

Economic impact assessment of 5G supply chain restrictions in the EU

April 2019

1. Background

National security concerns have led some governments to consider excluding Chinese vendors Huawei and ZTE from the supply chains for 5G equipment. While actual security concerns are often kept vague, the main focus seems to be the possibility of vendors establishing a software 'backdoor' which would allow third parties to gain control of Chinese vendors' equipment, bypassing operator security protocols. In late 2018, the US, Australia, New Zealand and Japan introduced measures in this direction.

In the European Union, officials from the UK, Germany, Poland and the European Commission are said to be considering bans. Recent reports suggest that some European countries are leaning towards tightening security rules for data networks rather than applying an outright ban on Chinese firms. The German telecoms regulator recently said it would not establish such a restriction; UK officials have stated that the risks could be mitigated without a ban; and the Polish government has said that a ban is unlikely. Still, reports are mixed and final decisions have not yet been made.

GSMA Intelligence has collated relevant market and industry data from key players and carried out an economic impact assessment of the implementation of a total ban on the use of Chinese equipment vendors in the EU, in order to understand the scope and scale of its potential implications.

2. Summary of findings

The exclusion of Chinese equipment vendors from 5G networks would have far-reaching consequences for the rollout of 5G in Europe and the realisation of the broader economic benefits associated with the technology for European citizens and businesses.

5G rollout costs increase by €55 bn

A ban on Chinese equipment vendors would increase 5G rollout costs to mobile operators by approximately €55 billion. Half of this would be due to European operators being impacted by higher input costs following significant loss of competition in the mobile equipment market. Additionally, operators would need to replace existing infrastructure before implementing 5G upgrades. In total, 5G RAN costs would increase by almost 40%, driving higher 5G service prices for European consumers and businesses, and reducing overall take-up.

5G launches delayed by at least 18 months

Internal contingency assessments by several European mobile operators consistently show that a ban and its impacts would likely result in a significant delay to 5G launches, of at least 18 months. The need to replace network equipment and the capacity constraints on the remaining mobile equipment vendors would disrupt current rollout plans. Such a delay would widen the gap in 5G penetration between the EU and the US by more than 15 percentage points by 2025.

The EU28 would lose €45 bn in productivity growth

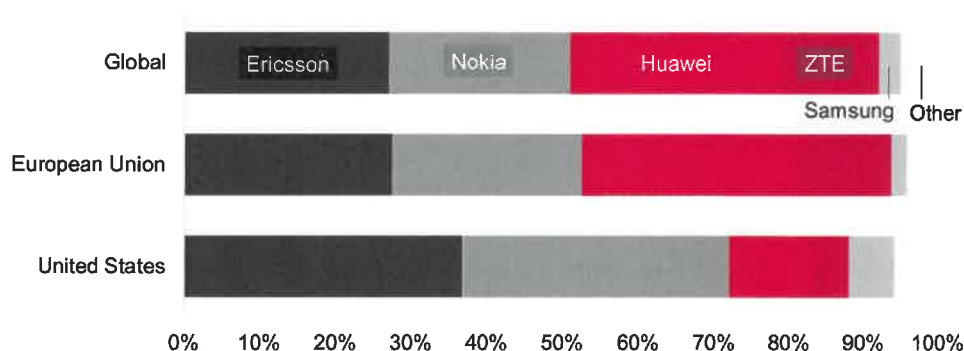
More importantly, the significant benefits available to European citizens and businesses from 5G would be put at risk. The rollout delay would cause a loss of €15 billion of economic value add in the period to 2025, growing to €45 billion by 2034 if the effects are permanent, damaging the global competitiveness of key EU industries. Productivity losses would be particularly concentrated in manufacturing, professional & financial services and public services.

3. Economic impact assessment

The EU mobile equipment market features a dynamic, competitive landscape – with a key role played by Chinese equipment vendors

The EU mobile equipment market comprises three large equipment makers (Huawei, Nokia and Ericsson) supplying about 80% of the market. Chinese vendors Huawei and ZTE play a significant role, with a combined market share of more than 40% of sales. This is in line with their global market share. Their presence currently makes the EU market less concentrated than the US, where Nokia and Ericsson combined represent more than 70% of sales. Chinese vendors are widely regarded as important innovators and disruptors: some industry sources indicate they are currently market leaders in innovation. Huawei alone invested in R&D more than Nokia and Ericsson combined for the period from 2012 to 2017, and is currently a pioneer in 5G technology.

