dot·econ

Award of 800MHz, 900MHz and 1800MHz – Fifth Benchmarking Report

A report for ComReg

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1 Introduction

1.1 Background

1. This is the fifth benchmarking report produced by DotEcon for ComReg as part of advice to ComReg on aspects of the 800MHz, 900MHz and 1800MHz auction. This report should be read alongside our previous benchmarking reports for ComReg, in particular, the most recent report (published as ComReg Document 11/59 "Further update report on benchmarking) which this report updates.

2. The first benchmarking report (09/99c)[1] produced by DotEcon in 2009 was in the context of a 900MHz only award process. Our aim was to produce a conservative estimate of the lower bound on market value of liberalised 900MHz spectrum using two methods:

    a) a regression analysis, that sought to explain observed prices for spectrum licences in different countries in terms of macroeconomic, geographical and other factors. A regression can take into account the joint effect of a number of explanatory factors on spectrum value and thus allows for country and award differences to be controlled for when estimating the value of spectrum; and

    b) a simple benchmarking analysis calculating mean auction prices across different samples of data.

    In both cases auction data was obtained from DotEcon's Spectrum Awards Database. The results of these two methods were used to provide a recommended range of values for a minimum price for 900MHz spectrum in Ireland of €16m-€34m (see Table 1 below).[2] We made a specific recommendation in our 09/99c Report that ComReg consider a minimum price towards the upper end of this range because of strong concerns about tacit collusion given the limited availability of spectrum.

3. Subsequently in September 2010, ComReg consulted on the inclusion of 800MHz spectrum in a joint award process along with 900MHz spectrum and DotEcon produced a second benchmark report (10/71b). We recommended setting a common minimum price for 800MHz and 900MHz spectrum within a joint auction.[3] We considered that setting a common minimum price was appropriate given the similarities between the two bands. However, we stressed that we were not implying that 800MHz is of identical value to

[1] The results of this analysis were published in Part C of DotEcon's Report (09/99c) which accompanied ComReg's response to and further consultation on its approach to liberalising 900MHz and 1800MHz spectrum – *'Liberalising the future use of the 900MHz and 1800MHz spectrum bands'*, ComReg Document 09/99.

[2] This minimum price would be implemented through reserve prices setting a floor on the upfront payment required immediately after the auction together with annual spectrum usage fees.

[3] DotEcon report *'Award of 800MHz and 900MHz spectrum – Update report on benchmarking'* (10/71b) published alongside ComReg's report – *'800MHz, 900MHz and 1800MHz release'*, ComReg document 10/71.

liberalised 900MHz spectrum, not least because of possible differences in equipment availability timetables for the two bands that may affect their usage in the short-run. Although we noted the uncertainties over the relative valuation of spectrum in these two bands, the lack of firm data available at that time about this relativity meant that there was an absence of evidence that these values differ significantly.

4. Under these circumstances we considered that the similarity of these bands justified setting a common minimum price and that any residual uncertainty regarding the differing values should be reflected in the use of a more conservative approach (choosing a lower minimum price) to setting the common sub-1GHz minimum price. Therefore, we recommended a tighter range of €18m-26m as a conservative estimate of market value of liberalised sub-1GHz spectrum (see Table 1).

5. In December 2010, DotEcon considered the implications of the inclusion of 1800MHz spectrum in the proposed joint award of 800MHz and 900MHz spectrum. The analysis was published in a report (10/105a) alongside ComReg's consultation on the same issue (10/105). In Section 7 of our report, we considered what would be an appropriate minimum price for 1800MHz spectrum if it were included in a joint award with 800MHz and 900MHz spectrum. In line with our approach to minimum prices for sub-1GHz, we proposed to set a minimum price for 1800MHz on a similar "conservative lower bound" basis.

6. Therefore, we benchmarked available market data from our Spectrum Awards Database to calculate the relative value between 1800MHz and sub-1GHz bands. We narrowed our sample to only look at countries where both 1800MHz and sub-1GHz bands had been auctioned and removed any country specific factors that may have skewed the relative value of these bands. The results from our calculations in Report 10/105a estimated that the relative value of 1800MHz spectrum to sub-1GHz frequencies ranged between 45% and 60%. In addition in Report 10/105, we considered there to be merit in setting the relative reserve prices of sub-1GHz and 1800MHz to match the proposed 2:1eligibility point ratio of sub-1GHz versus 1800MHz spectrum so as to not distort bidders' choices between spectrum in different bands and to simplify the rules around initial eligibility within the auction. On the basis of this analysis, we recommended that the minimum price of 1800MHz be set at 50% of the sub-1GHz minimum price (see Table 1).

7. In August 2011, we updated both our analyses to estimate a conservative market value of sub-1GHz spectrum (from Report 10/71b) and appropriate minimum price for 1800MHz spectrum (from Report 10/105a) in DotEcon Report 11/59 that was published alongside ComReg's draft decision on the multi-band spectrum release.[4] In this report, we responded to the issues raised

[4] DotEcon report *'Award of 800MHz, 900MHz and 1800MHz spectrum – Further update report on benchmarking'* (11/59) published alongside ComReg's report *'Multi-Band Spectrum Release – Release of the 800MHz, 900MHz and 1800MHz radio spectrum bands'* (11/60).

by respondents to the previous Consultation Documents (09/99, 10/71 and 10/105) in respect of the setting of minimum prices.

