Vodafone's financial results available at http://www.vodafone.com/content/dam/vodafone/investors/financial_results_feeds/preliminary_results_31march2014/sp_prelim2014.xlsx

The Commission has acknowledged in some cases, for example the Austria 2012 case, that there may be good reason to include a share of OPEX and CAPEX in the gross margin if operators do factor these costs in when making pricing decisions. They have, however, argued over the validity of assigning a fixed share of these costs to the gross margin. In the Austria

case, the Commission did perform a robustness-check of the GUPPI calculation, including shares of OPEX and CAPEX in the gross margin. This resulted in a reduction in the predicted price increase, from between 10-20% to between 5-10%, showing that this does have a significant effect on the predicted price increases.⁴²

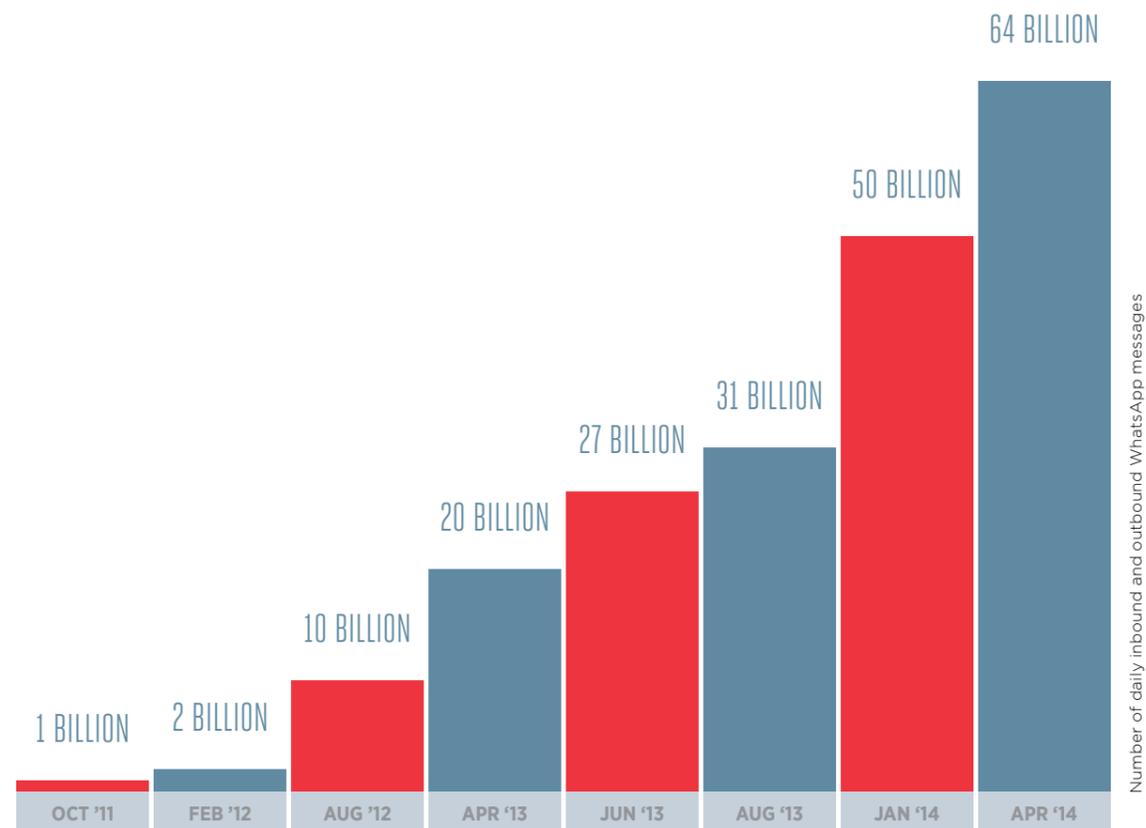
42. http://ec.europa.eu/competition/mergers/cases/decisions/m6497_20121212_20600_3210969_EN.pdf

Using historical margins may be misleading

Competition authorities' calculation of margins also tends to rely on historical data. With changes in the market, such as the increasing rise of Over-The-Top (OTT) players, historical margins may not be an accurate predictor of future margins. Operators are already seeing falling revenues from messaging and calls (mainly international calls) due to competition from players such as

WhatsApp and Skype. In view of the growth rates recorded by these service providers (for example, see Figure 23 and Figure 24 below on WhatsApp usage and OTT call usage), historical margins may under-estimate the competitive pressure exercised by such services (which are often offered at no charge to the user) in the future.

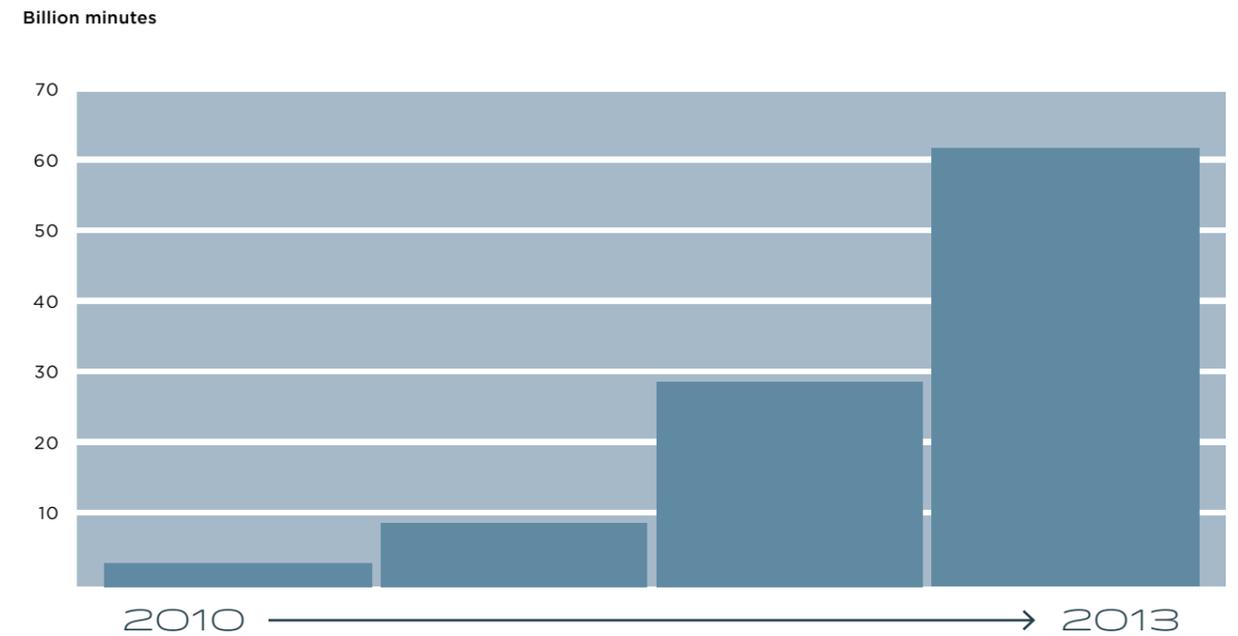
Figure 23
Increase in WhatsApp usage



Source: <http://www.statista.com/statistics/258743/daily-mobile-message-volume-of-whatsapp-messenger/> W

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

Figure 24
OTT calls in Western Europe



Source: **Analysys Mason (2013)**

Clearly, the use of OTT services will increase the demand for data, but higher data revenues may not offset the fall in call and messaging revenues. MNOs must offer faster speeds and quality to satisfy customers, which requires significant network investment. The evidence suggests that MNOs cannot easily generate revenues from this demand for OTT services and the derived demand for data. The result is that margins are reducing and are likely to continue to fall due to the growth in demand for OTT and switch in market focus.⁴³

While global data usage has been growing significantly (and is forecast to grow even more dramatically in the future), the cost per MB of data has been falling over the same period.⁴⁴ Operators' product bundles have not historically been structured in a way to reflect this data demand.

This suggests that historical margins may not be representative of MNO's future ability to generate profits from customers. Since the GUPPI calculation relies heavily on the margin to approximate the parties' future incentives, a historical margin will overestimate the MNOs' incentives to increase prices as a result of the merger.

43. Research suggests that telecoms companies will lose \$386 billion between 2012 and 2018 from customers using OTT services. See: <http://fortune.com/2014/06/23/telecom-companies-count-386-billion-in-lost-revenue-to-skype-whatsapp-others/> and <http://mobileforge.com/research-analysis/global-mobile-statistics-2012-part-c-mobile-marketing-advertising-and-messaging#ottmessaging>

44. Frontier based on Portio research.

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

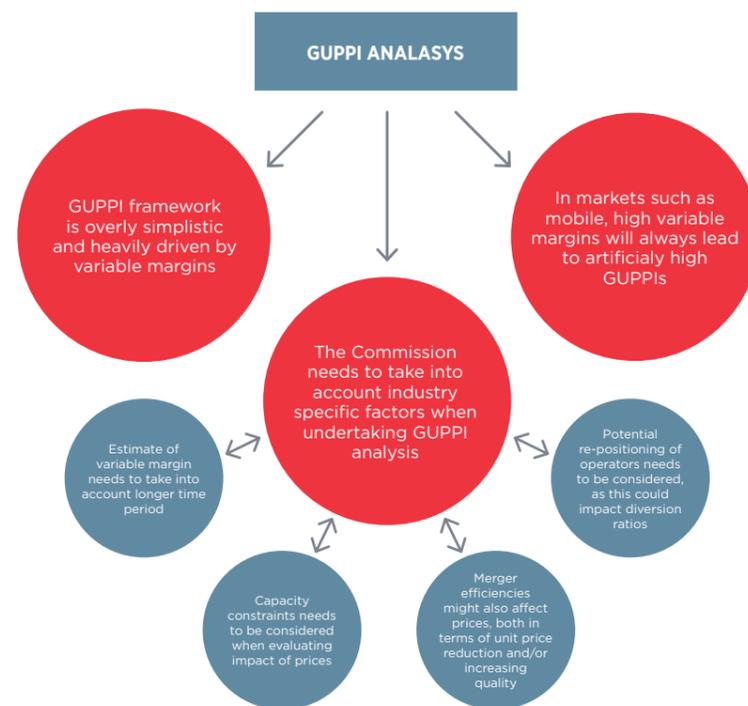
3.3.2 Less weight should be attached to the GUPPI approach even if the calculation of margins is improved

Even if the calculation of margins is improved, there are still a number of reasons why GUPPIs may fail to accurately capture the nature of competition in mobile markets:

- the GUPPI does not take account of efficiency gains and quality improvements;
- the GUPPI assumptions do not hold in markets with capacity-constraints;
- the calculation fails to take account of supply-side repositioning; and
- incorrect application of GUPPIs to narrow segments.

