Spectrum

Effective Spectrum Pricing in Europe: Policies to support better quality and more affordable mobile services

September 2017

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Authors:

Richard Marsden is a Managing Director and leader of NERA's Radio Spectrum Practice, which focuses on the design of allocation mechanisms, including auctions and trading, bidding strategy, and related competition, pricing, regulatory, and public policy issues. Based in NERA's New York City and London offices, Mr. Marsden has 20 years of experience in microeconomics, political economy, and business consulting. He has worked for regulators and private companies in more than 40 countries across the Americas, Africa, Asia Pacific, and Europe. He has particular expertise in auction design and in applying economics to the telecommunications and media sectors.

Hans-Martin Ihle is a Senior Consultant in NERA's Tokyo office, specializing in auctions and spectrum policy. Mr. Ihle has nearly 10 years of experience in the design and implementation of auctions. As a member of NERA's global Auctions Practice, he advises clients on auctions and regulatory issues in energy, communications, and other sectors worldwide, with a focus on the Asia Pacific region.

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1. Executive Summary

To deliver affordable, widespread, quality mobile broadband services, operators require fair access to sufficient radio spectrum. As is recognised in EU policy, careful spectrum management is central to the digital economy. This report highlights the damage done to consumers by policy decisions that artificially inflate spectrum prices. Put simply, higher prices are associated with more expensive, lower quality mobile broadband and irrecoverable losses in consumer welfare.

This report is one of a series of regional follow ups to the global study on the impact of spectrum prices.[1] This report highlights spectrum pricing trends in Europe and their impact on consumers, and highlight cases of good and bad practice by policymakers. As in the global study, it was observed that average spectrum prices have trended upwards in Europe, with a large number large number of high price outliers amongst awards since 2013.

There is a view that very high spectrum prices have no downside for consumers. Spectrum costs are categorised as 'sunk costs' and this has been interpreted as meaning they have no impact on operators' investment and pricing decisions. Thus auctions are sometimes viewed as a risk-free means of maximising state revenue. The spectrum pricing studies are part of the growing body of academic and industry research which refutes this thesis.

Presented here is statistical evidence linking high spectrum spend in Europe with:

- **lower quality and reduced take-up of mobile broadband services;**
- **higher consumer prices for mobile broadband data; and**
- **lost consumer welfare with a purchasing power of €34bn across a group of countries where spectrum was priced above the EU median – equivalent to €67 per person.**

High prices in auctions can often be traced to decisions by policymakers. The studies highlight three types of policy mistake that distort outcomes by artificially inflating prices:

1. **Setting reserve prices that are above the true market value**
2. **Limiting spectrum supply or creating uncertainty over future availability**
3. **Inappropriate award rules such that expose bidders to undue risk or are anti-competitive**

With a few notable exceptions, European countries have a solid track record of making spectrum available in a timely manner and signposting future releases. European-level initiatives to promote common availability of spectrum across the continent have likely helped in this regard. Approaches to setting reserve prices and award rules are much more varied, with examples of both good and bad practice. Bad award rules are the most common problem, and most high price outliers amongst European spectrum awards can be explained by policy decisions that encouraged bidders to bid beyond market value so as to protect broader enterprise value.

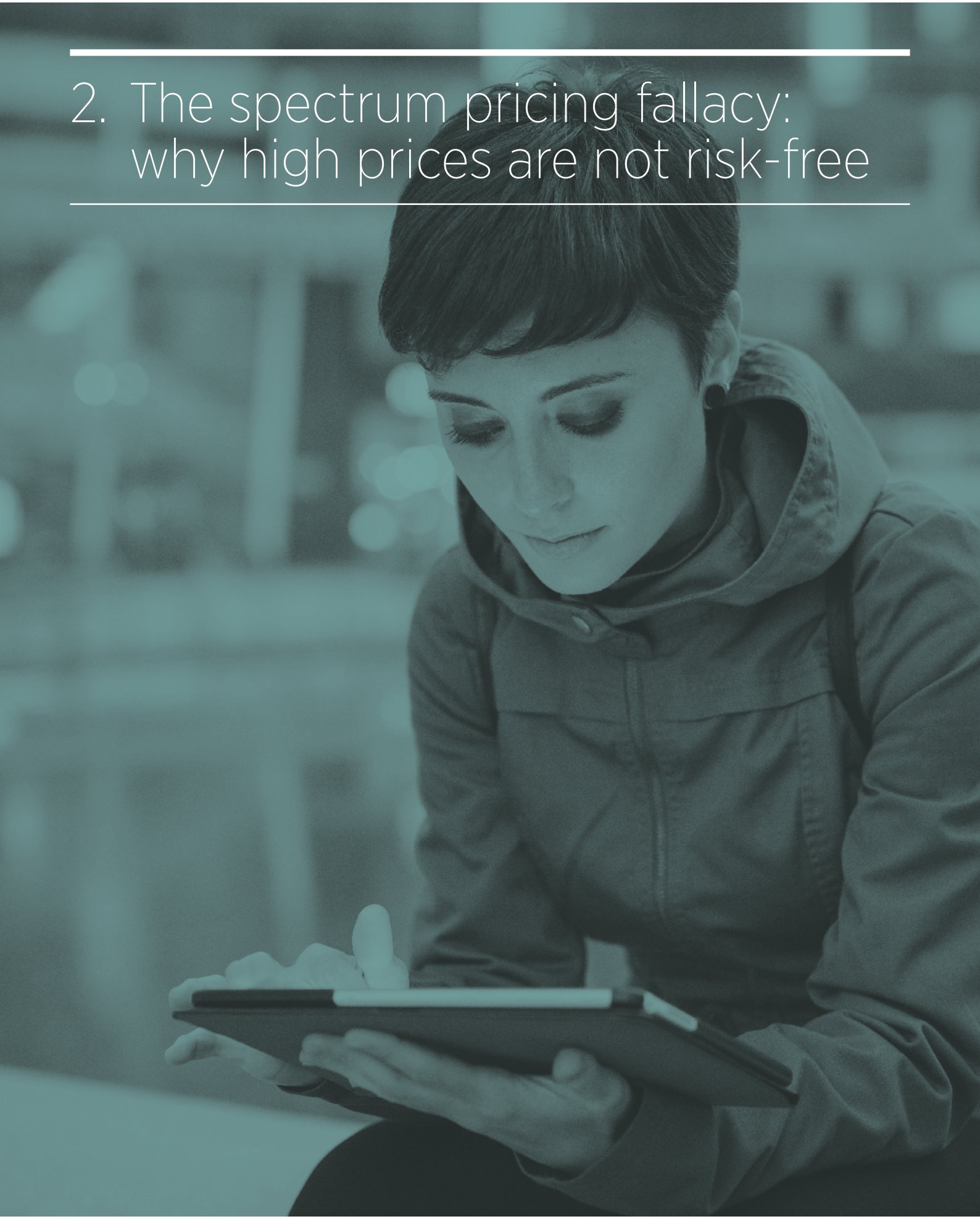
The report makes four key recommendations:

1. **Set modest reserve prices and annual fees, and rely on the market to set prices**
2. **License spectrum as soon as it is needed, so as to avoid artificial spectrum scarcity**
3. **Avoid measures which increase risks for operators**
4. **Publish long-term spectrum award plans that prioritise welfare benefits over state revenues**

With 5G and advanced 4G technologies requiring ever-increasing amounts of spectrum, European countries that inflate spectrum prices are not only damaging their broadband future, they are holding back their entire digital economies. The mobile industry, directly and as an enabler of adjacent sectors and services, contributed €500bn to EU GDP (i.e. 3.2%) in 2014. Governments and regulators must fully appreciate their ability to maximise – or thwart – their digital futures when making policies that determine spectrum prices.

1 The global report, "Effective Spectrum Pricing", was published in February 2017 and is available at www.gsma.com.

2. The spectrum pricing fallacy: why high prices are not risk-free



Radio spectrum is used to carry information wirelessly for a vast number of vital services. Demand for this precious national resource is so great that European governments and regulators take great care to ensure it is used as efficiently as possible. Efficient use helps to ensure that the socioeconomic benefits that spectrum enables can be maximised. This is why the European Commission recognises efficient allocation as a primary goal for spectrum awards, and optimal use of spectrum is mandated in European directives.

The main rationale for charging a price for spectrum, whether through upfront fees or annual charges (or both), is to promote its efficient use. The price is an objective means of distinguishing between different applications for spectrum licences. In this way a well-designed auction will allocate spectrum to those who value it most thus incentivising them to use it efficiently. Charging for spectrum also provides money for the state and where demand is great, this can be significant.

Following the huge amounts raised by some European 3G spectrum auctions in the new millennium, a critical question has arisen as to whether there is a trade-off between maximising revenues and maximising efficient spectrum use. Over time, does very expensive spectrum discourage efficient use and thus reduce the flow of welfare benefits?

On one point there is broad agreement. If spectrum is priced so high that it fails to sell, this does serious harm. Spectrum is a renewable resource, so when it is left unassigned for any prolonged period, welfare benefits that would have accrued to consumers, and society more widely, are lost forever. According to a GSMA study, the mobile industry, directly and as an enabler of adjacent sectors and services, contributed €500bn to EU GDP (i.e. 3.2%) in 2014.

But what if spectrum sells at a high price, is this risk-free? Historically, many mobile industry observers argued that because spectrum costs were 'sunk', no matter how high a price is paid, there should be no impact on network investment or higher mobile tariffs. The classic comparison is with investing in a piece of factory machinery which cannot be sold again. The upfront cost of the machine is sunk. Therefore, as it cannot be recovered, it should not influence future decisions regarding the price of the products created using the machine.