8. We concluded that it was still reasonable to set a common minimum price for 800MHz and 900MHz spectrum and to set an 1800MHz minimum price at around 45% - 60% of that of sub-1GHz spectrum. Our updated benchmark analysis produced a minimum price range for sub-1GHz spectrum of €15m - €26m therefore the updated minimum price range for 1800MHz spectrum was adjusted to €6.75m - €15.6m (see Table 1). We did not make any specific recommendations within the range produced by our benchmarking analysis for sub-1GHz spectrum but did suggest that a minimum price in the lower half of the range would likely create a moderation of incentives for strategic behaviour whilst running very little risk of discouraging serious bidders with a chance of winning spectrum from participating in the auction.

Table 1: Summary of reserve price recommendations from previous benchmarking analyses

Report	Spectrum band (2x5MHz lot)	Benchmarking results	DotEcon recommendation
09/99c	900MHz	€16m - €34m	€25m-€30m
10/71b	800MHz & 900MHz	€18m - €26m	No specific recommendation
10/105a	1800MHz	€8m - €16m	50% of sub-1GHz reserve price
11/59	800MHz & 900MHz	€15m - €26m	Lower half of range
	1800MHz	€6.75 - €15.6m	45% – 60% of sub-1GHz reserve price

9. As is illustrated in Table 1 there has been a general downward trend in the estimated market value of sub-1GHz spectrum throughout this period. This reflects the recent economic trend and sentiment in Ireland in particular, as well as across Europe more generally. Furthermore, with the inclusion of 800MHz and 1800MHz spectrum in a joint award process and in line with a more conservative approach, our recommendations have been targeted at the lower end rather than upper end of the proposed ranges.

1.2 Current report

10. In this report we update our analysis to estimate a conservative lower bound market value for sub-1GHz spectrum and on the relative value of 1800MHz and sub-1GHz spectrum. We take account of new auction data that has become available since August 2011, as well as update the demographic and economic data for Ireland used to derive estimates for Ireland in our analysis.

11. In particular, a number of countries have auctioned liberalised sub-1GHz spectrum recently, providing a number of highly relevant benchmarks – Spain

Italy, and Portugal have concluded their multiband auction in which they sold their digital dividend spectrum, and both Spain and Portugal also offered liberalised 900MHz spectrum in their auctions. Greece has used identical minimum prices (adjusted for Greek population) to those proposed by ComReg in Draft Decision Document 11/60 for the upcoming Irish auction in its recent 900MHz and 1800MHz auction and awarded all available lots in its auction.

12. In addition to being in the relevant frequency bands, spectrum offered in these recent auctions is liberalised. Further, these auctions have also been held in the current economic climate in countries that are in comparable economic positions to Ireland. Given the relevance of these benchmarks, we have considered the auction results carefully ensuring that our recommended minimum price is in line with these benchmarks.

13. Further, reflecting the economic difficulties in Europe, we will maintain the approach of seeking a conservative lower bound estimate of sub-1GHz market value. Any assumptions made will thus be skewed towards under- rather than over-estimating. As with previous analyses our approach to finding a conservative estimate includes:

    a) Using the average value of all mobile frequencies as a conservative lower bound estimate for sub-1GHz value. Sub-1GHz, being prime spectrum for mobile telephony applications, should be worth more than an average of different mobile spectrum bands.

    b) Using a mix of liberalised and unliberalised mobile licences in our sample. Liberalised spectrum should entail a premium given its greater flexibility. Our estimates should therefore be a conservative estimate of the value of liberalised sub-1GHz spectrum.

    c) In our Spectrum Awards Database, we have only included information on annual fees where this information is available. Therefore, there may be licences for which annual licence fees are applicable that we have not accounted for. As a result, our estimates may underestimate the actual overall amounts paid for spectrum (upfront price paid in an auction plus the stream of annual fees across the term of the licence).

    d) The proposed coverage obligations for the licences to be auctioned by ComReg are relatively modest, particularly when compared with the coverage obligations of 800MHz licences across Europe that have been ear-marked to improve broadband availability in rural areas. Therefore, the average value of 800MHz auctions across Europe should provide a reasonable lower bound estimate to sub-1GHz spectrum in Ireland.

    e) We have adopted a conservative exchange rate to convert prices from USD to euro that is 5% lower than the Purchasing Power Parity rate for 2011 (see Section 2.2.1).

14. In addition, in this report, we have modified our approach relative to our earlier reports in how we define relevant samples of data. This results in the exclusion of some outliers, which should then in turn yield a more precise estimate of spectrum value for the band-specific benchmarks (see section 2.2.2). This is

possible with the greater amount of more relevant benchmark data now available.

15. Therefore, to a larger extent than our previous reports, our estimates in this report should specifically yield *conservative* lower bound estimates for sub-1GHz spectrum. We describe our analysis in the rest of the report in the following sections:

    a) In Section 2, we describe the updates to the sample and the Irish demographic and economic data that is used in this analysis;

    b) In Section 3, we present the results of our benchmarking analysis; and

    c) In Section 4, we present our conclusions and recommendation on suitable minimum prices for the upcoming Irish multi-band auction.

16. In Annex A, we list the datasets used in various samples. In Annex B, we present the results of the regression models for the *European* and *sub-1GHz and 1800MHz* samples. In Annex C we present the relative band value of 1800MHz spectrum versus sub-1GHz from various awards and countries.