Figure 25

GUPPI analysis is not appropriate for assessing mobile mergers



Source: Frontier analysis

Given that there will still be shortcomings with the GUPPI approach for mobile markets, even when the calculation of margins has been

improved, we consider that authorities should not place too much weight on the GUPPI results.

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

The GUPPI does not take account of efficiency gains and quality improvements

The GUPPI is a simple tool and takes account of the pre-merger conditions to consider the likely post-merger upward price pressures. However, the calculation may be misleading as it only considers one side of the factors affecting price pressures and ignores efficiency improvements which will alter the post-merger pricing scenario, and which may counteract upward pricing pressure caused by a reduction in competition. There are models that try to adapt and improve on the GUPPI approach by considering efficiencies and other factors which also have pricing pressure impacts. However, these models require much more detailed data inputs which may be difficult to estimate or find accurate numbers for. For example, data inputs, such as estimations of the nature of consumers demand, measures product quality and makes valuations of quality improvements, along with details of capacity constraints, investment and detailed breakdowns of OPEX and CAPEX.⁴⁵

This illustrates that the GUPPI itself is a very simple representation and, even with improvements, will struggle to accurately represent the numerous outcomes of a merger on prices and the level of competition.

At the most basic level, a merger will result in economies of scale and scope as the assets can be managed jointly, and there will be synergies from the merger, which can lower marginal costs and encourage price reductions. Any marginal cost efficiencies directly counteract the upward pricing pressure measured in the GUPPI. Some models take account of this within the pricing pressure calculation, adapting it specifically for telecoms.⁴⁶ However, at the present time, other models are not often used in decisions and the GUPPI is the commonly used tool of the Commission.

In addition to the straight-forward efficiency effects mentioned above, there are also indirect effects leading to further synergies and improvements to consumer welfare. A product quality improvement can be seen effectively as a price reduction, which the GUPPI calculation does not take into account. A merger in the mobile sector is likely to have significant quality and service impacts, which are not captured by a simple GUPPI calculation. Considering hedonic prices (quality adjusted prices) after the merger would take into account that the overall value of a product may increase if quality increases at a given unit price.⁴⁷

It is possible to modify the GUPPI model to take account of some of these effects and it has been shown that when this is modelled, the additional elements of efficiencies resulting in downward pricing pressure can offset the upward pricing pressure as a result of the merger. In practice, it may be difficult to use these additional models as the information requirements are naturally more demanding than they are for a standard GUPPI model. However, these models illustrate that the GUPPI shows only one side of the pricing pressure effects and the net effect may mean that a merger results in consumer welfare benefits, even when the GUPPI suggests there may be significant upward pricing pressure.

Given the weaknesses of the GUPPI model in omitting the counteracting pricing pressures resulting from dynamic efficiencies/greater investment, which are highly significant in mobile markets, the GUPPI should not be the basis for decisions about pricing pressures and the likely competition outcomes of a merger.

45. For example see Willig, R (2011) "UPP methodology extensions to Product Quality and Capacity Issues" found at: <https://prodnet.www.neca.org/publicationsdocs/wwpdf/7251att3.pdf>

46. French paper

47. Willig (2011) UPP methodology extensions to product quality and capacity issues

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

The GUPPI assumptions do not hold in markets with capacity-constraints

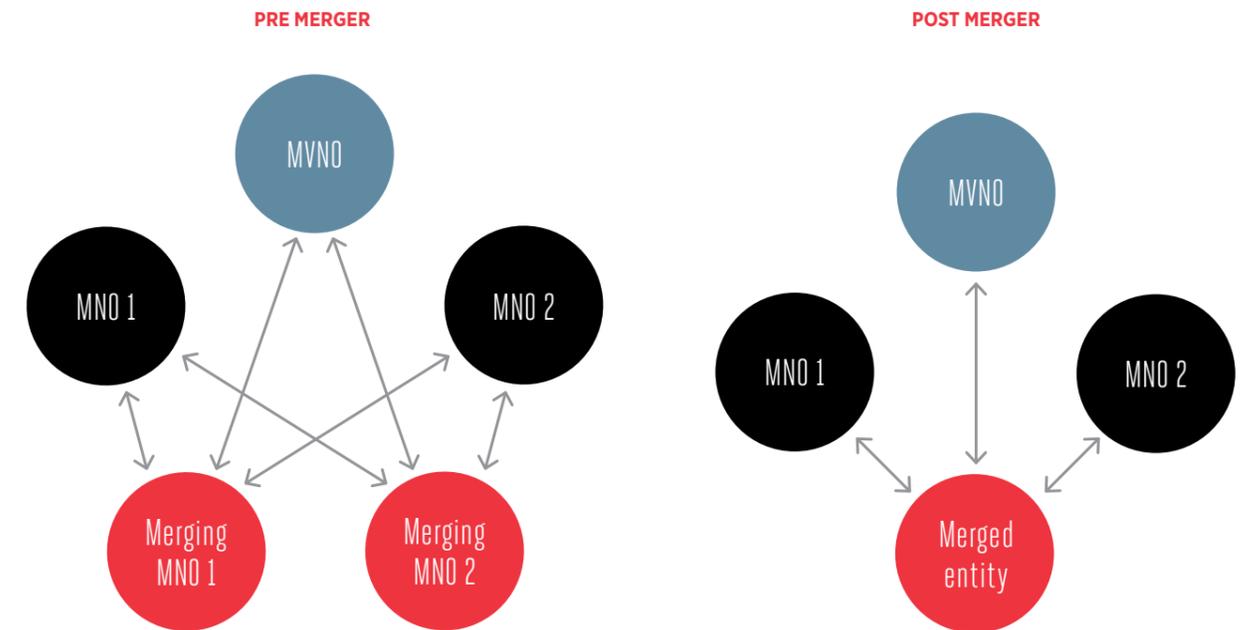
The GUPPI framework relies on the assumption that firms set their prices according to their level of market power. They profit maximise and set prices based on demand for their products and the prices of their rivals (which are, in turn, a product of demand and rival's prices – according to a Bertrand model). Therefore, the optimal price balances the benefits of higher margins against the risk of losing customers to rivals. However, if a firm is capacity constrained this assumption is no longer reasonable, as capacity constrained firms do not set prices in this way – prices are likely to be set at a level that fills the available capacity. Consideration of capacity constraints will be relevant to markets such as mobile telecoms if firms face short term capacity constraints which mergers can overcome. Mergers can do this by increasing the incentive and ability to invest in incremental capacity, or simply by allowing the more efficient aggregation of traffic over existing network assets (for example, if the customer bases of merging operators have different 'peak hour' profiles).

The GUPPI calculation fails to take into account supply-side repositioning

Within the GUPPI calculation, diversion ratios are taken as a given and are not altered by the merger. The diversion ratios will be calculated based on existing switching patterns, which are influenced by the position of both the merging and non-merging operators in the market. The GUPPI framework assumes that the merging parties do not re-position themselves following the merger and nor do its rivals. However, this is not likely to be an assumption that holds in reality. Rivals may re-position themselves closer to the merging party, which will impact the merging parties' ability to raise prices. The GUPPI does not take account of this effect. Further, the merging party may itself re-position itself. For example, in the UK, T-Mobile and Orange dropped their individual brands and instead created the EE brand. Unilateral effects calculations assume a world in which a merged firm attempts to maintain prices above the competitive level long term. This provides a commercial opportunity to rivals as they can identify that there may be high margin customers to target that are close to the merged entity. Therefore, rivals may position themselves closer to the merged firm's customers which may mean that the diversion ratios calculated by the GUPPI are too high. One way in which rivals can re-position themselves is by launching a new MVNO brand. For example, in a country like Germany, MNOs often use MVNO brands to target different market segments.

Figure 26

Rivals re-positioning themselves post-merger



Source: Frontier analysis

Incorrect application of GUPPIs to narrow segments

In all recent merger cases, the Commission has defined a single retail market for mobile services, which includes both pre-paid and post-paid services.⁴⁸ This implies that both pre-paid and post-paid services offer a considerable competitive constraint on the other, and that customers may substitute between these services. The Commission has, however, undertaken these GUPPI analyses by applying them to particular groups of customers or 'segments' within the overall mobile market. By only considering the constraints on the merging party within a given segment, the diversion

ratios may be higher than in a scenario where alternatives from all services are included. In reality, the merging parties' incentive to increase prices post-merger may be constrained by competition from the entire range of mobile services available to customers.

The consequence of this is that the GUPPI predictions for particular segments, even if correct, may not be a good indicator of how the market as a whole will behave post-merger (and may overstate concerns about prices).