In the global report, recent academic work is highlighted that contradicts this notion that firms ignore sunk costs when making decisions on investment and pricing (see box below). Far from being a distortion-free tax, the literature suggests that high upfront input costs can depress investment and reduce price competition, especially in settings when there are only a modest number of operators. This reinforces the point that regulators should take great care to avoid actions that could distort auction outcomes and lead to prices that exceed a fair market level. The financial upside, if any, for governments from revenues is offset by the risk of award failure and downstream inefficiencies leading to lower quality, more expensive services.

WHY DO HIGH SPECTRUM COSTS IMPACT INVESTMENT AND CONSUMER PRICING?

1. Hold-up problem	■ Spectrum awards are not one-off ■ If firms believe their expected returns will be extracted in successive auctions, they will change their investment strategy
2. Internal financing constraints	■ High spectrum spend may exhaust existing funds and require financing ■ Investment by multinational parents or external sources may be redirected towards more profitable markets or ventures
3. Observed pricing decisions	■ In sectors with naturally constrained competition, firms with high sunk costs may engage less in price competition ■ High spectrum spend may act as a signal for firms not to lower prices

3. How do rising spectrum prices impact European consumers?

In the global study, a series of empirical analyses of spectrum pricing trends worldwide were evaluated alongside the impact that spectrum price is having on consumers. For this report, those investigations using data for the 28 EU member states plus Switzerland and Norway were analysed. As with the global study, the observation is that average spectrum prices have trended upwards in Europe, although the incidenceand magnitude of high price outliers is less severe than for countries worldwide. Again, it appears to show a link between high spectrum prices and more expensive, lower quality mobile broadband services. These trends link directly to lost welfare benefits.

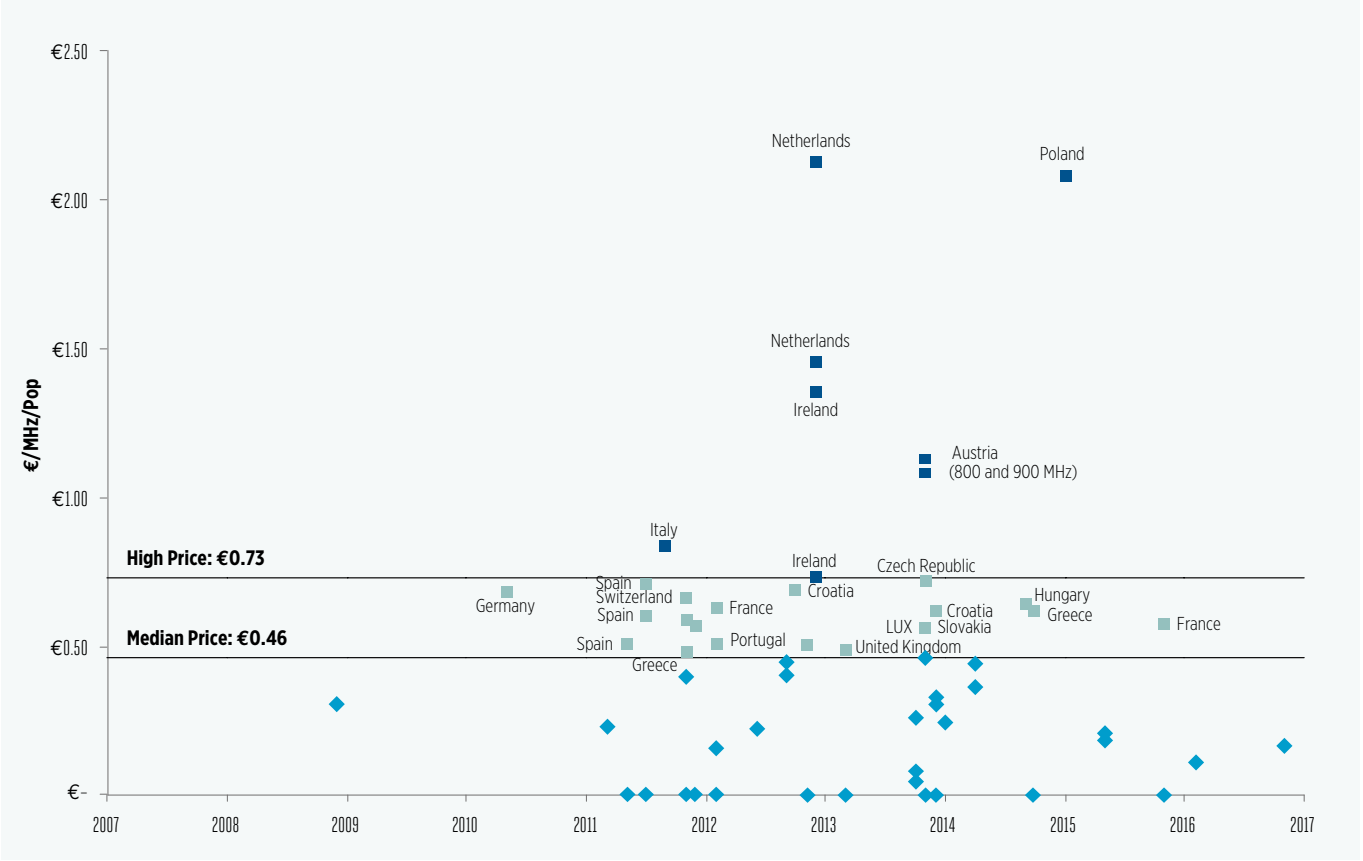
Rising spectrum prices

To explore the link between spectrum prices and consumer outcomes, the global study examined 325 awards of spectrum bands across 60 countries from 2000-2016. Over the 4G era (2008-2016), the average final price paid for spectrum sold increased 3.5 fold, while average reserve prices increased over 5-fold. Although the prices paid for many awards worldwide remain moderate, the upward trend was being driven by a growth in the number of very high price auctions, including many where regulators or governments set reserve prices well above the global mean.

The European study draws on a subset of these awards, covering 139 spectrum band releases across 30 European countries. Specifically in Europe, the average final price paid for spectrum sold increased 2 fold over the 4G era, while average reserve prices increased 1.6 fold. Figure 1 and Figure 2, compares the prices (combining up front payments and annual fees) for bands awarded in European countries for coverage and capacity spectrum respectively over a ten year period from 2007 to 2016. To facilitate meaningful comparison across European countries, prices have been converted into euros and adjusted using purchasing power parity exchange rates, with Germany as the base country.[2] For illustrative purposes, countries are labeled with prices above the 75% percentile as high prices. The price outcomes that were identified as outliers are ones where prices are so high that they would not be treated as plausible observations for comparative purposes in a statistical exercise.[3]

The same upward trend in prices in Europe, as worldwide, were observed. Although there are fewer examples of extreme high price auctions, these again are more common towards the end of the time period. It was noted that the boundaries for identifying outliers and high prices are somewhat lower than for the global sample, which is consistent with there being relatively fewer exceptionally high priced spectrum events in Europe than in the wider world.

FIGURE 1: COVERAGE SPECTRUM PRICES BY CATEGORY (2007-2016)

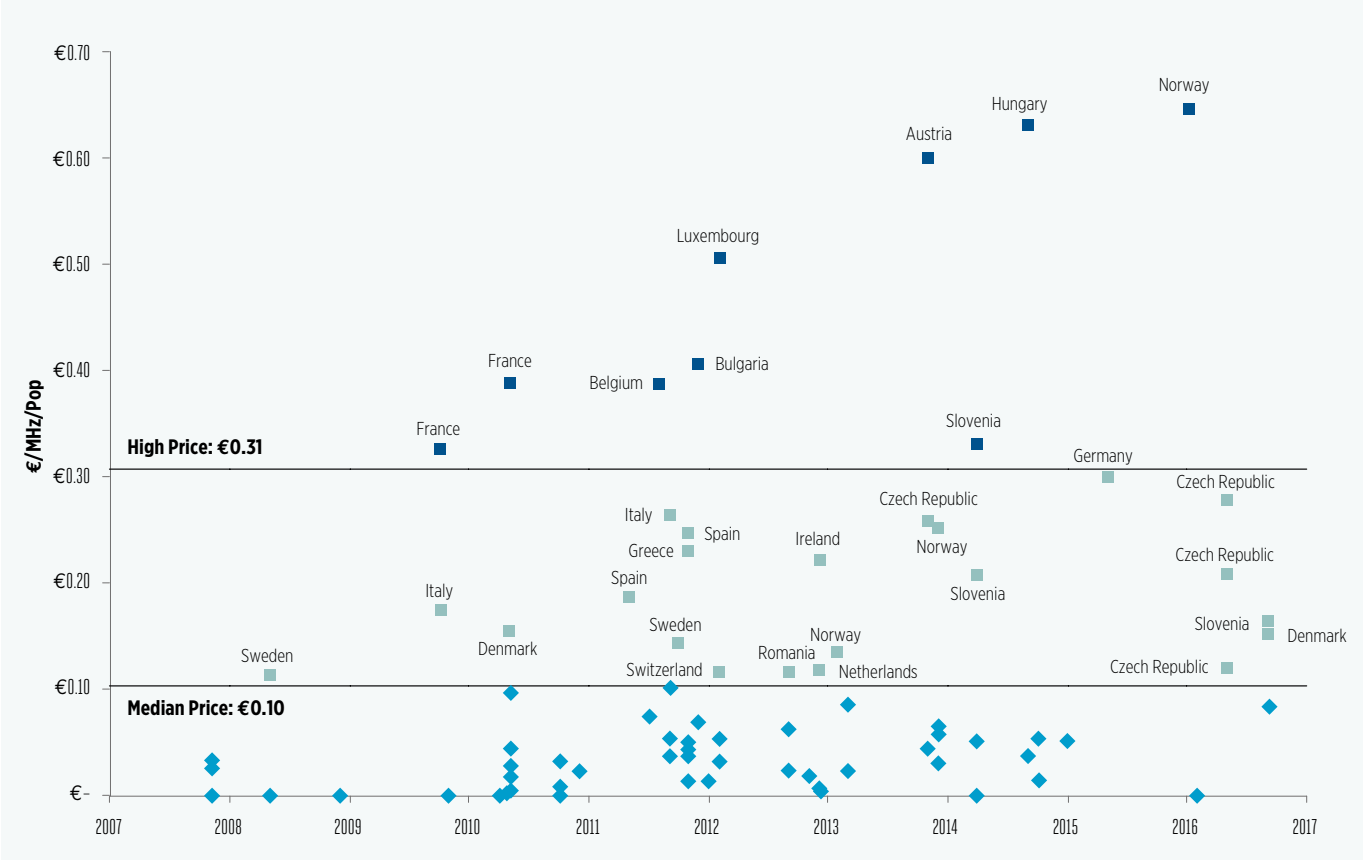


Source: NERA Economic Consulting. Notes: European coverage spectrum bands include 700, 800 and 900 MHz; prices are adjusted for PPP exchange rates, inflation and licence duration, and include annual fees.