17. In Annex D we summarise the responses to Consultation 11/60 which relate to our benchmarking analysis (ComReg document 11/59) and reserve price recommendations and we summarise the responses to 11/75 only where new issues have been raised to those already raised in response to 11/60. In Annex E we provide our commentary on these responses.

2 Updates to the data and treatment of data

18. This section describes the changes to the dataset since it was last used to produce the benchmarking analysis of sub-1GHz spectrum and relative valuation of bands to recommend a suitable minimum price for 1800MHz in August 2011 (11/59).

19. In Section 2.1 we describe the addition of new auction data relating to recent relevant awards, as well as augmentation of the original auction dataset due to the regular maintenance DotEcon carries out on its Spectrum Awards Database from which the dataset is drawn. We also describe the updates to the country level demographic and economic data used in our analysis. In Section 2.2 we discuss the updates to the treatment of the dataset we have made in this analysis.

2.1 Updates to dataset

2.1.1 Auction data

20. Several new auctions have taken place since the last benchmarking analysis in August 2011, including the Spanish (800MHz, 900MHz and 2.6GHz), Italian (800MHz, 1800MHz and 2.6GHz) and Portuguese (450MHz, 800MHz, 900MHz, 1800MHz and 2.6GHz) multiband 4G auctions. Furthermore, Singapore and Sweden have both awarded 1800MHz spectrums, the United States recently auctioned unsold 700MHz spectrum leftover from its initial C-block auction in 2008 and Belgium recently auctioned spectrum in the 2.6GHz band.

21. In addition, we have some backdated inclusions in the dataset as a result of the on-going maintenance we perform on our Spectrum Awards Database. These include the New Zealand 1710MHz-2300MHz auction in 2001 as well as the 1800MHz and 3G auctions in Brazil. Table 2 below presents a list of the new awards that have been added to the dataset since the DotEcon August 2011 Report (11/59).

Table 2: New auction data used in the updated benchmarking analysis

Country	Award	Date	Average auction price per MHz per pop (November 2011 Euro)
New Zealand	Auction 3 (1710MHz – 2300MHz)	January 2001	€0.0648
Brazil	GSM Auction 1800MHz	February 2007	€0.0102
Brazil	3G Auction	December 2007	€0.208
Singapore	1800MHz	March 2011	€0.583

Belgium	3G Auction	May 2011	€0.312
United States	Auction 92 – 700MHz band	July 2011	€0.526
Spain	800MHz, 900MHz and 2.6GHz	July 2011	€0.103
Italy	800MHz, 1800MHz and 2.6GHz	September 2011	€0.261
Sweden	1800MHz	November 2011	€0.152
Spain	Second 4G Auction	November 2011	€0.382
Greece	900MHz and 1800MHz	November 2011	€0.330
Belgium	2.6GHz	November 2011	€0.0594
Portugal	450MHz, 800MHz, 900MHz, 1800MHz and 2.6GHz	November 2011	€0.154

22. There are some auctions that have been excluded from our dataset as a result of our Spectrum Awards Database maintenance updates. Specifically the Danish 870MHz, 410MHz and 450MHz bands are not used as mobile spectrum bands in Denmark hence have been excluded from our dataset.

23. All of these revisions are detailed in tables listing the auctions included in the various datasets considered in our analysis, presented in Annex A.

2.1.2 Economic and demographic data

24. In our previous analyses, we used country-level demographic and economic data from the World Bank's World Development Indicators (WDI) database up to 2006. We supplemented the World Bank data with data from the CIA World Factbook for more recent demographic and economic data.

25. Since our benchmarking report was published in August 2011 we have updated the country level demographic and economic data in our database with the World Bank's WDI database up to 2010 (the latest available). We have extrapolated values for 2011 based on the economic and demographic data we have up to and including 2010. Therefore it is no longer necessary to use two separate sources of demographic and economic data. The use of a single data source is preferable as it ensures more consistent demographic and

economic data than the previous approach of using two different data sources.[5]

2.1.3 GDP and population data for Ireland in 2011

26. In our last benchmarking analysis, published in August 2011 (11/59), we used data on Irish GDP and population in 2010 from the Central Statistics Office Ireland. In this report we have updated this to 2011 data with information from the Central Statistics Office Ireland. Specifically, Irish GDP in 2011 at current market value (in 2011 prices) is estimated at €156,349m[6]; this equates to a GDP per capita of €34,128. This is 3.2% lower than the GDP per capita used in the 11/59 report (€35,274). Note that following the new census data available in Ireland the population figure for Ireland in 2011 has been revised up to 4,581,269. This population figure is 2.5% higher than the population figure of 4,470,700 used in the 11/59 report.

Table 3: Updated GDP and population data for Ireland

Economic and demographic indicators	11/59 report	Current report	% change
GDP	€157,702m	€156,349m	-0.85%
Population	4,470,700	4,581,269	2.5%
GDP per capita	€35,274	€34,128	-3.2%

[5] The one stark discrepancy between the CIA World Factbook data and current WDI data is that the PPP rate for Qatar in 2008 used to convert the price of the second mobile licence issued in Qatar from Qatari Riyal to USD. The PPP rate from the CIA data was based on an estimated rate from 2007 of 1.793 where as the analogous PPP rate in the WDI data for 2008 was 3.447. The derived CIA PPP rate of 1.793, based on the CIA 's estimated 2007 data is highly inconsistent to the derived PPP rate based on its estimated 2006 data (4.24) and estimated 2008 data (4.98), suggesting some sort of data anomaly or error in this derived 2007 PPP rate. Using the WDI PPP rate for Qatar in 2008 halves the Euro price of the second mobile licence in Qatar. This further underlines the benefits of using a single data source for economic and demographic data throughout our analysis.