48. <http://ec.europa.eu/competition/publications/cmb/2014/CMB2014-01.pdf>

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

3.3.4 The position of mavericks may change in future

Competition authorities have tended to place a considerable focus on the role of mavericks in mobile markets. This may overstate the importance of mavericks going forwards.

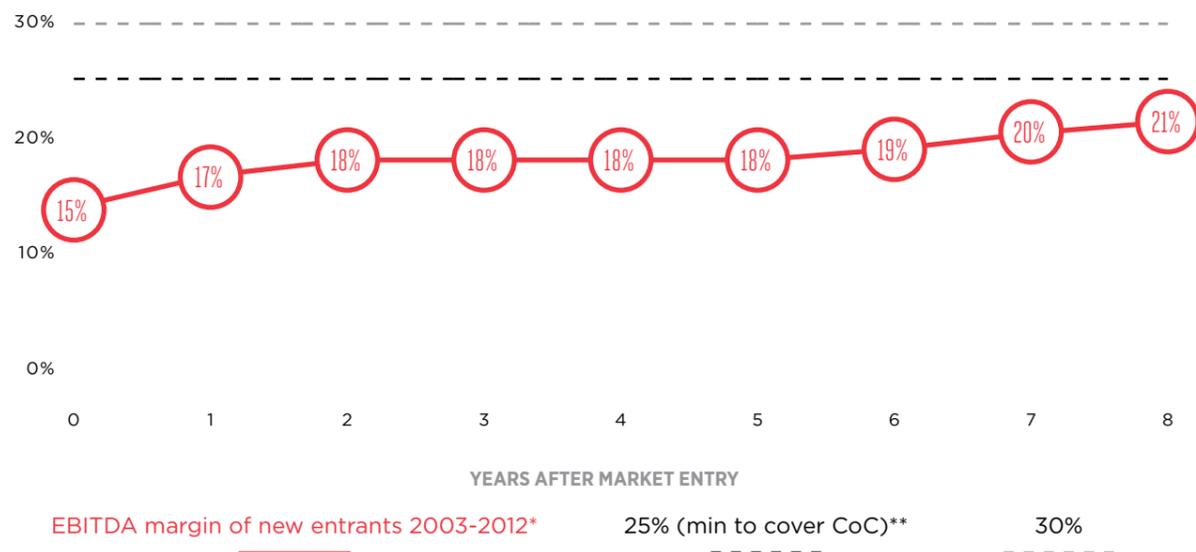
Authorities have tended to be reluctant to allow mergers involving mavericks. In spectrum auctions, authorities have also often been careful to ensure that new entrants/mavericks acquire sufficient spectrum by setting aside spectrum for them. The assumption is that new entrants and mavericks drive price reductions and retail innovation, and therefore, their position in the market must be protected as it is beneficial for competition and consumer welfare.

Although mavericks may have, in some cases, performed this role in the past it is not clear that mavericks will continue to do so. Many of these mavericks entered during the wave of 3G auctions (although there are exceptions such as

Free in France). At the time of the 3G auctions, there was considerable optimism about the potential revenues that could be made in the mobile sector. This may have encouraged the new entrants to invest in considerable capacity, driven by a combination of a positive industry outlook and favourable conditions for new entrants in the auctions (and through subsequent regulation such as asymmetric termination rates).

However, many mavericks have since struggled to earn a significant return on capital and to gain scale in an increasingly mature market. This may lead them to adopt a 'non maverick' strategy in the future as they seek to earn a return on the new investments which they are being required to make as the market moves from 3G to 4G. According to one study, an average new entrant in the EU was not able to generate sufficient EBITDA margin to cover its cost of capital, even 8 years after market entry.⁴⁹

Figure 27
New entrants are failing to cover the cost of capital years after entry



Source: Frontier Economics based on IEMR 2012Q3, BCG analysis

*Analysis by BCG based on non-weighted sample of 21 new entrants across EU having entered the market from 2003 to 2012 and respective EBITDA margins.

** Estimate of minimum EBITDA margin required to cover cost of capital (CoC) based on BCG analysis.

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

Currently, the outlook of the mobile sector is considerably less optimistic than at the time of the 3G auctions. The low margins operators are currently earning are factors that are likely to deter mavericks from undertaking further investments in the future. As shown in Section 2.2, consumer welfare in the future is likely to be influenced heavily by investment at the network level (in order to improve service quality), so mavericks may not have a strong role to play, as they will not have the means or incentives to invest in excess network capacity.

These 'mavericks' now face another investment and technology cycle, as mobile markets transition from 3G to 4G. The available evidence suggests that at least some of them are considering alternative strategies, such as pursuing scale through mergers, or withdrawing from competing in 4G altogether.

For example, Hutchison, one of Europe's leading 'mavericks', has recently pursued mergers in Ireland and Austria, and is contemplating a transaction in the UK. At the same time, as shown by the following table, some 'mavericks' were unwilling to pay the required prices to acquire 800MHz spectrum in the recent wave of auctions, suggesting that their role in 4G competition may be limited, or may require a merger with another operator that holds such spectrum.

If 'mavericks' change their behaviour in this way, then prices absent a merger could also be expected to fall less rapidly in the future compared to the past. We also note that there are very few new '4G' entrants in Europe who do not already have 3G operations.

Table 6. Impact of economies of scale on network upgrades

Country	'Maverick' Operator	800Mhz auction outcome
Austria	3 Hutchison	Did not secure 800Mhz spectrum in the auction
Croatia	Tele2	Did not bid for spectrum
Denmark	3 Hutchison	Did not secure 800Mhz spectrum in the auction
France	Free	Did not secure 800Mhz spectrum in the auction
Ireland	3 Hutchison	Did not secure 800Mhz spectrum in the auction
Italy	3 Hutchison	Did not secure 800Mhz spectrum in the auction

Source: GSMA database on spectrum holdings and various news articles

49. https://www.etno.eu/datas/publications/studies/BCG_ETNO_REPORT_2013.pdf

COMPETITION AUTHORITIES' APPROACH MAY OVERSTATE POST-MERGER PRICE INCREASES

4 Network sharing deals are not always commercially viable and are likely to lead to smaller efficiency gains compared to mergers

Operators and regulators in the mobile industry are keen to achieve cost savings and coverage increases in remote areas. These benefits may be achieved through mobile mergers, but competition authorities often consider network sharing agreements as a viable alternative. In such cases, the benefits put forward by merging parties are often discounted by the competition authorities as not being merger-specific.

In section 3, we explained why concerns about the effects of mergers, particularly the view that mergers will lead to higher prices, tend to be overestimated by competition authorities and are not supported by the evidence. Absent these concerns, authorities have no reason to prefer network sharing deals to mergers.

Nonetheless, in this section, we also explain why mergers are likely to deliver greater investment than network-sharing deals. This is particularly important given that investment is likely to be the main driver of quality improvements and unit price reductions in mobile markets, as discussed in section 3.

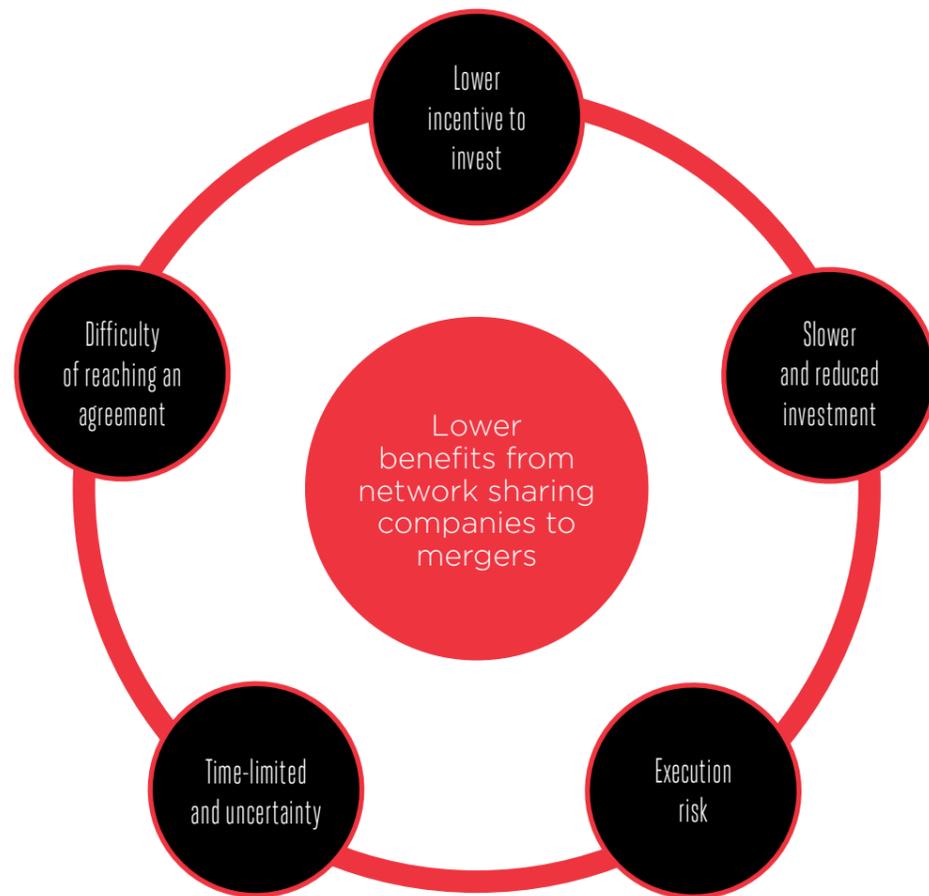
Network sharing agreements clearly play an important role in mobile markets. However, this section explores why network sharing agreements are likely to result in lower

investment than mergers do, as it is more difficult to gain a competitive advantage which provides the incentive to invest. Network-sharing deals will not deliver efficiencies at the retail-level and, in most cases, are also likely to deliver lower efficiencies at the network-level. In addition, it may be hard to reach a mutually acceptable network sharing agreement due to issues relating to asymmetry, coordination and information sharing. Although this does not necessarily mean that network sharing agreements cannot be reached, the network sharing agreements that proceed are typically limited in form, offering significantly lower benefits than those possible through consolidation. The following figure summarises why network-sharing agreements may deliver lower benefits than mergers.