2 Differences between real and adjusted revenues can be large. For example, in 2012, the Romanian award of 900 MHz raised EUR 0.20 per MHz/pop unadjusted, which more than doubles to EUR 0.45 per MHz/pop after adjusting for purchasing power and licence duration. However, purchasing power is only a rough proxy for differences in costs of access to communications services. In particular, such adjustments may be insufficient to address issues in some markets with large population groups that lack the income needed to afford basic communication services.

3 In order to identify outliers we used a standard statistical technique. The IQR is defined as the observations between the 1st and 3rd quartile. Outliers are classified as being above an "inner fence," and extreme outliers are classified as being above the "outer fence." Inner fence = 3rd quartile + 1.5*IQR. Outer fence = 3rd quartile + 3*IQR.

FIGURE 2: CAPACITY SPECTRUM PRICES BY CATEGORY (2007-2016)



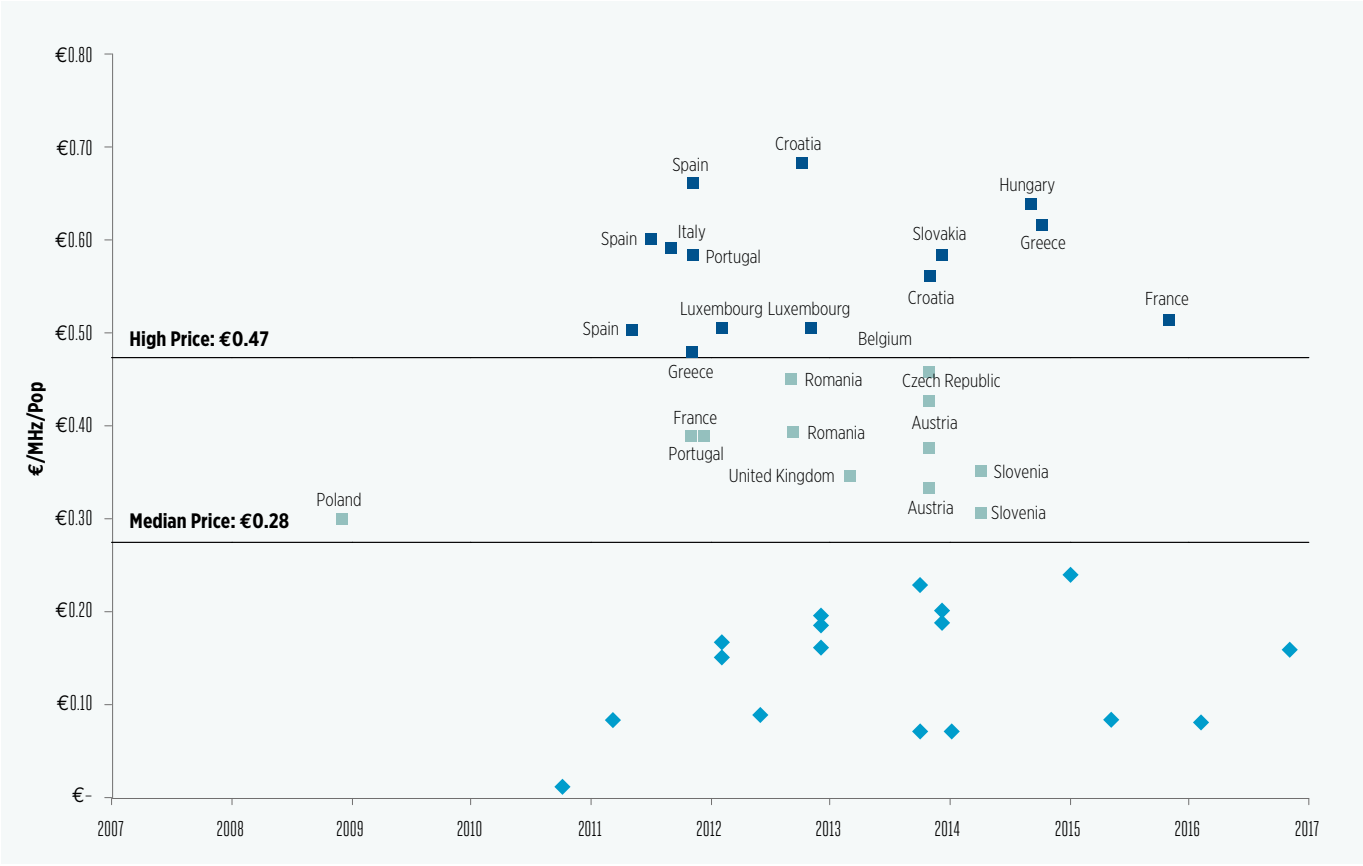
Source: NERA Economic Consulting. Notes: European capacity bands include 1800 MHz, 2100 MHz and 2600 MHz; prices are adjusted for PPP exchange rates, inflation and licence duration, and include annual fees.

This situation in Europe would not be concerning if all instances of very high prices were attributable to strong competition between bidders with robust business cases. However, the research shows that many of these outcomes were due to policy decisions, not market forces. For example, in the following chapter, although Austria (2013), Netherlands (2012) and Poland (2015) all saw strong competition between bidders, in each case this can be linked to distorted bidding incentives that stemmed from issues with the auction design and local policy decisions.

Wide variation in reserve prices

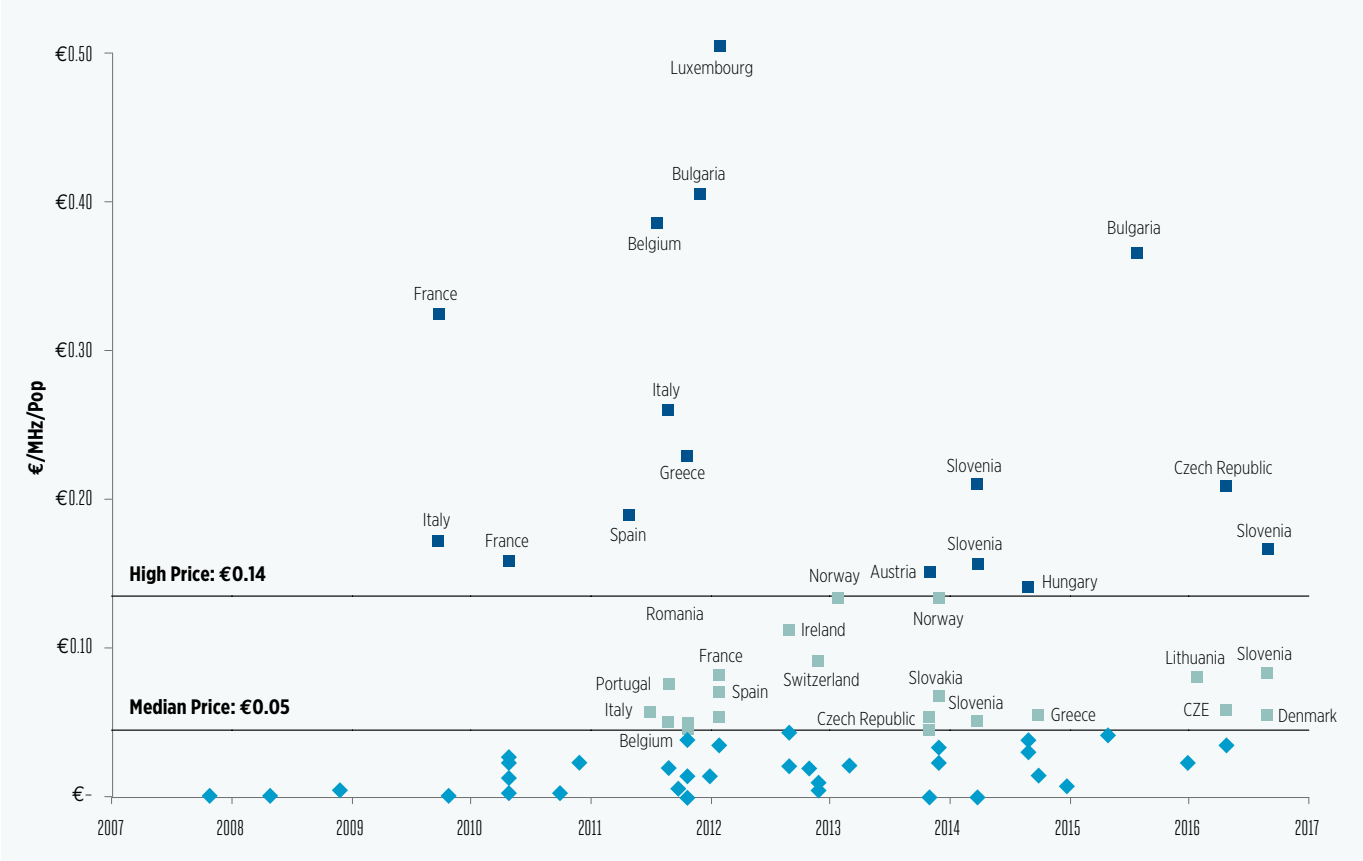
In the global sample, an upward trend in reserve prices over the ten years from 2007 to 2016 was identified. While there is no clear trend across Europe, very wide variation in reserve pricing for both coverage and capacity spectrum was noted, as illustrated in Figure 3 and Figure 4 respectively. This implies that local regulators are taking very different approaches to setting reserve prices, not with standing their common obligations with respect to spectrum management under the European directives. While many countries in Europe price conservatively – for example, Finland and Sweden, others have apparently attempted to set prices at or close to their market value – for example, Croatia and Hungary. This is explored further in the next chapter.