[6] At the time of analysis, estimates for GDP up to quarter 3 2011 are available from the Central Statistics Office Ireland (source: Central Statistics Office Ireland document 'Quarterly National Accounts, Quarter 3, 2011', 16 December 2011 available at: http://www.cso.ie/en/media/csoie/releasespublications/documents/economy/2011/qna_q32011.pdf). These are estimates and therefore are subject to revision. Using this data we have estimated overall 2011 GDP for Ireland by assuming Q4 GDP at the average of Q1-Q3 level i.e. GDP is calculated by taking the sum of (Q1(€38,484m) + Q2(€39,682m) + Q3(€39,096m) + Q4(€39,087m)) = €156,349m.

2.2 Data treatment

2.2.1 Converting to a common currency

27. DotEcon's Spectrum Awards Database stores licence price and minimum price information in local currency. When using the data, we apply a Purchasing Price Parity (PPP) exchange rate to account for price differences across countries in converting these prices into a common currency (the US Dollar (USD)).[7] This is because the dataset includes a wide range of countries far beyond just the Euro area. Prices in US dollars in the year of the award are then adjusted for USD inflation using monthly CPI data published by the US Bureau of Labour Statistics. This establishes comparable prices in real US dollars. For this analysis we have expressed all prices in November 2011 terms.

28. Prices in November2011 USD are then converted into November 2011 Euros using a Euro to USD PPP rate. As with previous analyses, we do not have up to date information about the current Euro to USD PPP rate in 2011. In previous analysis, we have estimated this rate by applying a conservative 10% mark up on the average mid-point official exchange rate over the period.[8]

29. For instance, in Report 10/71b, we applied a 10% mark up to the average official exchange rate from the start of 2010 up until May 2010 of 0.741$/€, yielding a PPP rate of 0.815$/€. The 2010 PPP rate as recorded by the WDI data however is 0.865$/€, more than 6% higher than the PPP rate we used. Therefore, in this report, adopting the same conservative approach of applying a 10% mark up the average mid-point official exchange rate from the start of 2011 till end of November 2011 of 0.715$/€ would yield a PPP rate of 0.787$/€ which should be similarly conservative.[9] Indeed we note that the estimated 2011 PPP rate extrapolated from our WDI data is 0.826$/€, which is 5% higher than our PPP rate applied.

30. The conversion of licence prices into Euro should therefore be in line with our generally conservative approach.

2.2.2 Creating different benchmark samples

31. In our analysis, we look at different samples in deriving estimates to value of sub-1GHz spectrum. Specifically, we use two frequency band specific samples:

    a) *Sub-1GHz and 1800MHz*; and

    b) 3G (2100MHz)

[7] The PPP rate accounts for price differences between the country in which the licences were auctioned and the US and avoids difficulties that might be caused otherwise by exchange rates being misaligned (possibly for long periods).

[8] See paragraph 46 of Report 11/59.

[9] The lower PPP rate applied compared to our previous analysis has resulted in the Greek 2G and 3G auctions in 2001 dropping out of the "countries with GDP per capita of €20,000 or more" sample as Greek GDP per capita in 2001 is now €19,477.

32. In our previous analyses, any licence which contained any of the frequency bands specified in the sample (so for the *3G* sample, this would be any licence with 2100MHz) would be part of that sample. This included multiple frequency band licences. For instance a licence comprising 1800MHz and 2100MHz spectrum would enter into both samples listed above. However, this means that the value of such a licence, and hence the benchmark that is derived from this sample, may be clouded by the value of a frequency band that is not within the sample. So for instance for the 1800MHz and 2100MHz licence in the *3G* sample, the value a licensee places on 1800MHz then enters the *3G* sample benchmark.

33. In this analysis, we have updated the way we define our band-specific samples such that only licences entirely within frequency bands specific to the sample would be included in the sample. If a licence contains spectrum from a frequency band non-specific to the sample it is excluded from the sample. For instance, a combined 1800MHz and 2100MHz licence will not enter into either the *sub-1GHz and 1800MHz* nor *3G* sample. As a result, the *sub-1GHz and 1800MHz* sample therefore only contains licences of sub-1GHz and/or 1800MHz frequencies and the *3G* sample contains only 2100MHz licences.

34. This approach was not adopted in our original analysis in 09/99c as we wanted to utilise as many of the available data points as possible given the small sample of data available at that time. Further, as we were deriving an estimate for liberalised 900MHz spectrum value, the average value of multiple frequency band licences should nonetheless constitute lower bound estimates of 900MHz spectrum given the superior technical characteristics of 900MHz spectrum relative to spectrum of higher frequency bands. In subsequent analysis, we maintained this approach so as to ensure a consistent methodology. However, the greater availability of data given the auction results in the past year and the increasing importance of reflecting the current economic difficulties in Ireland (and Europe more generally) has led us to modify our proposed approach to defining our band specific samples.