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

Figure 28

Reasons why network-sharing agreements may deliver lower benefits than mergers



The rest of this section is structured as follows:

- In section 4.1, we explain why operators will have a greater incentive to invest following a merger than under network sharing agreements;
- In section 4.2, we set out why network sharing agreements will not typically offer the same level of benefits as a merger;
- In section 4.3, we explain that network sharing may lead to slower and reduced investment compared to mergers;
- In section 4.4, we explain that network sharing involves considerable execution risk;
- In section 4.5, we explain that many network sharing deals involve uncertainty;
- In section 4.6, we set out why it may be difficult to reach a mutually acceptable agreement for network-sharing; and
- In section 4.7, we conclude.

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

4.1 Mergers vs. Network sharing: operators will have a greater incentive to invest following a merger

Investment into areas of the network covered under a Network Sharing Agreement (NSA) to improve quality or coverage would benefit both parties' subscribers, as would investment following a merger. However, an investment by the merged entity would allow it to distinguish itself from its competitors (e.g. in terms of network quality). This may not be true to the

same extent for a network sharing operator. Investment would not necessarily provide it with the same degree of differentiation as if it were a merged entity, because the subscribers of the other party in the NSA would benefit to a similar degree. This means that incentives to invest are likely to be considerably greater following a merger than under an NSA.

4.2 Mergers vs. Network sharing: mergers typically offer greater benefits than network sharing agreements

Network sharing agreements between operators are common in many mobile markets around the world. In 27 EU member states,⁵⁰ and also countries outside of Europe, such as India, Pakistan and Brazil,⁵¹ there is some form of network sharing in place. Operators typically engage in voluntary network sharing agreements due to various commercial reasons, which can be broadly summarised into two categories: cost savings and coverage increases.

- **Cost savings:** Sharing the access network with other operators can lead to OPEX and CAPEX savings.
- **Coverage increases:** In remote rural areas where it would not be commercially viable for more than one operator to deploy its access network, network sharing provides a solution. Network sharing agreements can help mitigate uncertainty around the ability of operators to recover their cost when deploying networks in these remote areas. Similarly, at the introduction of new technologies, such as 3G or 4G, national regulators may require MNOs to achieve minimum levels of national coverage

in certain time frames. Network sharing arrangements can help operators to roll out their networks faster and reach coverage targets more efficiently, i.e. at lower costs.

A merger should result in increased investment into coverage and capacity. Network-sharing agreements should encourage expanded coverage. However, as the operators will still act as separate entities, NSAs are not likely to result in changes to capacity. Since capacity is influenced by spectrum (which is only shared in the deepest forms of network sharing) and by investment (for which there are typically lower incentives under NSAs) we would not expect that capacity improvements, as a result of an NSA, would match those resulting from a merger.

In the following sections, we explain that:

- Network sharing will not lead to efficiencies at the retail level; and
- Network sharing is also likely to lead to lower efficiencies at the network level.

50. RSPG/BEREC research and survey among regulators (http://rspg-spectrum.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf)

51. GSMA: Mobile Infrastructure Sharing (<http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>)

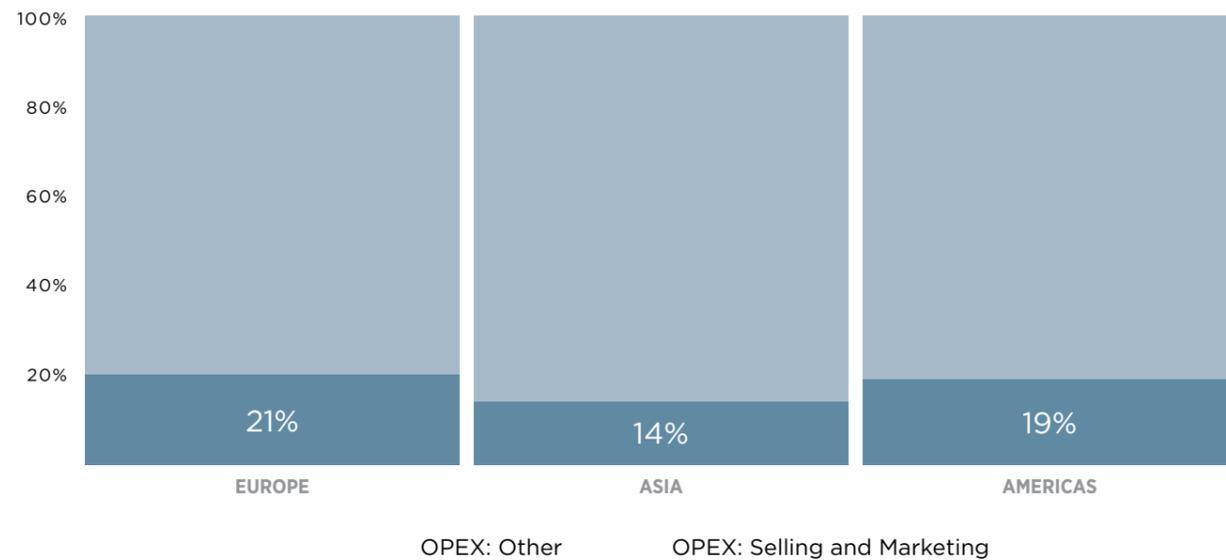
NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

4.2.1 Network sharing will not lead to efficiencies at the retail level

Under a merger, parties may combine retail operations as well as wholesale and network operations. Under network competition, however, although network and wholesale operations may be combined to some extent (determined by the level of network-sharing agreed), at the retail level parties are still separate and competing entities.

Although retail costs as a proportion of operating expenditure differ significantly across providers and countries, they typically form a significant proportion of operating expenditure. Selling and marketing alone contributed to an average of 21% of OPEX for operators in Europe over 2013 as shown in the figure below.⁵² Under a merger there can be additional cost reductions by removing duplication at the retail level with savings from combining these functions likely to be significant.

Figure 29
Retail expenditure: Selling and Marketing⁵³ makes up a significant proportion of OPEX



Source: Frontier based on GSMA database

Additionally, some network investments may require greater scale in retail operations (which a merger produces but network sharing does not). For example, new investments may require increases in customer uptake to be profitable.

This, in turn, may require significant work at the retail level regarding selling and marketing – if scale does not allow for this then operators will be less inclined to undertake the investment.

52. Frontier calculation based on GSMA database figures
53. This includes cost of marketing, sales commission and distribution costs.

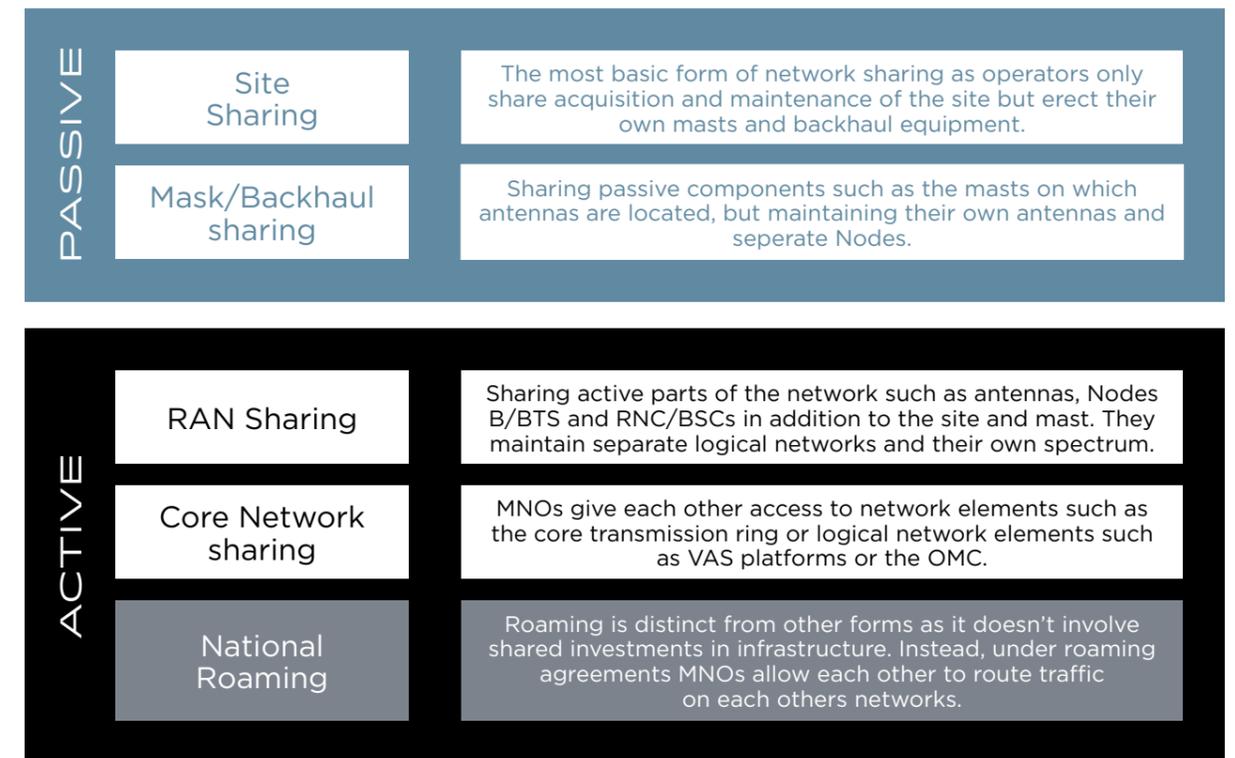
NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

4.2.2 Efficiencies are also likely to be lower at the network level

Network sharing can take several forms, but always involves more than one operator using a certain part of a mobile network. The options range from sharing only passive elements (e.g.

the site or masts) to sharing active elements (e.g. antennas or the core network). This is shown in the figure below and explained in more detail in “ANNEXE 1 – Details of types of network sharing”.