FIGURE 3: COVERAGE SPECTRUM RESERVE PRICES BY CATEGORY (2008-2016)

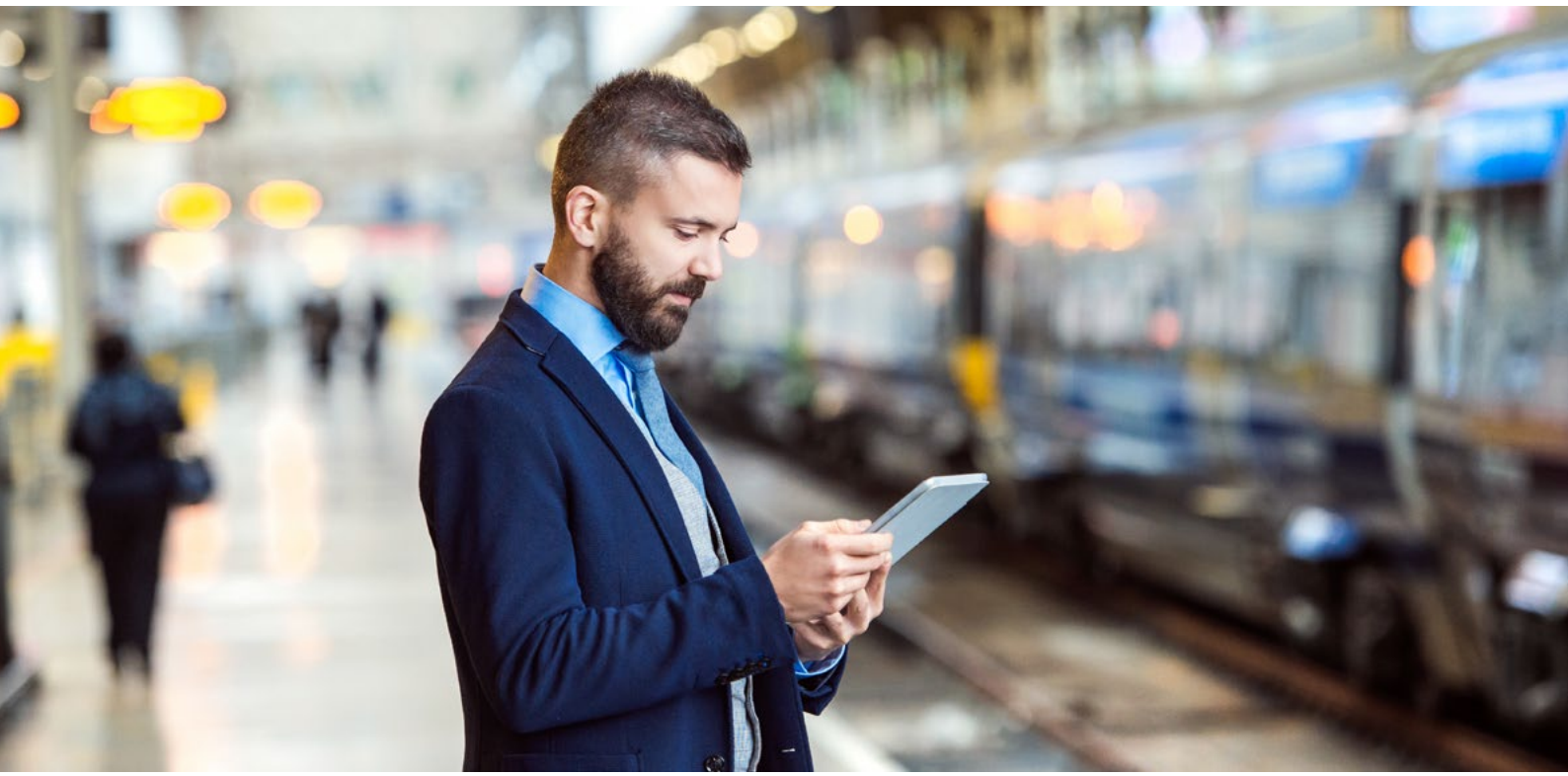


Source: NERA Economic Consulting. Notes: European capacity bands include 1800 MHz, 2100 MHz and 2600 MHz; prices are adjusted for PPP exchange rates, inflation and licence duration, and include annual fees.

FIGURE 4: CAPACITY SPECTRUM RESERVE PRICES BY CATEGORY (2008-2016)



Source: NERA Economic Consulting. Notes: European capacity bands include 1800 MHz, 2100 MHz and 2600 MHz; prices are adjusted for PPP exchange rates, inflation and licence duration, and include annual fees.

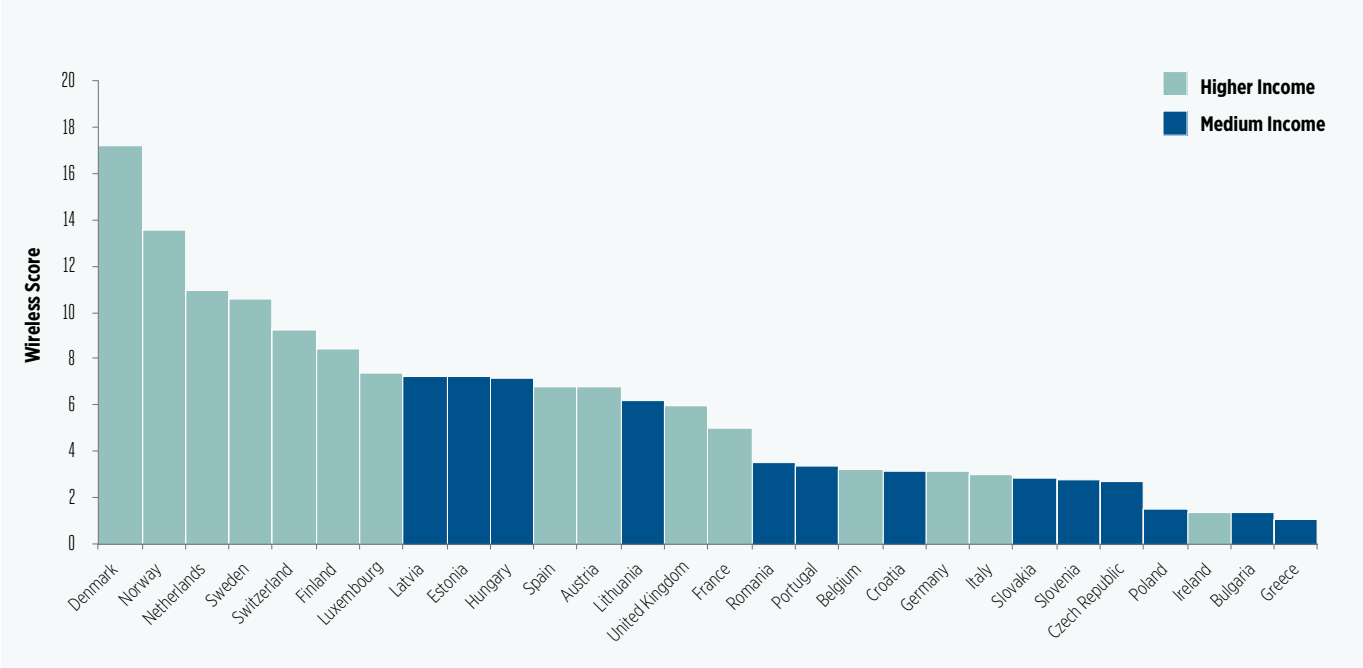


Spectrum prices and network investment

Network investment is at the heart of fast mobile broadband services with good coverage. As such, there is a growing interest from governments and regulators in adopting policies that incentivise heavy network investment by mobile operators. In the global study, the role of spectrum prices in driving incentives for network investment is analysed. Recent academic research suggests that high spectrum costs reduce incentives for network investments. To test this link, a 'wireless score' was created for each country in the sample, which measures service quality (ie. average speed[4] and coverage[5]) and 4G uptake[6]. This score is a proxy for investment data, which is not widely published.

For this report, the wireless scores for Europeancountries were updated, using newly available data on 4G network performance from November 2016. In the global report, the wireless score was based on combined 3G/4G coverage, so as to incorporate low income countries where 4G roll out was only just beginning. For European countries, the revised wireless score includes only 4G speed and 4G coverage. This change explains why wireless scores in some countries have declined relative to the previous report, and also why the rankings across European countries have shifted (modestly), as shown in Figure 5.