Figure 1: Market shares for RAN sales, 2018



Source: GSMA Intelligence

Mobile network equipment procurement by EU mobile operators has benefited from such a competitive landscape. In fact, a recent study suggests mobile equipment prices are lower in the EU than in the US (Shampine, 2018)¹. While vendors offer equipment with different attributes and prices, international standards allow operators to combine multiple vendors as part of the same network. Industry sources indicate that these multi-vendor strategies have helped promote strong competition between vendors, driving lower prices in procurement and promoting investment.

A ban on Chinese vendors would severely lessen competition in the mobile equipment market, increasing prices and driving additional 5G rollout costs by €25 billion

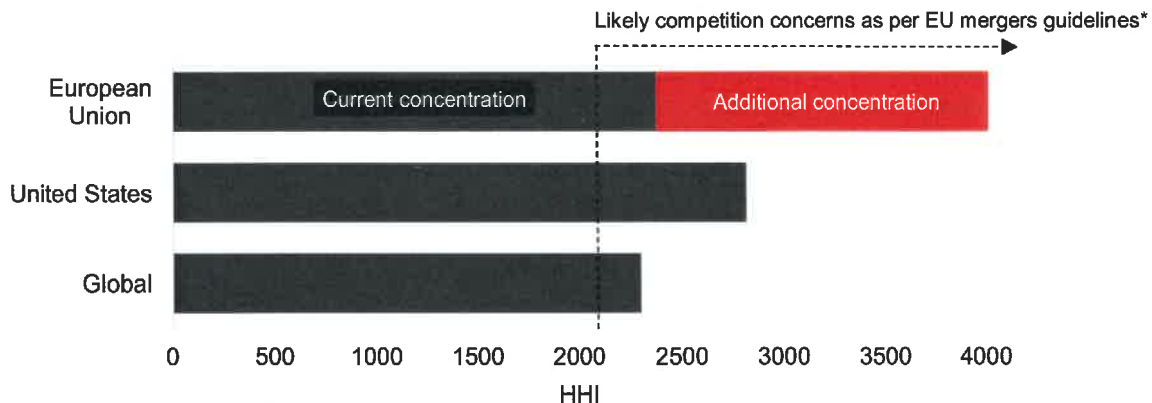
Excluding Chinese firms from the supply chain would mean a loss of rivalry between vendors and an increase in market power. This is likely to materialise in an increase in mobile equipment prices.² Operators would face few credible options in their procurement of mobile equipment, putting at risk multi-vendor approaches. As a result of the exclusion, the

¹ Declaration of Allan L. Shampine (Compass Lexecon), In the Matter of Protecting Against National Security Threats to the Communications Supply Chain Through FCC Programs, Federal Communications Commission. Dated June 2018, available at <https://ecfsapi.fcc.gov/file/107021419415731/107110__98178616v1_FINAL%20-%20Huawei%20Reply%20Comments%20-%20National%20Security%20Docket%2018-89.PDF>

² This is particularly the case considering the significant role of Chinese vendors in the EU. Notably, the European Commission approved the Nokia-Alcatel merger specifically arguing that "post-transaction, there will continue to be strong suppliers active in the market, namely Ericsson and Huawei with a share similar to that of the merged entity, as well as ZTE and Samsung" Paragraph 96 of the Case No COMP/M.7632 - NOKIA/ALCATEL-LUCENT

European equipment market would see concentration increase substantially: there would be effectively two large players left, supplying 90% of the market. Such an increase in concentration would make the EU equipment market significantly more concentrated than the US, and beyond global levels.³

Figure 2: Market concentration in the RAN market as per the HHI



Source: GSMA Intelligence. *Note EU Merger guidelines treat post-merger HHIs above 2000 and delta above 150 as cases of likely horizontal competition concerns.

Applying standard antitrust screening tools, we estimate prices of mobile equipment would increase by 17%, as a result of vendors having both more incentive and ability to raise prices.⁴ This result is in line with findings from related studies,⁵ and would mean additional costs of €25 billion in RAN capex between 2019 and 2025. Barriers to entry and expansion are strong in this market, in particular those related to R&D and scale. It is therefore unlikely that new entry or the expansion of smaller players can offset the loss of competition in the short to medium term.⁶

To roll out 5G under such restrictions, European mobile operators would first need to replace an important part of their 4G infrastructure. This would further increase RAN costs by €30 billion

The initial rollout of 5G networks will involve the adoption of new radio-transmission standards, requiring operators to upgrade their existing 4G infrastructure.⁷ Since this necessarily requires operators to purchase 5G equipment from their existing 4G suppliers, excluding Chinese vendors from procurement means operators would need to replace existing 4G physical infrastructure first. As European operators have widely relied on Chinese vendors in their rollout of 4G, this would create substantial additional costs. As of 2016, Huawei alone had supplied more than half of 4G networks globally, and two thirds of 4.5G networks – an intermediate step before 5G. In Europe, more than 60% of mobile subscribers use services from mobile network operators that have 4G contracts with Huawei.