Figure 30
Forms of Network Sharing⁵⁴



54. BTS/Node B: The equipment cabinet that houses the electronics and system necessary for the transmission and reception of signals between the network and the subscriber. For GSM operators this cabinet is referred to as a Base Transceiver Station (BTS) while 3G operators refer to this as the Node B

BSC/RNC: The Base Station Controller (BSC) is a 2G element which is connected to several BTS cabinets and gathers the data from these and forwards to the core network for further processing or routing. The BSC has some intelligence and is able to route calls between BTS cabinets if they are both connected to the same BSC. In the 3G world this functionality is performed by the Radio Network Controller (RNC). It also resides in the same position in the network hierarchy.

VAS: Value Added Systems

OMC: Networks are dynamic in their day-to-day operation and require constant monitoring to ensure service and performance is maintained. This requirement is fulfilled through the Operations and Maintenance Centre (OMC)

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

Most network sharing agreements will be of the more limited forms, sharing only passive elements or small amounts of active sharing. Although

network sharing is common in mobile markets, these NSAs do not typically involve high levels of active sharing, as shown by Figure 31.

Figure 31
Network sharing agreements

	Site/Mast sharing	RAN sharing	Core Network	Roaming	Spectrum sharing
Australia	X	X			
Brazil	X	X			
Channel Islands	X				
Cyprus	X			X	
France	X	X		X	
Germany	X			X	
Hungary					
India	X				
Italy	X				
Latvia					
Luxembourg					
Malta				X	
Netherlands	X				
Norway	X	X	X	X	
Pakistan	X				
Spain	X	X	X		
Sweden	X	X	X		X
UK	X	X		X	
USA	X				

Source: Frontier based on GSMA : <http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf> and updated based on publicly available information

The more limited the form of network sharing, the lower the cost savings (and coverage incentives). For example, site sharing can lead to cost savings of up to 10%⁵⁵ whereas RAN sharing can lead to potential total cost savings

of up to 30%.⁵⁶ Since mergers are equivalent to fully sharing all elements of the network, they will typically lead to much greater cost savings and efficiency benefits than even the most advanced network sharing agreements.

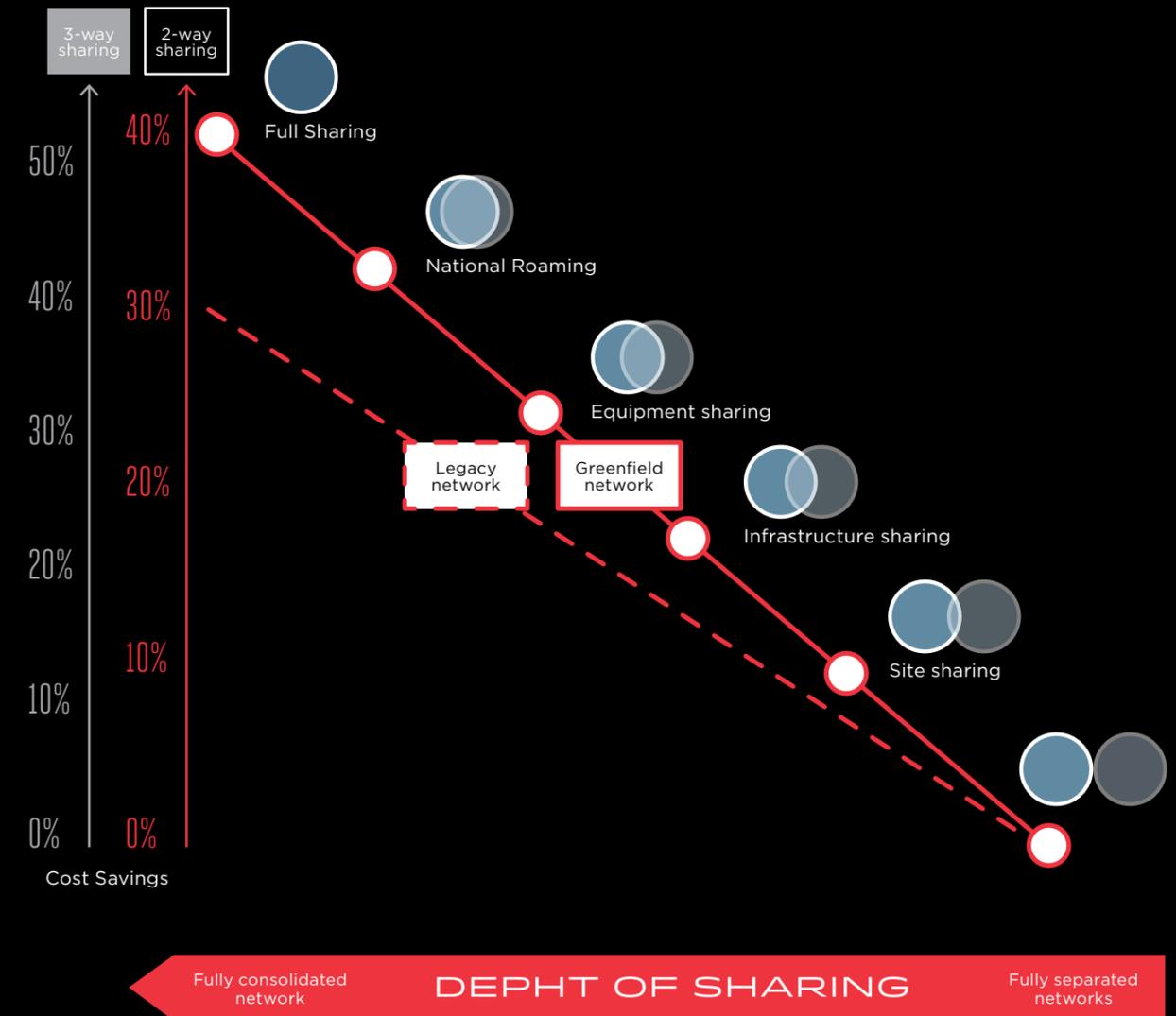
55. Vodafone: Network Sharing in Vodafone (<http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/06/Vodafone1.pdf>)

56. BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks (http://rspg-spectrum.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf)

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALLY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

Figure 32

Forms of Network Sharing and potential savings



Source: Frontier Based on Vodafone⁵⁷

57. <http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/06/Vodafone1.pdf>

4.3 Network sharing may lead to slower and reduced investment compared to mergers

Under a network-sharing agreement, the pace and scale of investment may be dictated by the party with the lowest incentive and ability to invest. Although this may still result in benefits compared to not sharing, it will produce lower benefits than under a merger in which one party has full control and is able to capture all of the resulting gains in the retail market.

Operators may have different views on the capacity and coverage that should be delivered through network sharing agreements. This is particularly an issue when the parties' customer

bases are asymmetric, either in terms of size or usage. For example, one party may have a customer base that has a high preference for quality, whereas the other party's customer base may be more price sensitive. Since the parties will not behave like a merged entity in these decisions, there will be differences in the advantages of investing in different areas for the two parties. This is likely to require repeated and involved negotiations and result in less investment on the whole. Other asymmetries, such as differences in spectrum holdings, could have a similar impact.

4.4 Network sharing involves considerable execution risk

A merger allows a firm to control a core asset, the network, whilst network sharing means that the firm has to assume the risk of dealing with a partner it cannot control and who is also a competitor. Given the importance of the network, and the significant degree of uncertainty about the future in a market characterised by

rapid technological change, this risk is highly significant. This is evidenced by the relatively small number of network sharing agreements in place in the world today, and their limited scope, despite the fact that many firms should have strong incentives to do them.

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

4.5 Many network sharing deals involve uncertainty

When considering a NSA, there will be uncertainty as to the benefits and costs resulting from a NSA, and subsequent difficulty in negotiating the precise terms and share of the benefits, as well as valuing the size of any compensatory payments between the parties. This means that such negotiations can take place for a long time without reaching a successful conclusion. With such potential deals, it is not possible for a single operator to reach a reliable estimate of the likely cost savings from network sharing without access to sensitive cost information from its potential partner. Information sharing occurs naturally as part of initiating a merger, however, it is more of an issue when the parties remain competitors and could cause

potential concerns for regulators. Although many NSAs are agreed on the basis of a long-term commitment, there is no guarantee that they would continue in perpetuity. Operators will have this in mind when considering the return they are likely to see on potential investments. In some cases, operators may be more cautious about investing heavily in a shared network when there may be uncertainty about the duration of the agreement, and the ownership of assets, should the agreement end. Since this creates additional risk for investments, particularly those which require a long time period for returns to materialise, operators may choose not to invest as much as they would do, given uncertainty (as would be the case under a merger).

4.6 It may be difficult to reach a mutually acceptable agreement for network sharing

Network sharing agreements require several stages of negotiation and information on both parties' costs, and network quality will need to be shared. There is likely to be a relationship between the difficulty of agreeing on a network

sharing deal and the depth of the sharing proposed. Given this, there may also be a link between the magnitude of benefits resulting from a merger, and the difficulty of reaching a NSA.