FIGURE 5: WIRELESS SCORE BY COUNTRY



Source: NERA Economic Consulting with data from OpenSignal.com and Telegeography GlobalComms database. No data available for Cyprus or Malta.

Across Europe, there are significant differences in the uptake of 4G services and the coverage and speeds experienced by users. Countries with higher incomes typically have substantially higher wireless scores than countries with medium incomes. This reflects differences in launch dates of services, and the obvious fact that consumers in higher income countries have greater ability to pay for and more scope to use next generation mobile data services. The best way to account for these differences was to divide European countries into two groups: medium income (15 countries); and higher income (15 countries).[7]

4 The average download connection speed that users in each country experience when connecting to 4G networks, as measured by Open Signal (November 2016).

5 The proportion of time users have access to a 4G network, as measured by Open Signal (November 2016).

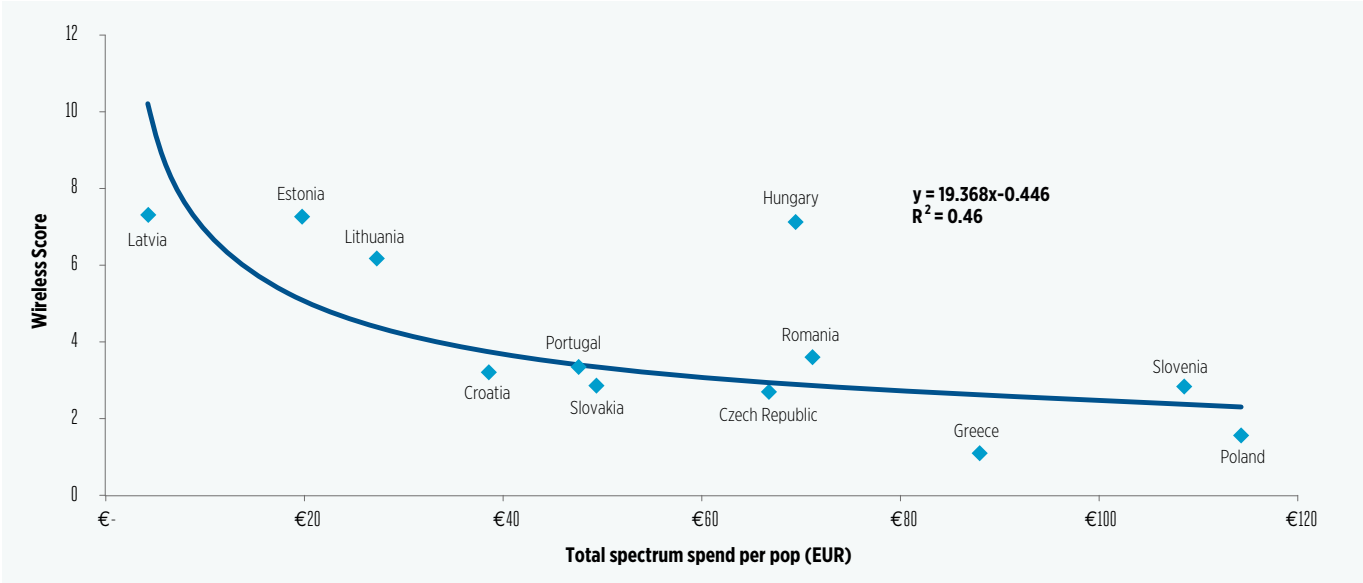
6 The percentage of total subscribers by country with access to 4G services, as measured by Telegeography (September 2016).

7 We define high income as any country with GDP per capita above €25,000. The remaining medium income countries all have GDP per capita above €7,000.

For both country groups, a correlation between lower total spend on spectrum[8] and higher wireless scores was noted. These results mirror the findings of the global study, and support the hypothesis in the academic literature that high input costs suppress investments. They contradict the more simplistic hypothesis that licence costs do not affect investment because they are sunk costs. Although spectrum cost is one of a number of factors that cause differences between countries in network investment, the results reinforce the previous conclusion that they are an important factor.

The relationship between spectrum costs and wireless score for the middle income countries is reported in Figure 6. Bulgaria, Cyprus and Malta are omitted from this group, owing to lack of comparable data.

FIGURE 6: RELATIONSHIP BETWEEN TOTAL SPECTRUM SPEND AND WIRELESS SCORE IN MIDDLE INCOME EUROPEAN COUNTRIES

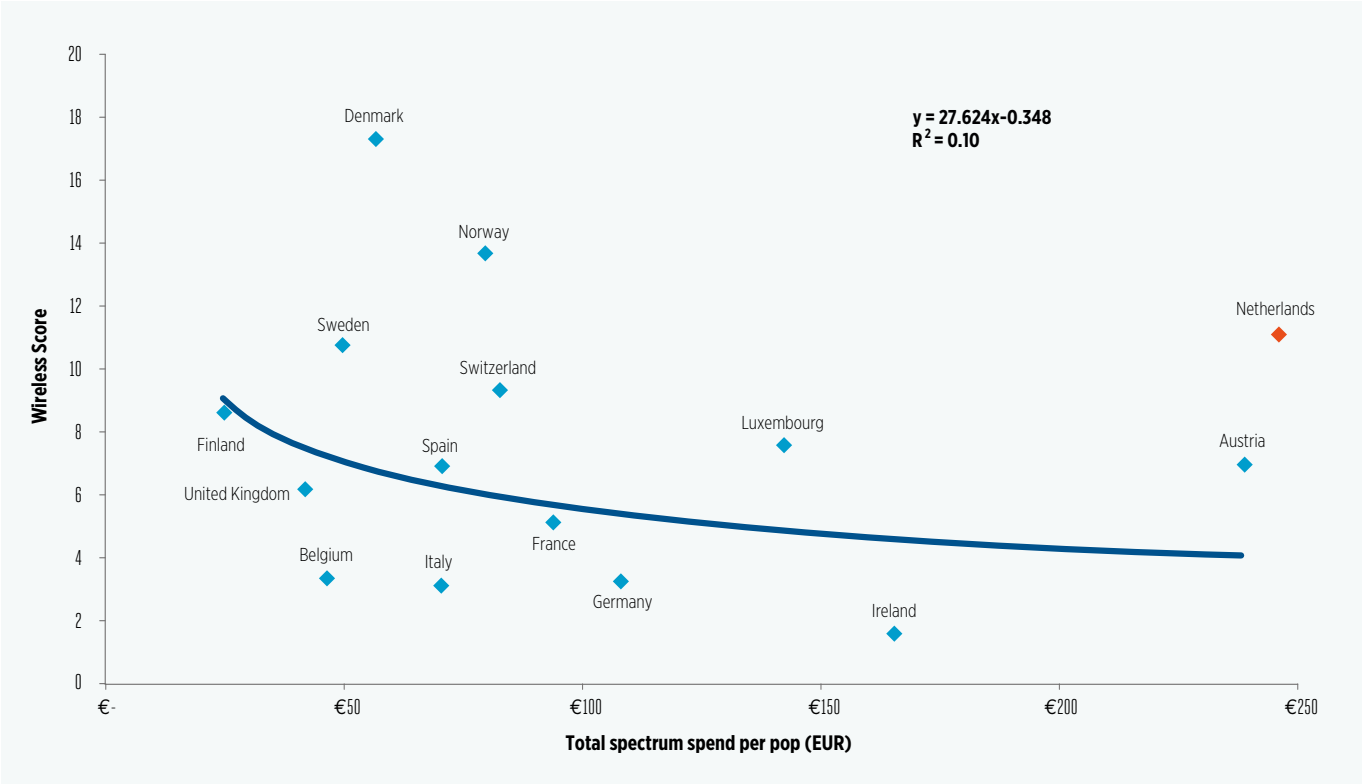


Source: NERA Economic Consulting with data from OpenSignal.com and Telegeography GlobalComms database.

8 To calculate aggregate spend on spectrum across operators in each country, we summed the total of upfront payments and relevant annual fees for spectrum in the 700, 800, 900, 1800, 2100 and 2600 MHz bands for awards between 2007 and 2016 (the same set of awards as shown in Figures 1 through 4). We excluded spend on spectrum in the 1500, 2300 and 3500 MHz, as these bands have not yet been widely allocated to mobile operators across Europe.

Figure 7 shows the correlation for higher income countries, which is positive but weaker than for medium income countries. This correlation is highly sensitive to the wireless score for Austria, where spectrum spend is exceptionally high. Until recently, Austria had the second worst wireless score in the EU but latest available data indicates that it improved its position significantly in 2016, owing to a surge in take up of 4G services. The correlation shown excludes the Netherlands, which is an outlier to the group with high spectrum costs but also a relatively good wireless score.[9]

FIGURE 7: RELATIONSHIP BETWEEN TOTAL SPECTRUM SPEND AND WIRELESS SCORE IN HIGHER INCOME EUROPEAN COUNTRIES



Source: NERA Economic Consulting with data from OpenSignal.com and Telegeography GlobalComms database.

9 We think it is reasonable to exclude the Netherlands from the correlation, as when compared to other European countries, it has unique characteristics – high population density and flat topography – which reduce the costs of 4G network rollout. (In our global study, we omitted Hong Kong and Singapore from our correlation, for similar reasons.) If the Netherlands is included, the R2 falls from 0.10 to 0.03.