³ The HHI of the European equipment market would rise from 2,380 to 4,070 (a 1690-point change). Current HHI in the US is approximately 2,820. HHI calculations based on market shares of Ericsson, Nokia, Huawei, ZTE, Samsung and Other players. Use of the "Other" category may overstate HHI.

⁴ Price increase based on Indicative Price Increase method with linear demand, see Technical Appendix.

⁵ See Technical Appendix.

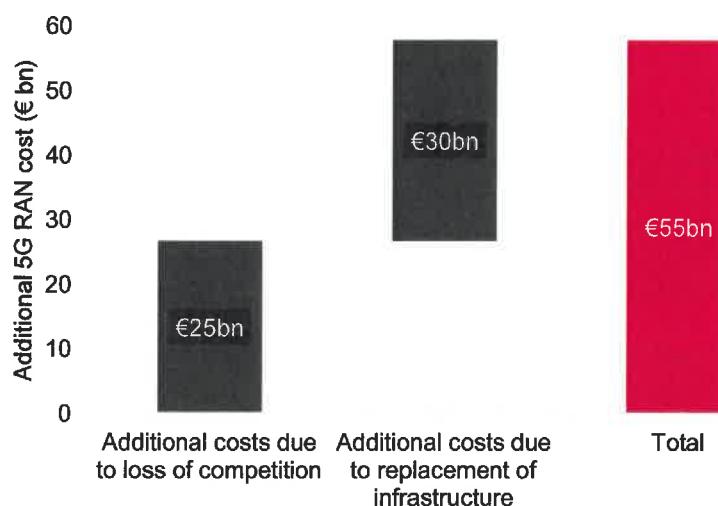
⁶ In fact, in the last 10 years there has been no entry of significant global players. Instead, there has been a trend towards consolidation.

⁷ In this first phase, operators add a 5G component to existing 4G base stations, and upgrade existing 4G core networks to support the new 5G standard and functionalities. Ultimately, this implementation (referred to as "non-standalone") means the 4G network functions as an "anchor network" for the new 5G network.

Based on the technical evaluations of several leading European mobile operators, we estimate that the switching costs for physical infrastructure would be approximately \$35 billion from 2019 to 2025.⁸ Beyond the replacement of physical infrastructure, additional switching costs may arise for some smaller European operators that rely on Chinese vendors for the management of their networks (particularly Huawei). The exclusion of Chinese vendors from 5G supply chains would mean these operators would have to transition these, adding more costs to the above estimate.

Taking into account both increased costs due to a loss of competition and the additional costs due to the replacement of existing infrastructure, the ban would increase 5G rollout costs by €55 billion. This means 5G RAN capex would increase substantially, by more than 40%, putting upward pressure on retail prices for 5G services.

Figure 3: Additional 5G RAN costs from excluding Chinese vendors from 5G supply chains in the European Union (2019 to 2025, in present value)