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

Figure 33

Difficulty of reaching an agreement is correlated with the level of benefits



Source: Frontier Economics

In practice many NSAs are discussed, but fail to develop due to the complexities of finding a commercially attractive agreement between two parties. Although agreements of some form are often reached these may be less involved than those originally discussed. As shown earlier, existing NSAs are most commonly limited to passive sharing or the most limited forms of active sharing. Although these do clearly offer synergies, they are not likely to be comparable to the scale of the savings possible after a merger.

The co-ordination difficulties and transaction costs are likely to be highest when the depth of sharing is high. The risks are also likely to be higher, and therefore more analysis of the allocation of potential costs and benefits, will be required. This is particularly true when there are asymmetry or co-ordination issues.

Where two parties are interested in forming a network sharing agreement, they will have to consider the relative benefits they receive from the agreement. If the MNOs are asymmetric this is likely to create challenges for the parties. The impact of the agreement will be as follows:

- Both parties will benefit from positive cost savings (CAPEX and OPEX) as a result of reducing the network duplication in areas where their networks overlap. If one operator is of a significantly smaller scale (or smaller geographic reach) they would be expected to accrue significantly greater benefits than those available to the larger operator.

- The agreement will impact the competitive position of the operators in the retail market. If one operator has a more extensive network and/or this network is of higher quality, the other MNO would be expected to benefit from a stronger competitive position as a result of the agreement, at the cost of the other operator's market share. This would also put pressure on prices, affecting both operators.

Due to the differing impact of the efficiencies effects and competitive position effects on each of the parties, a NSA would thus result in an asymmetric distribution of cost and revenues. For the smaller operator such an agreement would clearly be beneficial, as it would get increased revenues and reduced costs, whereas the larger operator would have to weigh up the expected loss of retail revenues, against the expected cost reductions.

The benefits and costs of the sharing model will depend heavily on the market and the future position of the parties involved. There is likely to be a high degree of uncertainty and risk involved, and therefore, the process of reaching an agreement is likely to be a long and involved one with many areas where a deal may fall through. The transaction costs are likely to be significant.

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

4.7 Conclusion

Competition authorities have typically argued that network sharing represents a superior outcome to mergers, because it does not impact competition at the retail-level.⁵⁸ This view is based upon the unsupported assumption that four to three mobile mergers should, in general, be expected to lead to higher prices which, as explained previously, is inconsistent with the available evidence. This means that it may be inappropriate to generally prefer network sharing deals to mergers. On the contrary, the benefits of network sharing may often be more speculative - because the agreement may not be reached in the first place, or may prove more difficult to implement and manage as the sharing parties' interests change, and potentially diverge over time - than those that can be attributed to mergers.

On balance, we consider that network sharing deals are likely to be an inferior alternative to mergers. This is primarily because mergers are

likely to provide a greater incentive to invest than network sharing deals. By investing, a merged operator gains an advantage over all its competitors. This is not possible under a network sharing deal, because at least one other operator will also benefit at the access level from the network sharing deal. This means that the potential return from the investment is likely to be higher under a merger, and the investment may therefore be more likely to take place.

Even though there are many network-sharing deals in place across countries, none of these deals will involve any efficiency gains at the retail-level. Furthermore, many of the deals do not involve full network sharing, as they will be limited to particular areas of the country, technologies or type of infrastructure that is shared.

58. This is the view expressed in a recent OECD study (OECD (2014), "Wireless Market Structures and Network Sharing", OECD Digital Economy Papers, No. 243, OECD Publishing)

NETWORK SHARING DEALS ARE NOT ALWAYS COMMERCIALY VIABLE AND ARE LIKELY TO LEAD TO SMALLER EFFICIENCY GAINS COMPARED TO MERGERS

5 Remedies may undermine the potential benefits from mobile mergers

Over recent years, a number of mobile mergers have been cleared by the Commission. However, many of these mergers have been cleared only with the provision that the parties adhere to a number of remedies to address the competition concerns expressed by the Commission. These remedies have been considerably more intrusive than in previous cases. There is a risk that some remedies, if not considered carefully, could undermine the parties' ability to invest (which we have argued is a strong reason why consolidation may be desirable in mobile markets) or actually weaken the competition in the market. This means that the potential impact of remedies should be carefully considered to ensure that they do not have counter-productive effects on the mobile market.

This is particularly important if, as the evidence presented above suggests, the concerns regarding price increases resulting from a merger are misplaced. Remedies that aim to counteract the parties ability to increase prices could damage consumers if, as we present earlier in the report, the main consequence of mergers is not price increases, but increased investment incentives which lead to improved consumer outcomes.

The Commission has imposed remedies in several forms often in combination, including:

- **MVNO access** - where the merging parties must commit to allowing MVNOs to buy wholesale access, either on a per unit basis or based on a pre-agreed amount of capacity. The aim is to encourage service-based entry and eliminate barriers to competition.⁵⁹
- **Spectrum divestment** - where the merging parties must commit to divesting some of their spectrum holdings either to existing competitors or for a potential new entrant. This may be intended to equalise imbalances caused by the merger and/or eliminate barriers to infrastructure-based entry.

- **Continuation of network-sharing** - where the parties have existing network sharing agreements they are required to commit to continue them to avoid the risk of the merged entity foreclosing a competitor by ending the agreement.

- **Access to sites** - where the parties may be required to commit to allow access to sites, or to divest sites to competitors or new entrants, particularly where the merger results in redundant sites, due to synergies.

In the recent merger cases in Ireland, Germany, Austria and the UK, a combination of these remedies have been applied (see table below for details).

⁵⁹ In some mergers, the merging parties agreed to offer an MNO access package. These packages included retail assets, national roaming and spectrum.

Table 10. Remedies in recent merger decisions

	Germany 2014	Ireland 2014	Austria 2012	UK 2010	Netherlands 2007
MVNO remedies	Upfront commitment to allow wholesale access of up to 30% of the network capacity to between one and 3 MVNOs at fixed payments and to extend the existing wholesale agreements with Telefonica and E-plus's partners and to offer 4G services to all interested players in the future.	Upfront commitment to allow wholesale access of up to 30% of the network capacity to two MVNOs at fixed payments.		Allow wholesale access of up to 30% of H3G's network for up to 16 MNOs for 10 years and an upfront commitment to enter into an MVNO agreement before closing the acquisition. Wholesale access prices were set on a per unit basis.	
Spectrum divestment	Lease spectrum to a new MNO or the MNOs taking up MVNO network capacity.	H3G committed to divest five blocks of spectrum in the 900 MHz, 1800 MHz and 2100 MHz bands. The spectrum will be available for ten years, starting from 1 January 2016.		Commitment to offer for sale 2x19MHz in the 2.6GHz band which must be offered to the approved new entrant purchaser of the reserved auction spectrum in the 800MHz band.	Required to divest 2x10MHz and 2x5MHz in the 1800MHz band.
Network sharing requirements		Committed to offer eircom a continuation of the existing network sharing agreement with O2 on improved terms.		Allow national roaming of up to 30% capacity of the H3G network for 6 years to the new entrant	Agree to modify and amend the RAN sharing agreement with 3UK involving further commitments and removal of early termination rights
Site Access	Divest unrequired sites as a result of merger synergies to a new entrant			Divest unrequired sites as a result of merger synergies to a new entrant	

Source: EC decision

Whilst the aims of the Commission in applying remedies are relatively clear, the effectiveness of these tools in alleviating the stated competition concerns is relatively unproven. We do not suggest that remedies may never be appropriate in mobile mergers, or that consumer benefits cannot be obtained by approving mergers with conditions rather than blocking them outright, but this will depend upon the facts of each case. However, remedies should be internally consistent and informed by a clear understanding of how mobile markets function and what drives beneficial outcomes for consumers in terms of availability, quality and price.

This section explores some of the potential negative consequences that significant measures could have. In the following sections we discuss how:

- The investment incentives of the merging parties could be harmed; and
- The remedies could lead to the underutilisation of resources.

5.1 Investment incentives of the merging parties could be undermined

Requiring MVNO access as a strict requirement in mergers is relatively new and untested in the mobile market. There appears to be no consensus on the impact of MVNOs on competition in the mobile market. Moreover, the approach to MVNO access remedies being taken in mergers is not consistent with the decision by the Commission to not regulate access prices elsewhere (e.g. in relation to new fibre networks), where investment is equally important. There is a risk that remedies of this kind could undermine the unilateral investment incentives of the merging parties going forward, which may harm consumers.

Mobile operators have an incentive to invest in their networks to gain a competitive edge through offering higher quality or coverage for customers. The differentiation from competitors allows the operator to gain a competitive advantage which should translate into greater revenues, thereby allowing operators to recover the costs of the investment. Where the merging party is required to allow access to their network, then any investment which improves their product offering will also have the same effect on competitors utilising their network (unless there are restrictions in the MVNO agreements). This undermines the unilateral incentive to invest as the competitive advantage gained from investing is reduced⁶⁰. Although the benefits from the investment will be shared by the access seekers, the risks from the investment are still borne exclusively by the investing party, as it is the network operator that will have to incur the full cost of the investment.

The rationale for many of the remedies imposed by the Commission is to allow MVNOs and new entrants to enter the market and compete with the merged entity, increasing the competition in the market and safeguarding prices. However, this argument appears to be in opposition to arguments made regarding MVNOs in other circumstances. The Commission has argued

that MVNOs would impose limited constraint on the merging parties in its assessment of the competition concerns from mergers. Despite this, when deciding on remedies, the Commission seems to consider that MVNOs can act as an effective competitive constraint by focusing its consideration of remedies on MVNO access packages.⁶¹

Reduced investment incentives should be a considerable concern given the importance of dynamic efficiencies in the mobile market. As we have argued earlier, (Section 2.2) dynamic efficiencies have a very significant role in reducing unit prices and increasing speed and capacity which is crucial given forecasts for future data usage.