35. This modified approach provides more precise data to benchmark spectrum value which is not clouded by valuation of other less relevant frequency bands. The result of this modified approach to defining our samples mean that the following licences in these auctions (highlighted in green in Figure 1 below) are no longer included in the sub-1GHz and 1800MHz as well as the 3G samples:

    a) Latvia 2G/3G auction, 1800MHz and 2100MHz;

    b) Egypt 2G/3G auction, 1800MHz and 2100MHz;

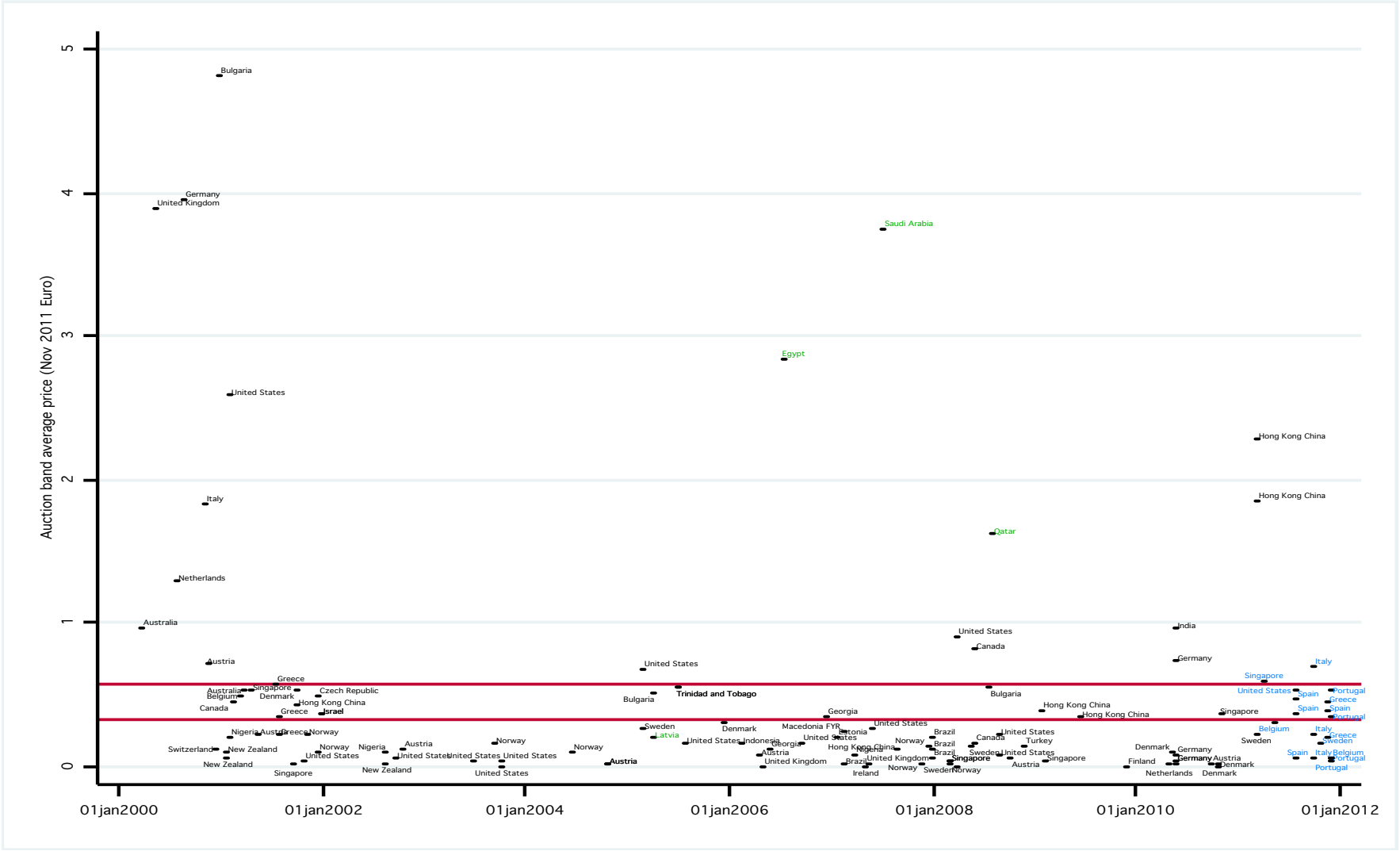
    c) Saudi Arabia 3rd GSM and 3G auction, 900MHz, 1800MHz and 2100MHz; and

    d) Qatar, second mobile licence, 2G/3G auction, 1800MHz and 2100MHz.

36. Nonetheless, these auctions still enter the general sample of *global mobile auctions* and their informational content taken into account. These auctions also form the more recent outliers within our sample (see Figure 1) and the exclusions of these from the *sub-1GHz and 1800MHz* as well as *3G* samples will have a downward effect on our benchmarks derived from these samples.

37. Note that this modified approach relates to the definition of the frequency band specific samples, so these changes apply to both the sample used for the frequency band specific averages benchmarks presented in Section 3.1.1 as well as the frequency band specific regression benchmarks presented in Section 3.1.2.

Figure 1: Scatter of global mobile auctions in sample



3 Results of updated benchmarking analysis

38. In this section we present the results of our updated benchmarking analysis in light of:

    a) the additional and revised auction data (discussed in Section 2.1); and

    b) revised macroeconomic data (discussed in Section 2.1.2)

39. In Section 3.1, we consider the value of sub-1GHz spectrum. We calculate simple averages from different samples and run regression models with the new auction data set and updated demographic and geographic data such as GDP and population.