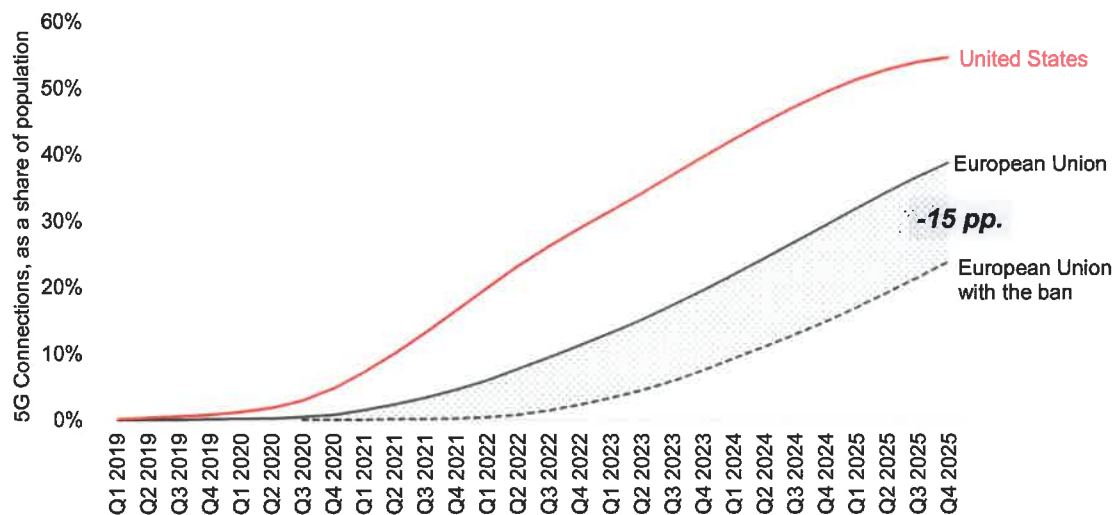
Source: GSMA Intelligence

Higher costs are not the full story; the restriction would likely delay rollout and take-up of 5G technologies across Europe

Having assessed internal contingency plans by several leading European mobile operators, we estimate that the rollout of 5G in the EU would likely be delayed by at least 18 months, possibly more. Only taking into account this delay, and without accounting for additional reductions in take-up due to higher prices, we estimate that the ban would widen the 5G gap between the EU and the US by 15 percentage points by 2025.

⁸ This only takes into account RAN infrastructure and presumes a conservative 4G footprint of Huawei and ZTE in the European Union

Figure 4: 5G penetration in the event of an 18-month delay



Source: GSMA Intelligence

Mobile operator 5G rollout plans would be disrupted by several factors. Firstly, the process of switching 4G physical infrastructure and managed services from Chinese vendors to other providers is regarded by operators as a complex operation. While some of this switching may be possible in parallel to installing 5G equipment, this can to a large degree be a sequential process, therefore delaying overall 5G rollout timelines.

Secondly, there is a significant risk that remaining players Ericson and Nokia experience supply-side capacity constraints in the short to medium term. The scale of the gap would be such that, for them to be able to absorb the current market share of Chinese vendors, they would need to almost double their current production. Samsung has been recently expanding its capabilities and capacity, but industry sources indicate it would unlikely be able to meet any significant additional demand for at least two or three years.⁹

Finally, the investment case for mobile operators can rapidly deteriorate with such increased costs and uncertainty, reducing expected returns and hence slowing down incentives for the deployment of 5G networks. Similarly, final demand for 5G mobile services would be negatively affected, as some of the additional costs would translate into higher prices, reducing the take-up of 5G – which could further weaken investment incentives.

Putting the EU's global competitiveness at risk

As the next generation of mobile communications, 5G is expected to have a transformative effect not just for European telecommunications and digital services but for the European economy and society as a whole. By allowing enhanced mobile broadband, massive machine type communications, and ultra-reliable and low-latency connections, 5G can digitise whole sectors of the economy and drive economic growth and prosperity.

5G is expected to be a key asset to improve the productivity of European businesses, enabling them to efficiently compete on a global scale – in an increasingly challenging and interlinked global economy. For instance, an EC study (Tech4i2 et al, 2016¹⁰) estimates that

⁹ Vendors would need time to expand their production capacity, not only to serve 5G equipment produced by Huawei and ZTE, but also to serve the new demand for 4G infrastructure as a result of operators switching vendors.