In mobile markets, MVNO access prices are normally only regulated where there is evidence that one or more operators have significant market power (SMP), which arises in only three markets in Europe today.⁶² Although a merger may result in changes to market power for operators, typically, the merged entity would not have SMP following the merger. The Commission may argue that it has not directly regulated access prices when devising MVNO remedies in Austria, Ireland and Germany; but it is clear that the Commission has provided the merging parties with strong guidance as to what would be acceptable to it, and what would not. These terms differ substantially from those that have previously been offered on unregulated, commercial terms in these markets.

It is also notable that in the fixed sector, the Commission was concerned that regulated access prices could deter investment in fibre networks⁶³. As a result of this concern, the Commission produced a recommendation stating that fibre access prices would not require regulation provided that certain safeguards were in place.

5.2 The remedies could lead to the underutilisation of resources

Remedies which involve reallocating network assets or reserving spectrum for other operators or potential operators mean that these resources are not available for the merged party to use. It will often take time to transfer these resources to the regulator or to other operators (since existing users will need to be migrated off them) and during this period there is likely to be limited ongoing investment in these assets and increasing underutilisation. Additionally, this creates uncertainty about future spectrum holdings which limits a company's ability to plan and invest appropriately to take full advantage of their spectrum allocations. This problem will be compounded if, as occurred in Austria, the assets are then reserved for future entrants who do not emerge. During this period, valuable assets lie unused.

Competition authorities may choose to impose remedies involving spectrum divestment, either to correct significant asymmetry in spectrum holdings that will be created by the merger (for

example in the UK case), or to free up spectrum for a potential new entrant (for example in Germany and Austria). In the first case, this will not necessarily improve the consumer's position. Asymmetry creates unilateral investment incentives, which may be of benefit to consumers (this is explored in more detail in section 2.4, which discusses how creating a 'leader' in the market can help accelerate investment in new technologies)). The Commission recognises that *"if competitors have sufficient spectrum to compete before the merger and these spectrum holdings allow them to compete effectively after the merger, then the mere fact that the merger increases the merged entity's spectrum is not likely to give rise to competition concerns"*.⁶⁴ Given this, it is not apparent that spectrum divestment is necessary in many cases.

Where capacity has to be set aside for an MVNO, this could also lead to the underutilisation of resources if the MVNO fails to fill the network capacity.

60. A good example can be found in the German market, where it emerged during the EC merger review that existing operators did not allow MVNOs to access their new 4G networks (in order to retain the benefits of their network investments). One of the remedies adopted by the EC was to require the merged party to make such access available.

61. It should be recognised that a recent decision in Ireland was taken whereby the Commission designed a capacity-based MVNO remedy, i.e. a commitment by an MVNO to purchase a fixed amount of network capacity with the aim to partly replicate a cost structure of an MNO and incentivise competition with existing MNOs.

62. Cyprus, Slovenia and Spain

63. EC costing recommendation (2013).

64. <http://ec.europa.eu/competition/publications/cmb/2014/CMB2014-01.pdf> page 12.

6 ANNEXE 1

– Details of types of network sharing

- Site Sharing:** This involves the sharing of compound on which masts and any backhaul equipment of a substation are installed. It is the most basic form of network sharing as operators only share acquisition and maintenance of the site but erect their own masts and backhaul equipment. This form of sharing can lead to cost savings of up to 10%⁶⁵ and make roll-out in rural areas more viable. In urban areas, there might sometimes be no other choice than to co-locate sites due to limited space. Most agreements include the sharing of sites like, for example, in Australia, Cyprus, Germany and Pakistan.⁶⁶ The degree to which sites are shared differs a lot across countries, but can reach up to 50% as in Austria in 2009.⁶⁷
- Mast/backhaul sharing:** MNOs can take a step further by sharing passive components such as the masts on which antennas are located, but maintaining their own antennas and separate Nodes B/ BTS⁶⁸ and RNC/ BSC.⁶⁹ Estimates of the potential overall cost savings for an MNO for such a form of network sharing are up to 15%.⁷⁰ If backhaul equipment is shared additional cost savings of up to 15% are possible.⁷¹ We note that in some countries, such as India, there are third-party infrastructure providers called TowerCos, who specialise in the provision of shared infrastructure. These companies do not themselves operate mobile networks but lease shared antenna sites to MNOs.

- RAN sharing:** This form of sharing includes active parts of the network such as antennas, Nodes B/ BTS and RNC/ BSCs in addition to the sharing of sites and masts. This means that operators share their entire infrastructure up to the point where it connects to the core network. They maintain however separate logical networks and their own separate spectrum. Sharing of the RAN (including passive and active elements of the network) can lead to potential total cost savings of up to 30%.⁷²
- Core Network sharing:** This is the most involved form of infrastructure sharing as MNOs give each other access to network elements such as the core transmission ring or logical network elements such as Value Added Service (VAS) platforms or the Operation and Maintenance Centres (OMC).⁷³ Transmission ring sharing occurs if an operator has spare

capacity on its lines and can be of great value for new entrants who have not yet rolled out their own infrastructure. Total cost savings achievable tend to be lower than those of Radio Active Service (RAN) sharing, because the RAN usually accounts for a larger part of network costs than the core network.⁷⁴

- National roaming:** Roaming is distinct from other forms of network sharing as it doesn't involve shared investments in infrastructure. Instead, under roaming agreements, an MNO makes use of another MNO's network and spectrum for part of the country. It is therefore not necessary for an MNO to operate its own access network across the country to achieve certain levels of coverage. We include it as a form of network sharing because it has been proposed by MNOs and permitted by regulators as part of network sharing agreements in the past.⁷⁵

65. Vodafone: Network Sharing in Vodafone (<http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/06/Vodafone1.pdf>)

66. GSMA Mobile Infrastructure Sharing (<http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>)

67. BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks (http://rspg-spectrum.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf)

68. Nodes B include radio frequency transmitters and receivers used to communicate with mobile devices and are used in UMTS networks. Base transceiver stations are the GSM equivalent of Nodes B.

69. Radio network controller (RNC) and base station controller (BSC) control several Nodes B/ BTS (for example manages the handover between them) and acts as an aggregator.

70. GSMA Mobile Infrastructure Sharing (<http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>)

71. Coleago Consulting: Network Sharing business planning (http://www.coleago.co.uk/fileadmin/user_upload/Downloads/Network%20Sharing%20Overview%20Coleago.pdf)

72. BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks (http://rspg-spectrum.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf)

73. Coleago Consulting: Network Sharing business planning (http://www.coleago.co.uk/fileadmin/user_upload/Downloads/Network%20Sharing%20Overview%20Coleago.pdf)

74. GSMA Mobile Infrastructure Sharing (<http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf>)

75. Please note that there is an important distinction between national roaming as part of a voluntary network sharing agreement and roaming obligations forced upon MNOs by national regulating authorities, e.g. as a measure to promote new entry.

7 ANNEXE 2

– Sensitivity tests on our econometric analysis

In this annexe, we provide the results of sensitivity analysis that we have carried out on our preferred investment and price models. These results suggest that our preferred models are robust to a range of factors. This therefore provides further evidence that investment is not higher in four player markets and that prices are not lower in four player markets.

7.1 Investment sensitivities

7.1.1 Testing for panel effects

We test whether a Random Effects (RE) model is more appropriate than an Ordinary Least Squares (OLS) model by applying the Breusch-Pagan Lagrange multiplier test to our preferred specification. This test is not valid if lagged dependent variables are included, so we exclude lagged investment. The results of the test produce a test statistic of 2,876.81 and a p-value of approximately 0.00, which allows us to reject the null hypothesis that the variation in unobserved Fixed Effects (FE) is zero. Using this result and economic intuition, we reject OLS in favour of RE.

Similarly, we test whether a FE or RE model is more appropriate using a Hausman test on our preferred specification. This produces a test statistic of 962.58 and a p-value of approximately 0.00, on which basis we reject the null hypothesis that RE is more appropriate than fixed effects. This supports our decision to use FE in our preferred regression.

7.1.2 Testing alternative variables

We test our results are robust to using different measures of capex. In particular, we consider:

- capex as a dependent variable and subscribers as an independent variable; and
- capex/revenue as a dependent variable.

We also test whether we have included appropriate variables in our preferred specification. In particular, we consider:

- whether spectrum could have an impact on investment by including it as an independent variable – we might expect MNOs with greater amounts of spectrum to invest more in their networks; and
- whether HHI could be endogenous by using one quarter lags as instruments.

The results of these sensitivities are shown in Table 11 as relationships (1) to (4) respectively. These results do not differ significantly from those of our preferred specification, meaning that there is no evidence that investment is higher in less concentrated markets.