Spectrum prices and the cost of mobile data

The need for affordable mobile broadband access is undeniable and is a primary focus for all telecom regulators. However, empirical evidence from behavioural economics research suggests that firms with high sunk costs are more reluctant to engage in price competition. The implication is that high upfront fees for spectrum licences will lead to higher consumer prices.

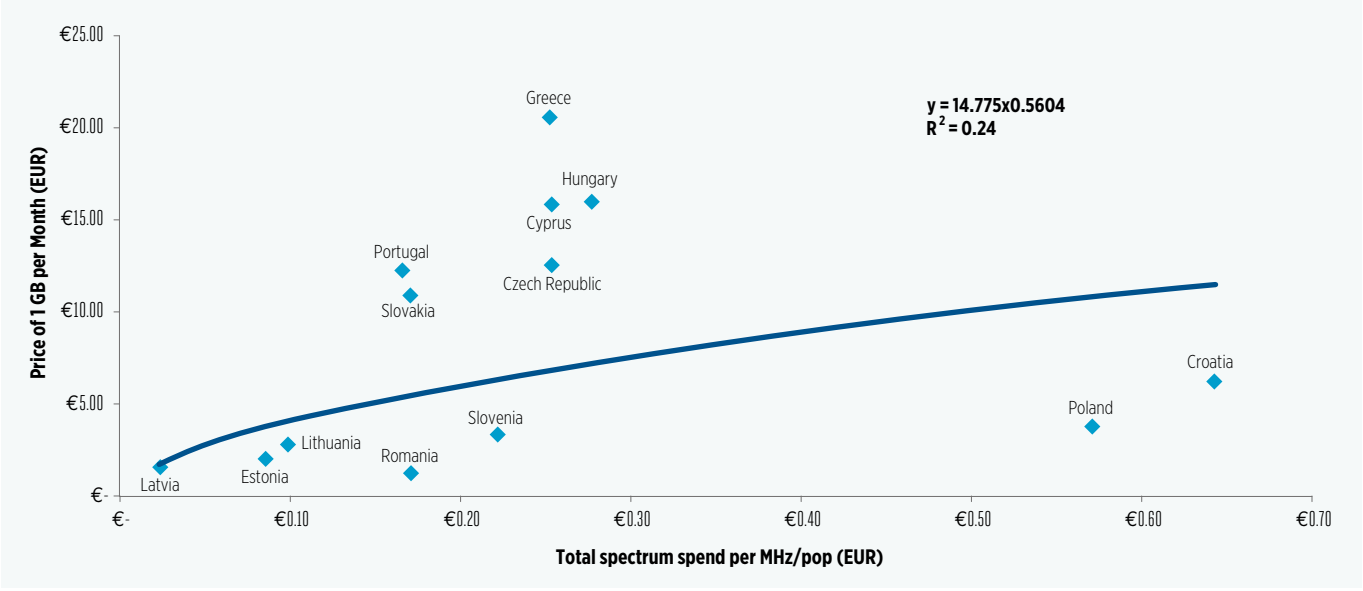
To test whether this relationship holds, the global study compared total spend on spectrum, inclusive of upfront and annual fees, and observed prices in March 2017 for wireless data by country. This required creating a 'representative plan' for 1 GB of data in every mobile network operator within a country.[10] For this study, the same exercise for 28 European countries was repeated, using updated price data collected in February 2017.[11]

The countries were divided into the same two income groups as for the wireless score analysis.

For both income groups, a correlation between lower spectrum costs and lower consumer prices for data services was observed. As with the global study, these results support the hypothesis that high input costs may suppress incentives for price competition. This suggests that high spectrum prices may in part be being passed on to consumers through higher prices for mobile data.

Figure 8 shows the negative relationship between total spend on spectrum and the price of data for the group of 13 medium income countries.[12]

FIGURE 8: RELATIONSHIP BETWEEN THE PRICE OF DATA AND TOTAL SPECTRUM SPEND IN MIDDLE INCOME EUROPEAN COUNTRIES



Source: NERA Economic Consulting.

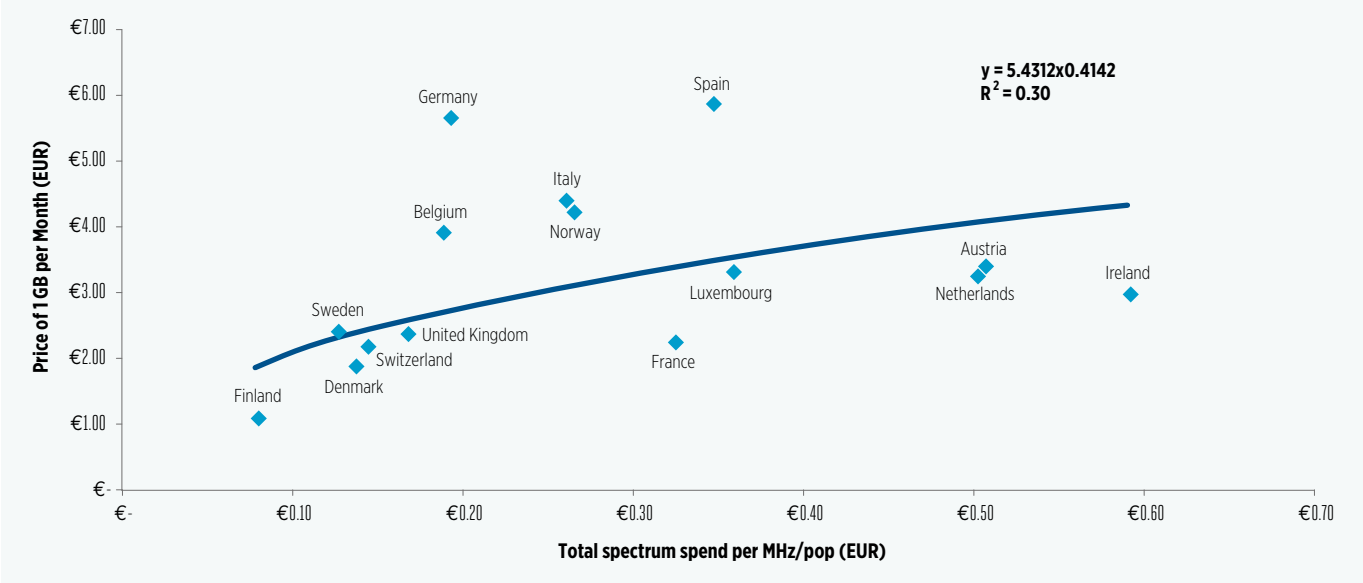
The correlation is even stronger for the group of 15 higher income countries, as illustrated in Figure 9.

10 For more information about our methodology for determining the price of data, please see Chapter 2.3 of the global report.

11 We replicated our analysis using data on consumer prices from the European Commission's report on "Mobile Broadband Prices in Europe 2016" (https://ec.europa.eu/digital-single-market/en/news/mobile-broadband-prices-europe-2016). We find similar correlations hold for basket 1 (102.4MB, 60 minutes voice) in middle-income countries, basket 2 (512MB, 200 minutes voice) in both high- and middle-income countries, basket 3 (1GB, 600 minutes voice) in both high- and middle-income countries, basket 4 (2GB, 180 minutes voice) in middle-income countries and basket 6 (4GB, 1800 minutes voice) in middle-income countries.

12 Cyprus is included here because data is available for both total spectrum and the price of data. We excluded Cyprus in Figure 7 because OpenSignal does not provide data on coverage and speed in Cyprus.

FIGURE 9: RELATIONSHIP BETWEEN THE PRICE OF DATA AND TOTAL SPECTRUM SPEND IN HIGHER INCOME EUROPEAN COUNTRIES



Source: NERA Economic Consulting.

High spectrum prices and lost consumer welfare

High spectrum prices can have serious economic consequences by driving up consumer data costs which in turn restricts broadband demand. The financial cost of these lost consumer welfare benefits can be calculated. These lost benefits can be weighed against the greater treasury revenues that accrue from higher priced spectrum.

To explore this, the global study used an econometric model[13] of mobile data demand to calculate the potential welfare gains from lower spectrum costs (via lower consumer prices). It measured the extent of the consumer welfare gains if those countries where spectrum prices were above the median had in fact sold spectrum at the median price level instead.

For this study, the same econometric model, but with data from a group of 25 European countries.[14] Bulgaria, Croatia, Cyprus, Malta and Slovakia were omitted as it was not possible to identify reliable data for all variables for these countries. Across the group, 12 countries had costs above the median. The lost welfare gains across these countries amounted to €34bn or €67 per person. This would come at the expense of €9.8bn in reduced treasury revenues. Thus, the net welfare gain from lower spectrum prices would be €24bn or €48 per person.[15]

These statistics may understate the negative economic impacts. More expensive, lower quality mobile broadband services will also constrain the growth of industries that rely on mobile communications and thus also reduce the ability of governments to earn higher revenues through taxation across the economy.

13 Based on Hazlett and Muñoz's respected methodology in A Welfare Analysis of Spectrum Allocation Polices (2004).

14 For further information regarding our methodology, please see Appendix A of the aforementioned global report. The regression results are reported in the Appendix to this report.

15 All these figures are adjusted to account for differences in purchasing power across the countries.

4. Challenges in spectrum pricing

In the analysis of European awards, as with the global study, many examples were identified of awards generating prices well above average levels. This included a notable increase in the number of instances of high price outliers for sub-1 GHz spectrum from 2013. The variations in price are simply too great to be explained by differences in local mobile market conditions, such as market penetration or revenues per user. Sometimes, high prices may simply be the result of strong competition between current and aspiring mobile operators. This should not generally be a concern for regulators. However, in Europe as elsewhere, high spectrum prices are typically linked to decisions by local policymakers. This in turn implies that many countries are implementing pricing policies that discourage roll-out of next-generation mobile services and constrain consumer welfare.