40. In the Section 3.2, we derive a conservative estimate of 1800MHz market value.

3.1 Sub-1GHz spectrum benchmarks

41. As per our previous analyses, we calculate averages across the following samples of auctions:

    a) Global mobile spectrum auctions;

    b) European mobile spectrum auctions;

    c) Auction in countries with GDP per capita greater than €20,000;

    d) Auctions of sub-1GH and 1800MHz licences;

    e) *Auctions of 3G (2100MHz) licences*;

42. In addition, we have also included a new average benchmark of all 800MHz auctions in Europe thus far (termed "*Europe 800MHz*"). This includes Spain, Italy, Sweden and Germany. This sample was not included previously, as some of these auctions have only recently concluded.

43. For our regression analysis, we use the same samples as our previous analyses:

    a) Global mobile spectrum auctions;

    b) European mobile spectrum auctions; and

    c) Auctions of sub-1GHz and 1800MHz licences.

3.1.1 Updated averages benchmarks

44. In Table 4 below we present our updated averages for each sample. These averages are derived by taking a simple average of the auction price (which is itself an average of lot prices) across all auctions within the sample. Each auction has equal weight.

45. For the non-frequency band specific samples (*Global mobile, European* and *countries with GDP per capita greater than €20,000),* the average auction price is the population-weighted average licence value of all licences sold in the

auction.[10] Therefore regions with larger populations will have more weight within the auction average, but licences of different spectrum endowment will have the same weight. Therefore, in an auction with only national licences, each licence will have equal weight in the computation of the auction average value.

46. For the frequency band specific samples – the *sub-1GHz and 1800MHz*, *3G* and *Europe 800MHz* samples - the average auction price is the band-specific auction average[11]. This is a simple average of the price of all licences of the relevant frequency band for the sample. For instance the average auction price for the Spanish multi-band auction in the *Europe 800MHz* sample would be the average price of all 800MHz licences in the Spanish auction.

[10] See paragraph 72 and Equation 1 in Report 11/59.

[11] See paragraphs 73 and 74 in Report 11/59.

Table 4: Updated averages benchmarks

Benchmark group	Auction average		Auction-Band Average	
	Average price per MHz per pop (Euros)	Implied value of 2x5MHz in Ireland (Euros	Average price per MHz per pop (Euros)	Implied value of 2x5MHz in Ireland (Euros
Global mobile	€0.554	€25.4m	Not applicable	
Europe	€0.474	€21.7m		
Similar GDP per capita (greater than €20,000)	€0.499	€22.8m		
Sub-1GHz and 1800MHz	Not applicable		€0.396	€18.1m
3G (2.1GHz)			€0.641	€29.4m
Europe 800MHz (NEW)			€0.531	€24.3m

Table 5: 11/59 averages benchmarks (for comparison)[12]

Benchmark group	Auction average		Auction-Band Average	
	Average price per MHz per pop (Euros)	Implied value of 2x5MHz in Ireland (Euros)	Average price per MHz per pop (Euros)	Implied value of 2x5MHz in Ireland (Euros
Global mobile	€0.639	€28.6m	Not applicable	
Europe	€0.506	€22.6m		
Similar GDP per capita (<€20,000)	€0.565	€25.3m		
Sub-1GHz and 1800MHz	€0.706	€31.5m	€0.714	€31.9m

[12] This is Table 3 of Document 11/59 reproduced.

3G	€0.860	€38.4m	€0.856	€38.3m

47. Despite a 2.5% increase in Irish population from the population figure we used in Report 11/58, our averages benchmarks have fallen across the board in all samples with the addition of new auction data. Specifically, the frequency band specific benchmarks have fallen the most given the modification to the manner in which we define our frequency band specific sample described in Section 2.2.2. In particular, we noted that this modification has removed the expensive Middle East licences that were outliers within these samples and this modification would have notably contributed to the decrease in these benchmarks.

48. As a result, these frequency specific benchmarks that previously fell outside our recommended range set out in Document 11/59 of €15m-€26m, representing a conservative estimate of sub-1GHz spectrum have now come within range (for sub-1GHz and 1800MHz) or are significantly closer (for 3G). Furthermore, the addition of new auction data has also now brought the *global mobile* benchmark that was previously above the range within the range.

49. The new *Europe 800MHz* benchmark of €24.3m falls at the upper end of our previously recommended range of €15m-€26m.

3.1.2 Updated regression benchmarks

50. In this report we continue to use the same regression models as those used in our last benchmarking report, published in August 2011 (11/59) except for the *European* regression model, which we have now modified. In our benchmarking analysis, published in September 2010 (10/71b) as well as subsequently in our analysis in 11/59, we dropped all the 2.6GHz auctions from our *European* regression model as the "twopointsix" dummy variable in the *European* model, had a positive coefficient.

51. This meant that sub-1GHz spectrum value would be lower relative to 2.6GHz spectrum value. This is counter-intuitive given the relative technical benefits of sub-1GHz spectrum compared with 2.6GHz. However, since updating our auction data with recent auction results in the 2.6GHz band (Spanish and Italian auctions) we find that the "twopointsix" dummy variable now has a negative coefficient, which is consistent with general expectations on the relative value of 2.6GHz and sub-1GHz spectrum. Therefore rather than lose the 2.6GHz licence price data in our *European* regression model as in 11/59 and 10/71b, we include the 2.6GHz data and include the 2.6GHz dummy in the functional form of our *European* regression, which has the effect of increasing the sample size.

52. Equation 1 below details the regression used in our sample of *global mobile spectrum auctions* (see Annex B for details of the *European* regression model and *sub-1GHz and 1800MHz* regression model used in this update).