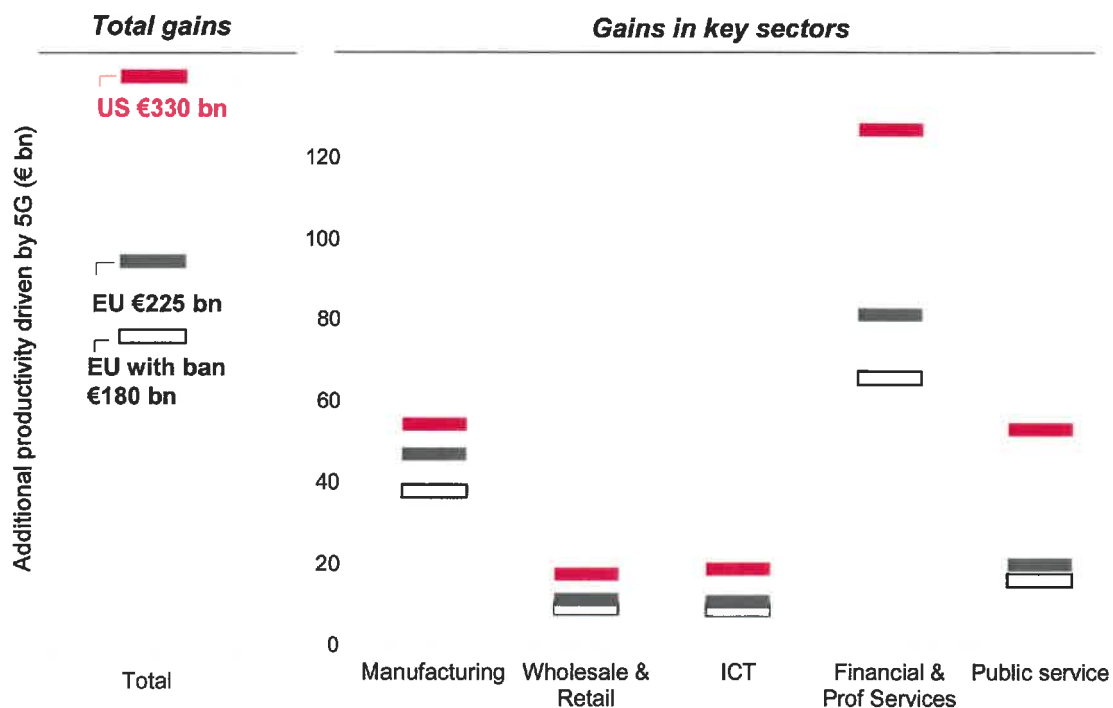
¹⁰ See "Identification and quantification of key socio-economic data to support strategic planning for the

5G can generate benefits reaching €50.6 billion per annum in 2025, across EU's automotive, healthcare, transport and utilities verticals. A more recent study commissioned by the GSMA (TMG, 2018¹¹) finds more conservative estimates, with productivity benefits reaching €25 billion per annum by 2034, and a cumulative productivity improvement of €225 billion over the period 2019-2034 (in present value terms). While this growth is significant, it is smaller than the 5G-led productivity growth the study expects to see in the US of approximately €330 billion over the same period.

A ban on Chinese equipment vendors would result in slower rollout of 5G networks in Europe and reduced take-up, which would further increase the productivity gap between the EU and the US. As a result, the EU would lose out on €15 billion in productivity improvements over the 2019-2025 period, in present value terms. In the longer term and if these effects are sustained beyond 2025, we could see an aggregate economic loss in Europe in the period to 2034 reaching €45 billion.

Productivity losses would be particularly concentrated in the manufacturing, professional & financial services and public services sectors. These are the sectors that would accumulate most of productivity gains over the 2020 to 2034 period, given they benefit from initial 5G use cases in both Europe and the US. A ban on Chinese vendors would intensify the productivity growth gap between the US and the EU28 in these sectors.

Figure 5: Economic gains driven by 5G, with and without a ban on Chinese vendors from the 5G supply chain, between 2020 and 2034 (in present value)



Source: GSMA Intelligence. Breakdown of industries includes selected categories only (more industries contribute to the total impact).

introduction of 5G in Europe", a study prepared for the EC by Tech4i2, among other research institutions.

¹¹ See "Study on Socio-Economic Benefits of 5G Services Provided in mmWave Bands", GSMA/TMG (2018). Available at <<https://www.gsma.com/spectrum/wp-content/uploads/2019/01/5G-mmWave-benefits.pdf>>

4. Technical appendix

4.1 Estimation of additional costs

We use GSMA Intelligence's forecast for 5G RAN capex in the EU28 from 2019 to 2025 as our cost baseline (€147 billion in present value). We have applied two uplifts, based on the price increase due to loss of competition and the costs to replace existing infrastructure. Costs were distributed over the 2019 to 2025 period, and published results are in present value with a discount rate of 5%.