The global study identified three broad policy mistakes:

Setting spectrum prices that are above the true market value	Limiting spectrum supply or creating uncertainty over future availability	Inappropriate award rules
High upfront reserve prices: ■ Distort the market by artificially inflating prices leading to in-demand spectrum selling at above market rates or going unsold. ■ Instances of unsold spectrum are increasing which means higher prices can result in lower state revenues as well as the lost welfare benefits when spectrum goes unassigned.	**Holding back spectrum from the market:** ■ Artificially inflates demand and therefore prices. ■ Causes may include a general failure to licence enough spectrum for mobile services, or use of spectrum caps or set-asides that create artificial scarcity for a subset of operators.	**Onerous or ambiguous licence obligations:** ■ Reduce the value of licences to operators, leading to reduced participation or risk of subsequent failure in meeting the licence terms. **Rules that promote insincere or anti-competitive bidding:** ■ Rules that encourage bidders to adopt tactics to increase the amount their rivals pay.
High annual fees: ■ Distort the market by discouraging interest in licences and/or raise operator costs to a level that risks creating more expensive, lower quality services.	**Failing to provide a roadmap for future spectrum releases:** ■ Demand is artificially inflated when bidders do not know when future opportunities to acquire spectrum will arise.	**Rules that put enterprise value on the line:** ■ Rules that create situations where failure to win spectrum would put the value of an operator, or its ability to successfully offer services, in jeopardy.

As set out below, these same mistakes can be observed in countries across Europe. However, there are also many examples of good practice. With a few notable exceptions, European countries score highly with respect to making spectrum available in a timely manner and signposting future releases. European-level initiatives to promote common availability of spectrum across the continent have likely helped in this regard. Approaches to setting reserve prices and award rules are much more varied.

4.1. Excessive minimum prices

Approaches to setting reserve prices in the 4G era have varied hugely across Europe. For example, as illustrated in Figure 3, reserve prices for 800 MHz on a PPP based range from under €0.01 MHz/pop for 60 MHz spectrum in Germany (2010) to as high as €0.68 for 60 MHz spectrum in Croatia (2012). Notwithstanding this variation, few European countries have set reserve prices for 4G spectrum so high that they have choked off demand, and European regulators in general have a good track record of assigning all available spectrum. Bulgaria and Romania are exceptions. As of March 2017, Bulgaria is yet to award any new 4G spectrum, owing to legacy issues with clearing 800 MHz and a 2015 industry boycott of the 2600 MHz award; local operators objected to a reserve price of €0.17 per MHz/pop (€0.37 on a PPP basis) in a comparatively low income EU market. Although Bulgarian operators have launched 4G services using 1800 MHz, none of them have access to a 2x20 MHz carrier, and the country has one of the lowest wireless scores in the EU.

High annual fees can also create difficulties for regulators trying to set reserve prices for new spectrum awards. This is typically not at issue in Europe, where most countries (e.g. Denmark) set annual fees at low levels, sufficient to recoup administrative costs. Spain is an exception; for example, annual fees account for 27% of the price of an 800 MHz licence. These fees did not prevent Spain from having a modestly competitive 4G auction, but in combination with a substantive reserve price, they likely limited scope for price discovery and contributed to the unusual decision of fourth-player Yoigo to sit out the award.

With future awards more likely to be focused on higher-frequency bands – where there is significant new bandwidth available but potential high deployment costs given limited signal propagation, the need for moderation in reserve pricing so as to avoid award failure will likely become more important than ever. Prices for comparatively scarce 4G spectrum may be poor benchmarks for the wider capacity bands needed for 5G.

UK 900 & 1800 MHz (2013-16)

The UK Government directed Ofcom to set annual fees for liberalised 900 MHz and 1800 MHz spectrum at "full market value". Ofcom adopted a methodology based in part on benchmark prices from 4G awards across Europe. This precipitated a marathon consultation process during which operators warned against the risk of over-estimating market value and complained about the weight placed on certain high price awards, such as Austria (2013). After more than two years of deliberations, Ofcom ultimately set prices at levels about 30 to 40% below its original estimates.

German 4G auctions (2010 & 2015)

Germany has released more spectrum for 4G (and 5G readiness) than any other country in Europe, with two large multi-band awards in the last six years. In both auctions, reserve prices were set modestly compared to expected value, facilitating competitive bidding with plenty of headroom for price discovery. All spectrum sold.

Romania 4G (2012)

The Romanian regulator failed to sell 2x5 MHz at 800 MHz and 2x40 MHz at 2.6 GHz, in a multiband auction with four competing bidders. The two large operators, Orange and Vodafone, each bought 2x10 MHz at 800 MHz. However, the reserve price for 800 MHz of €0.17 per MHz/pop (€0.40 on a PPP basis) was too steep for the country's two smaller operators, Cosmote (which bought one 2x5 MHz block) and RCS & RDS (which did not buy any).

Greece 4G auction (2014)

The reserve prices for 800 MHz and 2600 MHz spectrum sold in 2014 were amongst the highest in Europe. Spectrum is included in the portfolio of the Hellenic Republic Asset Development Fund, which has a mission to maximize the proceeds from the sale of public assets. Thus, it appears that revenues were explicitly prioritised over other industry goals. Unsurprisingly, the award was not very competitive, with most spectrum blocks selling at or close to reserve price. Greece has the lowest wireless score in the EU.

4.2. Artificial scarcity of spectrum

Many European countries have an admirable track record for timely release of new spectrum bands, stretching back to the 3G era. In February 2012, the European Parliament adopted the five-year Radio Spectrum Policy Programme (RSPP) which, amongst other things, confirmed target dates already set by the Commission for the authorisation of mobile services in new 4G bands, including 1 January 2013 for 800 MHz. Only 12 of 28 member states met the 800 MHz deadline, but most of the remainder released the spectrum soon afterwards. Recently, the European Council set a 30 June 2020 target date for release of the 700 MHz band. France, Finland and Germany have already allocated 700 MHz for mobile services.

EU countries also have a good track record of releasing spectrum bands in their entirety, consistent with European mandates. Bulgaria is as an exception, where 800 MHz release has been delayed and the amount of spectrum released reduced, owing to difficulties clearing legacy military use in the band.

Many EU regulators also publish regular updates on their approach to releasing future bands, which makes it easier for operators to value spectrum. This practice may be even more beneficial going forward, as EU countries continue the often challenging task of clearing bands earmarked for 5G services, such as 700 MHz and 3.4-3.8 GHz.

UK spectrum awards

Ofcom maintains a site dedicated to providing information about past and future awards. It regularly publishes updates on future releases for mobile. For example, it has released regular updates on the award of spectrum in the 2.3 GHz and 3.4 GHz bands, planned for 2017. It has also set out its intention to release 700 MHz and recently consulted on the release of 3.6-3.8 GHz.

Bulgaria 800 MHz

Award of 800 MHz is scheduled for 2017, about 5 years behind the European average. The award is delayed owing to legacy issues with clearing military use. However, only 2x10 MHz instead of the normal 2x30 MHz will be available, much less than is needed in a country with four mobile operators. This scarcity threatens to drive up prices in a country that is at the bottom end of 4G performance in the EU.

4.3 Poor choice in award rules

Prices in spectrum auctions reflect the conditions under which bidders are competing for the scarce resource. If those conditions are distorted, then the price may deviate from the fair market level. In the global report, a range of policies, award rules and licence conditions were highlighted that create risk for bidders, and distort award outcomes

Across Europe, governments and operators have often clashed over the appropriate level of coverage obligations. However, these have generally not disrupted 4G awards, and auctions have typically provided opportunities for operators to price obligations into their bids. Indeed, several countries – notably Denmark, Germany and Sweden – have identified innovative ways to use auctions to extend 4G coverage without mandating wasteful duplication of network infrastructure in economically marginal areas.

A much bigger problem in Europe has been poor choices in award rules which lead to excessive spectrum pricing, through promotion of insincere bidding, exposure of bidders to loss of enterprise value or encouraging anti-competitive bidding. In recent years, many European countries have held large multi-band awards. Such large auctions offer both advantages and disadvantages. At their best, such events make it easier for bidders to manage substitutability and complementarity across bands, and thus identify the optimal spectrum portfolio for their needs. At their worst, they open up the possibility that an incumbent could suffer serious network disruption or even be knocked out of the market, especially where they face losing access to legacy spectrum. It is highlighted below the cases of Austria, the Netherlands and Poland where prices were, almost certainly, inflated beyond true market value, and contrast them with Sweden's successful single band 800 MHz auction.