Equation 1: Regression equation for all mobile licences sold in an auction

$$PMHzPop = \beta_0 + \beta_{GDPpc} \cdot GDPpc + \beta_{ApPop} \cdot ApPop + \beta_{WtB} \cdot WtB + \cdots$$
$$\ldots + \beta_{invNMNOs} \cdot invNMNOs + \beta_{national} \cdot national + \cdots$$
$$\ldots + \beta_{twopointsix} \cdot twopointsix + \beta_{AFME} \cdot AFME + \beta_{preIT} \cdot preIT + \cdots$$
$$\ldots . + \beta_{year01} \cdot year01 + \beta_{year0203} \cdot year0203 + \beta_{year0405} \cdot year0405 + \cdots$$
$$\ldots + \beta_{year0607} \cdot year0607 + \beta_{year0809} \cdot year0809 + \cdots$$
$$\ldots + \beta_{year1011} \cdot year1011$$

where:

- $PMHzPop$ is price per MHz per population (our dependent variable);
- β_0 is a constant;
- $GDPpc$ is GDP per capita. We note that there are differences in recent movements of Irish GDP versus GNP. We maintain that GDP as a measure of domestic economic activity is an appropriate explanatory variable (see Annex D1.2 for more details);
- $ApPop$ is area per capita, a measure of population density;
- WtB is the ratio of winners to bidders in the auction, a measure of the level of competition in the auction;
- $invNMNOs$ is the inverse of the number of MNOs with a network operating before the start date of the auction, a measure of competitiveness in the telecommunications market;
- $national$ is a dummy variable which is 1 if it is a national licence and 0 if not;
- $twopointsix$ is a dummy variable that is 1 if the spectrum licence sold is within the 2500-2690MHz range;
- $AFME$ is a dummy variable which is 1 if the licence is awarded in an African or Middle-Eastern country and 0 if not;
- $preIT$ is a dummy which is 1 if the licence was awarded before the Italian 3G auction (the last auction before the TMT equity bubble burst) or 0 if the licence was awarded afterwards; and
- $year$ is a dummy, which is 1 if the licence was awarded in the relevant years and 0 if not. Years are grouped where there are few awards in a year. For example $year0607$ is 1 if licence was sold in 2006 or 2007 and 0 otherwise.

53. We use an ordinary least squares estimator to estimate the coefficients of the model, weighting observations using the same weights for each individual licence as for the calculation of weighted average price per MHz per population for each auction in the average-based benchmark approach.[13] The results of our main regression model using a dataset of *global mobile* licences auctioned are summarised in Table 6 below. We present the regression results

[13] The data set used consists of both auctions where only national licences are sold as well as auctions where regional licences (e.g. Spanish auction) were sold. In calculating the auction average price, individual licence prices were population weighted so as to give a relatively heavier weight to larger regional or national licences. The same population weights were used in the regression analysis as 'analytic weights'. Analytic weights inversely scales the variance of an observation, that is the variance of an observation is inversely proportionate to the weight applied. Therefore in our analysis, a larger regional or national licences would have a heavier weight (and smaller variance) while smaller regional licences will have a smaller weight (and a larger variance).

for our *European* regression model and *sub-1GHz and 1800MHz* model in Annex B.

Table 6: Regression analysis results using all mobile licences sold in an auction

Coefficient for	Estimated coefficient	Standard Error
GDPpc	0.00000112	0.00000115
ApPop	-1.21**	0.214
WtB	-1.37**	0.0512
invNMNOs	1.59**	0.216
national	-0.286**	0.0371
twopointsix	-0.160**	0.0432
AFME	0.362**	0.0531
preIT	0.782**	0.0925
yearD_01	-1.02**	0.0780
yearD_0203	-1.84**	0.0889
yearD_0405	-1.49**	0.0834
yearD_0607	-1.57**	0.0801
yearD_0809	-1.54**	0.0808
yearD_1011	-1.33**	0.0790
Constant (β_0)	2.68**	0.112

Note: Coefficients which are significant at the 5% and 1% level are marked with one and two stars respectively.

54. As a result of the addition of new auction data, the GDP per capita variable in our regression of *global mobile auctions* has now become statistically insignificant. In addition, the dummy variable identifying national licences now has a negative coefficient in all three regression models. This is somewhat counter-intuitive as we would normally expect national licences to be at a premium, particularly in simultaneous multi-round ascending type auction formats where bidding for regional licences entail aggregation risk of not winning a national footprint. One possible reason behind the change in sign of this variable could be the inclusion of the Spanish multi-band auction results

where the regional 2.6GHz lots in aggregate sold for a higher price than the national 2.6GHz lots[14].

55. We have used the most recently available Irish population data in our model and have updated the winners to bidders ratio to reflect the new auction sample average. The updated explanatory variables used in our current report are compared to those used in the 11/59 report in Table 7 below. In Table 8 below we present the forecast of our current licence values for Ireland obtained from the three regression models for the different sample groups. We also present predicted spectrum values using the same explanatory variables as were used in Report 11/59 for comparison. This allows the source of the revisions in the estimates to be identified.

56. In addition, we note that some of the mobile operators have disagreed with our approach of using the sample average winners to bidders ratio in forecasting the spectrum value for Ireland. We respond to these comments in Annex D.4.