Table 11. Testing alternative variables in our preferred capex regression

	(1)	(2)	(3)	(4)
Dependent variable	log(capex)	log(capex/revenue)	log(capex per subscriber)	log(capex per subscriber)
HHI	-0.13 (0.32)	-0.03 (0.35)	0.31 (0.31)	-
HHI	-	-	-	-0.12 (0.21)
Spectrum	-	-	0.17*** (0.05)	-
Subscribers	0.89*** (0.24)	-	-	-
Auction dummy	0.09** (0.04)	0.10*** (0.04)	0.10*** (0.04)	0.09** (0.04)
3G network dummy	0.22*** (0.08)	0.18** (0.09)	0.31*** (0.10)	0.22*** (0.06)
4G network dummy	0.34*** (0.09)	0.32*** (0.08)	0.30*** (0.10)	0.34*** (0.06)
% prepaid connections	-0.40*** (0.14)	-0.12 (0.09)	-0.34** (0.13)	-0.38*** (0.08)
GDP per capita (in PPP terms)	0.07 (0.46)	0.04 (0.49)	0.64 (0.51)	0.07 (0.25)
Lagged capex	0.18*** (0.04)	-	-	-
Lagged capex/revenue	-	0.19*** (0.06)	-	-
Lagged capex per subscriber	-	-	0.18*** (0.05)	0.18*** (0.02)
Number of observations	2,293	2,293	1,959	2,293
R ²	0.17	0.18	0.24	-
Time FE	Yes	Yes	Yes	Yes
MNO FE	Yes	Yes	Yes	Yes
Methodology	FE	FE	FE	FE

Source: Frontier based on GSMA database
 Figures in parentheses indicate robust standard errors for (1), (2) and (3) and standard errors for (4) *** p<0.01, ** p<0.05, * p<0.1
 All relationships are log-log models with all non-dummy variables in logarithmic form

Including lagged capex per subscriber in our regressions allows us to determine the short-run and long-run impacts of competition. The short-run impact is represented by the coefficient on the competition variable. The long-run impact, in other words the impact in a world of constant capex per subscriber, is given by the coefficient on the competition variable divided by one minus

the coefficient on lagged capex per subscriber. Applying a Wald test to this composite coefficient in our preferred specification, gives a test statistic of 0.2 and a p-value of 0.66. This implies that we cannot reject the hypothesis that competition has no impact on investment in the long-run.

7.1.3 Testing alternative data

We estimate our preferred investment relationship using alternative data sets. Table 12 presents the results of these sensitivities. In particular:

- relationship (1) includes data for all markets regardless of the number of players (in comparison in our preferred specification we focus on markets with three or four players);
- relationship (2) considers data from 2004 onwards rather than from 2000 onwards;
- relationship (3) utilises country level data rather than operator level data;
- relationship (4) defines a “player” in a three or four player market as an MNO with at least 2.5% market share, rather than 5% as in our preferred specification; and
- relationship (5) removes capex per subscriber outliers, defined as those at or above the 99th percentile, or those at or below the first percentile in each quarter; and
- relationship (6) uses annual data, rather than quarterly data.

The results of these sensitivities do not significantly differ from the results that we obtain under our preferred capex specification.

Table 12. Testing alternative data in our preferred capex regression

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	log(capex per subscriber)					
HHI	0.30 (0.24)	0.22 (0.39)	-0.43 (0.40)	-0.02 (0.32)	-0.18 (0.27)	0.55 (0.38)
Auction dummy	0.12*** (0.03)	0.07* (0.04)	0.11*** (0.04)	0.09*** (0.04)	0.07** (0.04)	0.16** (0.06)
3G network dummy	0.22*** (0.08)	0.22** (0.10)	0.02 (0.10)	0.25*** (0.09)	0.16*** (0.06)	0.03 (0.08)
4G network dummy	0.32*** (0.09)	0.33*** (0.09)	0.27** (0.12)	0.33*** (0.09)	0.29*** (0.08)	0.19* (0.10)
% prepaid connections	-0.32*** (0.10)	-0.55*** (0.13)	-0.47** (0.22)	-0.35*** (0.11)	-0.34*** (0.12)	-0.36*** (0.10)
GDP per capita (in PPP terms)	0.12 (0.36)	0.37 (0.52)	-0.83* (0.45)	-0.01 (0.43)	-0.12 (0.42)	0.65 (0.47)
Lagged capex per subscriber	0.21*** (0.05)	0.16*** (0.05)	0.24*** (0.06)	0.19*** (0.05)	0.16*** (0.04)	0.31*** (0.08)
Number of observations	2,498	1,913	1,122	2,283	2,208	541
R²	0.24	0.13	0.27	0.23	0.26	0.32
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
MNO FE	Yes	Yes	Yes	Yes	Yes	Yes
Methodology	FE	FE	FE	FE	FE	FE

Source: Frontier based on GSMA database
 Figures in parentheses indicate robust standard errors
 *** p<0.01, ** p<0.05, * p<0.1
 All relationships are log-log models with all non-dummy variables in logarithmic form

7.2 Price sensitivities

7.2.1 Testing for panel effects

We test whether an RE model is more appropriate than an OLS model by applying the Breusch-Pagan Lagrange multiplier test to our preferred price regression specification. This test is not valid if lagged dependent variables are included, so we exclude lagged prices. The results of the test produce a test statistic of 3,286.93 and a p-value of approximately 0.00, which allows us to reject the null hypothesis that the variation in unobserved fixed effects is zero. Using this result and economic intuition, we reject OLS in favour of RE. Similarly, we test whether a FE or RE model is more appropriate using a Hausman test on our preferred specification. This produces a test statistic of 52.68 and a p-value of approximately 0.00, on which basis we reject the null hypothesis that RE is more appropriate than fixed effects. This therefore supports our decision to use FE in our preferred specification.

7.2.2 Testing alternative variables

We test whether we have included appropriate variables in our preferred specification. In particular, we consider:

- whether spectrum and opex could have an impact on prices by including them as independent variables; and
- whether HHI could be endogenous by using one quarter lags as instruments.

The results of these sensitivities are shown in Table 13 as relationships (1), (2) and (3) respectively. These results do not differ significantly from those of our preferred specification.

Table 13. Testing alternative variables in our preferred price regression

	(1)	(2)	(3)
Dependent variable	log(ARPM)	log(ARPM)	log(ARPM)
HHI	0.04 (0.06)	-0.01 (0.06)	-
HHI	-	-	0.03 (0.03)
Spectrum	0.00 (0.01)	-	-
Opex	-	0.03** (0.01)	-
3G network dummy	0.01 (0.01)	0.01 (0.01)	0.00 (0.01)
4G network dummy	0.01 (0.01)	0.00 (0.01)	0.01 (0.01)
% prepaid connections	-0.01 (0.02)	0.00 (0.02)	0.00 (0.01)
GDP per capita (in PPP terms)	-0.09** (0.05)	-0.16*** (0.05)	-0.11*** (0.04)
Subscribers	0.01 (0.03)	-0.04* (0.02)	0.01 (0.01)
Lagged ARPM	0.89*** (0.02)	0.86*** (0.02)	0.89*** (0.01)
Number of observations	2,099	1,900	2,340
R²	0.94	0.96	-
Time FE	Yes	Yes	Yes
MNO FE	Yes	Yes	Yes
Methodology	FE	FE	FE

Source: Frontier based on GSMA database
 Figures in parentheses indicate robust standard errors for (1) and (2) and standard errors for (3)
 *** p<0.01, ** p<0.05, * p<0.1
 All relationships are log-log models with all non-dummy variables in logarithmic form

Including lagged prices in our regressions allows us to test whether the competition impact would be significant in both the short-run and the long-run. The short-run impact is given by the coefficient on the competition variable. The long-run impact (under which prices are constant) can be calculated as the coefficient on

the competition variable divided by one, minus the lagged price coefficient. Applying a Wald test to this composite coefficient in our preferred specification gives a test statistic of 0.22 and a p-value of 0.64. This implies that we cannot reject the hypothesis that competition has no impact on prices, assuming a long-run price equilibrium.

7.2.3 Testing alternative data

We estimate our preferred relationship using alternative data sets. Table 14 presents the results of these sensitivities. In particular:

- relationship (1) includes data for markets with less than three or more than four markets;
- relationship (2) considers data from 2004 onwards rather than from 2000 onwards;
- relationship (3) utilises country level data rather than operator level data;
- relationship (4) defines a “player” in a three or four player market as an MNO with at least 2.5% market share, rather than 5% as in our preferred specification; and
- relationship (5) removes ARPM outliers, defined as those at or above the 99th percentile, or those at or below the first percentile in each quarter.

The results of these sensitivities do not significantly differ from the results that we obtain under our preferred specification.

Table 14. Testing alternative data in our preferred price regression

	(1)	(2)	(3)	(4)	(5)
Dependent variable	log(ARPM)	log(ARPM)	log(ARPM)	log(ARPM)	log(ARPM)
HHI	0.02 (0.04)	0.01 (0.06)	0.00 (0.05)	0.02 (0.07)	0.03 (0.07)
3G network dummy	-0.01 (0.01)	0.00 (0.01)	0.01 (0.02)	-0.00 (0.01)	0.01 (0.01)
4G network dummy	0.00 (0.01)	0.01 (0.01)	0.00 (0.01)	0.01 (0.01)	0.01 (0.01)
% prepaid connections	-0.00 (0.02)	0.01 (0.02)	0.01 (0.02)	-0.00 (0.02)	0.00 (0.02)
GDP per capita (in PPP terms)	0.01 (0.06)	-0.11* (0.05)	0.02 (0.08)	-0.09* (0.05)	-0.12** (0.06)
Subscribers	0.02 (0.02)	0.04 (0.04)	-0.19*** (0.07)	0.02 (0.03)	0.01 (0.03)
Lagged ARPM	0.89*** (0.02)	0.88*** (0.02)	0.89*** (0.02)	0.88*** (0.02)	0.87*** (0.02)
Number of observations	2,475	2,023	861	2,318	2,266
R²	0.94	0.94	0.96	0.95	0.95
Time FE	Yes	Yes	Yes	Yes	Yes
MNO FE	Yes	Yes	Yes	Yes	Yes
Methodology	FE	FE	FE	FE	FE

Source: Frontier based on GSMA database
 Figures in parentheses indicate robust standard errors
 *** p<0.01, ** p<0.05, * p<0.1
 All relationships are log-log models with all non-dummy variables in logarithmic form

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