Sweden 800 MHz (2011)

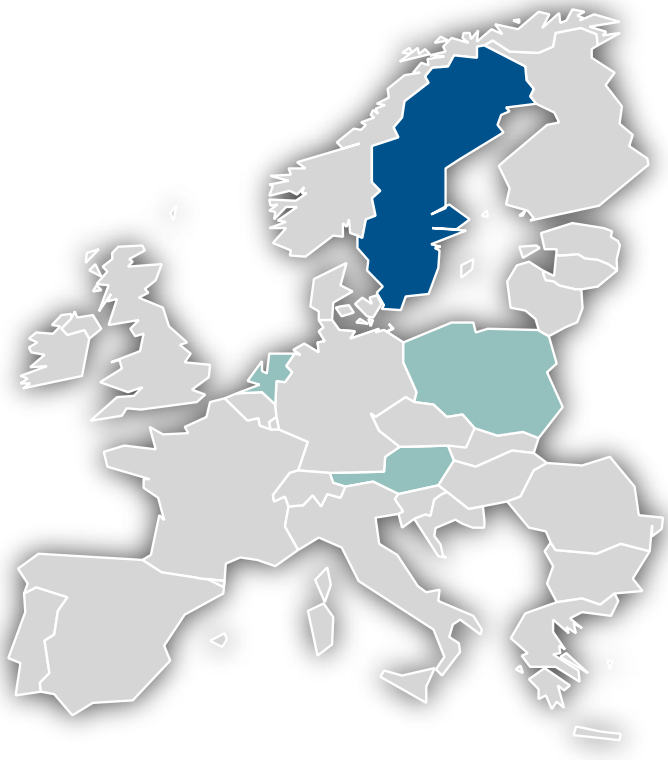
This single band auction has been widely praised for stimulating effective competition and delivering an efficient outcome at a fair market price. Some of the attractive features included: a modest but material reserve price; a flexible packaging with six lots of 2x5 MHz but rules to encourage contiguous allocation; and a coverage obligation attached to just one lot with an innovative scheme to incorporate investment commitments into the bid value. Sweden was also early to market and has long been a leader in 4G take-up across Europe.

Netherlands 4G auction (2012)

This auction sold spectrum in five bands, including the 800, 900, 1800 and 2100 MHz bands in their entirety. It raised €3.8bn, well above pre-auction expectations. The high price outcome was shaped by decisions to reserve 2x10 MHz at 800 MHz for a new entrant; and not impose any spectrum caps on bidders. This meant that at least one incumbent would fail to win 2x10 MHz in this core LTE band, and all were at risk of not winning back sufficient 900 MHz and 1800 MHz spectrum to maintain their legacy 2G businesses.

Poland 4G auction (2015)

The auction of 800 and 2600 MHz took nine months to conclude. As prices climbed to high levels, confidence in the auction was eroded owing to concerns that bidders might exploit a loophole enabling them to renege at no cost on winning bids. The regulator stepped in, first to pause the auction and then announce a sealed bid finale. Ultimately, the entire spectrum sold for $2.3bn, but new entrant winner NetNet declined to pay for the 800 MHz lot that it won. The implication is that competition from an "insincere" bidder may have pushed prices beyond true market value.



Austria 4G auction (2013)

This auction featured unexpectedly heated competition between three incumbent operators for 800, 900 and 1800 MHz. The rules obliged participants to bid blind for spectrum without being able to observe competitor demand. In the context of a combinatorial clock format, in which bidders set prices for rivals not themselves, and spectrum caps too lax to guarantee essential spectrum, bidders were incentivised to bid their enterprise value. This resulted in record spectrum prices. For the next three years, take up of 4G services significantly lagged other Western European countries, with Austria not catching up until 2016.


VINTAGE
CARGO RUNS TO
MERIDA MEXICO
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5. Spectrum pricing policy best practice

The goal of pricing policies should be to award spectrum to those who will use it most efficiently to deliver maximum benefits for society. This Europe-focused study reconfirms the conclusion from the global study that policy decisions that distort market-based spectrum awards by artificially inflating prices discourage efficient use and destroy consumer welfare. With 5G and advanced 4G technologies requiring ever increasing amounts of spectrum, those countries that artificially inflate prices are impeding broadband access and stifling their digital economies. As such, European governments and regulators need to carefully assess how their policies impact spectrum prices.

European regulators have a mixed track record with respect to policies that impact spectrum pricing, including many examples of best practice but also some glaring policy failures:

- **European countries perform best with respect to avoiding artificial scarcity; most allocate spectrum in good time and avoid policies that hold spectrum back from the market.**
- **There is no consistency on reserve price setting across EU member states, with a huge range in prices being set for the same bands. In the 4G era, there are fortunately few examples of spectrum going unsold owing to it being over-priced, but this remains a risk in Europe for future awards.**
- **Many European awards have seen inflated prices as a result of bad rules that put enterprise value of the line. There are often good reasons for countries to develop different award rules, but there is also great scope to learn from the successes and failures of others.**

The European Commission is in the process of reviewing and updating the EU telecommunications framework. This provides an opportunity for increased consistency and best practice in spectrum licensing across the EU, and a common commitment against governments using spectrum licensing explicitly to raise revenues. Any amendments should ideally bind Member States to best practice while maintaining a degree of national flexibility to adjust for local conditions.

Looking forward, this report offers the following four key policy recommendations:

#1 PRIORITISE SPECTRUM ALLOCATION

- Release usable spectrum in anticipation of need
- Provide a roadmap for future spectrum availability, so operators understand their options

#2 SET MODEST RESERVE PRICES

- Do not set reserve prices above a conservative estimate of true market value
- Treat annual fees as an integral part of the reserve price

#3 ADOPT A LONG-TERM PERSPECTIVE

- Avoid options for bidders to foreclose the market and be mindful of threats to the enterprise value
- Adopt an integrated approach to spectrum pricing and licence conditions, such as coverage obligations

#4 HELP OPERATORS MANAGE RISK

- Prioritise consumer welfare benefits from investment and competition over short-term revenue benefits
- Adopt longer licence durations
- If possible, de-politicise decisions on spectrum pricing by delegating to independent regulator with mandate to protect consumers

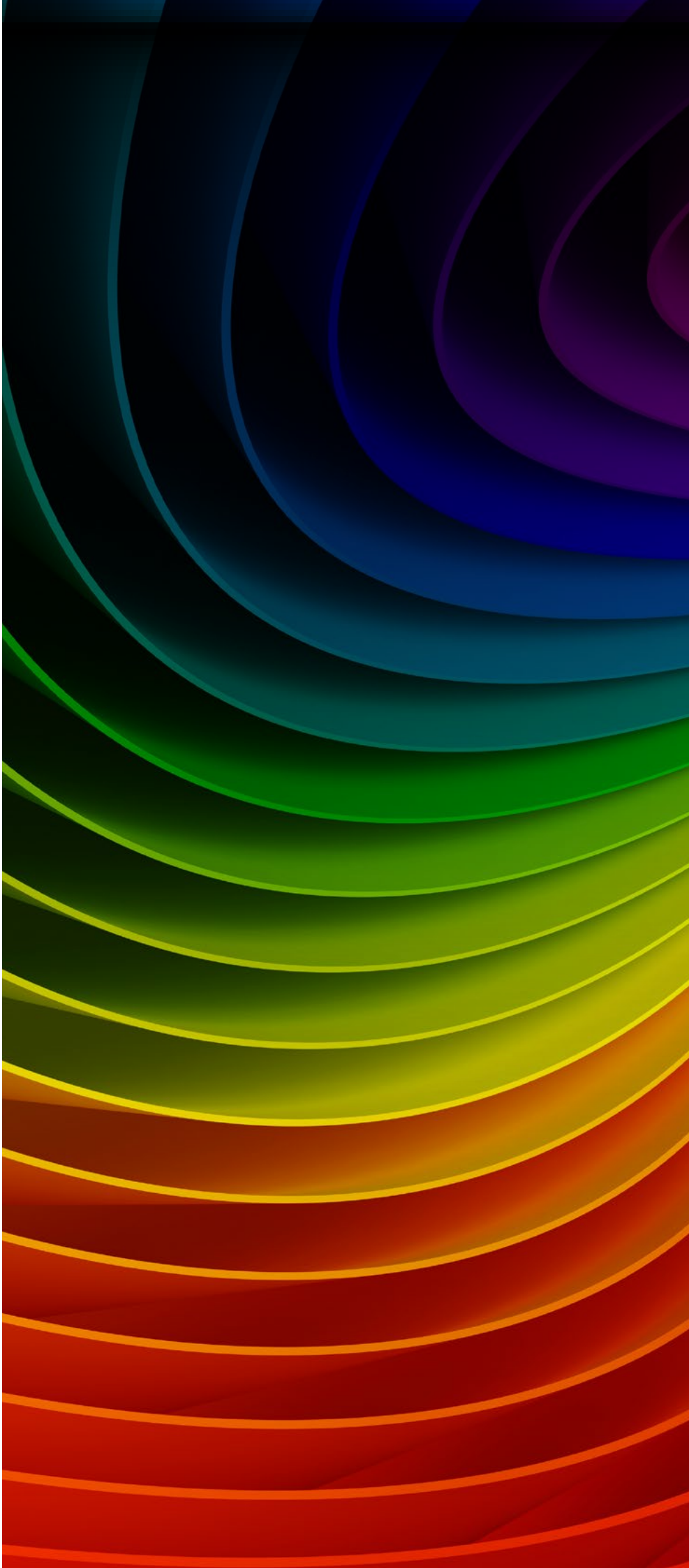
European countries which artificially inflate spectrum prices are damaging broadband access and their digital economies.

Appendix

In this appendix, we provide the regression results for the econometric model we used to estimate the welfare losses from high spectrum costs, as presented in Chapter 3. We follow the methodology used by Hazlett and Muñoz (2004) for mobile voice to estimate a demand curve for mobile data services in 2016, as described in Appendix A of the global report. This model is based on data from 25 European countries.

	First Stage Regression	Demand equation
Independent variable	Price	Quantity
Explanatory variables:		
Constant	5.82	-1.00
Price (IV)	-	-0.83***
GDP	-0.91***	0.21
Urbanisation	1.89*	
Spectrum cost	0.57***	
HHI	2.03**	
R2	49%	36%

Notes: Significance levels: *** at the 1% level, ** at the 5% level, and * at the 10% level.



Floor 2, The Walbrook Building
25 Walbrook, London EC4N 8AF UK
Tel: +44 (0)207 356 0600

spectrum@gsma.com
www.gsma.com