Price increase due to loss of competition

The price increase due to loss of competition has been calculated through the Indicative Price Increase method, which approximates incentives to raise prices following a merger with data on margins and diversion ratios. The method has been applied using linear demand, resulting in conservative estimates compared to alternative demand functions (e.g., isoelastic). Price increases have been calculated per firm, leading to a weighted average. The cost uplift has been applied to the baseline forecast of 5G RAN capex, and the additional RAN investment required due to replacement of existing infrastructure.¹²

Table 1: Indicative Price Increase

Firm	Gross margin	Diversion ratio(a)	Price increase
Ericsson	40%	51%	21%
Nokia	39%	43%	15%
Samsung	47%(b)	3%	1%
Total, weighted			17%

(a) Use of market shares (post-exclusion of Chinese firms, assuming a proportional distribution of sales) as a proxy for diversion ratios between firms

(b) Includes all businesses (not only infrastructure)

The resulting price increase of 17% broadly aligns with findings from other relevant studies (Table 2). For instance, Shampine (2018) finds a price impact of 18-66%; and DG Comp (2015) finds impacts ranging from 9.7 to 19.7%. With respect to the latter, note that the Chinese ban in the EU equipment market would produce market shares and an HHI substantially above the thresholds in DG Comp (2015).

¹² The increase in costs that we present in absolute terms therefore presumes that operators purchase the same quantities of 5G equipment that GSMA Intelligence currently forecasts from 2019 to 2025.

Table 2: Relevant studies on the price impact due to exclusion of Chinese vendors

Source	Finding	Price impact
Shampine (2018) ¹³	Allowing Huawei to compete in the US market has contributed to cost savings of 15-40%; by extension, restricting Huawei would increase costs by 18-66% on current levels	18-66%
DG Comp (2015) ¹⁴	Among 22 merger evaluations, market shares greater than 35% yield a price increase of 9.7%	9.7%
DG Comp (2015)	Among 14 merger evaluations, on average, an HHI greater than 2400 yields a price increase of 19.7%	19.7%

Source: GSMA Intelligence

Costs to replace existing infrastructure

GSMA members with operations in the EU have provided data on additional costs incurred if they were to replace existing 4G RAN due to a ban on Huawei and ZTE. For each operator, we have calculated reported additional costs as a proportion of the 5G RAN capex that we expect from them, from 2019 to 2025. Separately, operators have informed on the extent to which their RAN is currently sourced from Huawei and ZTE.

On the basis of these two inputs (additional costs as a proportion of forecast 5G RAN capex, and the proportion of infrastructure via Chinese vendors), we have scaled up costs to the EU level. To do this, we have presumed a conservative 4G RAN footprint of Huawei and ZTE in the entire EU of 41%, in line with their current overall market share.¹⁵

4.2 Estimation of impact on prices and take-up

Resulting from the analysis above, the cost increase in capex RAN represents an uplift of approximately 40%. Using the assumptions in Table 3, a price increase of over 2% is calculated, which would in turn lead to a reduction in take-up of at least 2%, using a conservative price elasticity of demand (likely higher for 5G services).

Table 3: Assumptions for the impact on prices and take-up

Parameter	Value	Source
Share of RAN costs in retail price	7%	Industry insights
Cost pass-through factor	80%	Review of pass-through factors of operator taxes in the mobile industry
Price elasticity of demand	-1.02	Houngbonon & Jeanjean (2019) ¹⁶ , based on mobile data usage in Europe

Source: GSMA Intelligence

¹³ Declaration of Allan L. Shampine (Compass Lexecon), In the Matter of Protecting Against National Security Threats to the Communications Supply Chain Through FCC Programs, Federal Communications Commission. Dated June 2018, available at <https://ecfsapi.fcc.gov/file/107021419415731/107110__98178616v1_FINAL%20-%20Huawei%20Reply%20Comments%20-%20National%20Security%20Docket%2018-89.PDF>

¹⁴ DG Comp (2015) "A review of merger decisions in the EU: What can we learn from ex-post evaluations?". Authored by Ormosi, Maurizio and Havell.

¹⁵ Note that industry sources indicate Huawei alone has provided at least half of all 4G network globally. The combined market share of both Huawei and ZTE of 41% is therefore likely an underestimate of their overall 4G footprint.

¹⁶ Houngbonon & Jeanjean (2019), "Investment and market power in mobile mergers". Journal of Industrial and Business Economics.

4.3 Estimation of additional costs

We have developed alternative rollout scenarios on the baseline 5G economic impact model developed by TMG for the GSMA.¹⁷ The EU take-up profile has been reduced, according to the estimated price increase. The rollout profile has been delayed by 18 months, following inputs from industry sources. Economic gains are calculated for the 2019-2034 period and calculated in present value with a discount rate of 5%.

¹⁷ See "Study on Socio-Economic Benefits of 5G Services Provided in mmWave Bands", GSMA/TMG (2018). Available at <<https://www.gsma.com/spectrum/wp-content/uploads/2019/01/5G-mmWave-benefits.pdf>>