[14] See article "The Little Things That Matter" from DotEcon's Autumn 2011 newsletter (http://www.dotecon.com/publications/perspec7.pdf)

Table 7: Inputs (explanatory variables) used for predictions in Report 11/59 regression analysis and current benchmark analysis

Explanatory variable	Report 11/59	Current report
Population	4,470,700	4,581,269
GDP per capita (Euro)	35,274	34,128
Number of mobile network operators	4	4
Number of participating bidders	5	5
Winners to bidders	0.77	0.74
Area (in square kilometres)	70,280	70,280
Year	2011	2011

Table 8: Current analysis regression benchmarks

Dataset	11/59 regression with 11/59 explanatory variables		Current regression* with 11/59 explanatory variables		Current regression* with current explanatory variables	
	Price per MHz per pop (Euro)	Implied value of 2x5MHz block in Ireland (Euro)	Price per MHz per pop (Euro)	Implied value of 2x5MHz block in Ireland (Euro)	Price per MHz per pop (Euro)	Implied value of 2x5MHz block in Ireland (Euro)
Global mobile	€0.719	€32.1m	€0.390	€17.5m	€0.390	€17.8m
Europe	€0.344	€15.3m	€0.177	€7.89m	€0.174	€7.98m
Sub-1GHz and 1800MHz	€0.760	€33.0m	€0.181	€8.08m	€0.200	€9.14m

*The regression model specified in Equation 1 above using the new auction data set described in section 2.1 of this report.

57. Relative to our benchmarks from Report 11/59, our current regression benchmarks have decreased. Table 8 above shows that the bulk of this decrease is a due to the changes to the sample used in the analysis, rather than changes to Irish population and GDP used to predict licence values.

58. There are a number of reasons behind these decreases. First, as mentioned above, the negative coefficient of the dummy identifying national licence has reduced the predicted licence values for Ireland in all three regression models.

59. Second, the predicted licence value in 11/59 was particularly high due to the uplift in the 2010/2011 year dummy[15] as a result of the updates to the sample used in the previous analysis and therefore put an upward pressure on the results. Specifically, there were a number of auctions that were included within the global mobile auctions sample in 11/59 that were above our recommended range of €15m-€26m set out in 11/59. These were (see Figure 1): the Indian 3G licences; German 800MHz licences and in particular, Hong Kong 850MHz and 900MHz licences (which sold for roughly five times the sub-1GHz minimum price proposed by ComReg in 11/60). The average licence values of the new auction data (highlighted in blue in Figure 1 above) included in the current analysis however, are mostly within our previously recommended range or below, thus bringing down the predicted licence value of a licence.

60. While the *European* regression model is not affected by the Hong Kong auction in 2011 unlike the other two samples, in the *European* regression model, we have now included all 2.6GHz licences in our predicted licence value. Auction results in German, Italy, Spain and Sweden suggest that the average licence value of 800MHz spectrum is between 1.5 to 30 times that of 2.6GHz spectrum. The wide range is in part due to the low 2.6GHz licence prices in the German auction due to a lack of competition for these lots where eventual licence values were very close to the low but non-trivial reserve prices set by the regulator. Therefore in addition to the effects described above, the inclusion of 2.6GHz licences within the *European* regression model will depress estimated licence value in this model relative to our prediction in Report 11/59.

61. In the *sub-1GHz and 1800MHz* model, again in addition to the factors (negative national coefficient and lower 2010/2011 year dummy coefficient) explained above, the modification to our approach in defining the relevant frequency band specific samples as described in Section 2.2.2 involved removing a number of the expensive Middle Eastern mobile licences that were outliers within the sample, the exclusion of which would further lower our estimated licence value in this model. The coefficient of the Africa and Middle East dummy that identifies auctions in this region, which was positive in our regression in Report 11/59, is now negative in this current regression, as a result of excluding these outliers. In addition, the current regression model for

[15] That is the coefficient of the 2010/2011 dummy increased. As the coefficient is negative, a decrease in absolute magnitude, that is the coefficient becoming less negative would bring about an uplift in the 2010/2011 dummy.

the *sub-1GHz and 1800MHz* sample now has a negative coefficient on GDP per capita.

62. However, the decrease in predicted licence value in our regression models means that the predicted licence value in the *global mobile auctions* model that was previously above the recommended range of €15m-€26m set out in 11/59 has now falls within this range.

3.2 Relative value of 1800MHz and sub-1GHz spectrum

63. In Report 10/105a, we set out to estimate the minimum price for 1800MHz on a similar conservative lower bound basis to that of sub-1GHz. One of the main reasons why our estimate of sub-1GHz value is conservative (as set out in Section 1.2) is because we use a range of frequencies in our sample to predict sub-1GHz value whereas liberalised sub-1GHz spectrum should be more valuable given its superior propagation characteristics relative to higher frequency spectrum.

64. If we adopted the same methodology to derive market value estimates of 1800MHz, it would not be on a similar conservative lower bound basis as sub-1GHz because 1800MHz spectrum has no clear technical superiority relative to other frequency bands. Instead, estimates derived would be central estimates.

65. Therefore we proposed to calculate the relative market value of 1800MHz against sub-1GHz spectrum and derive a conservative lower bound estimate of 1800MHz spectrum by applying a relative band value to our conservative estimates of sub-1GHz value. In our analysis in 10/105a, we considered the relative value of 1800MHz and sub-1GHz spectrum within the same auction process as well as across different auctions within the same country. Based on our analysis in 10/105a using auction data and substantiating with technical studies, we derive that the relative value of 1800MHz and sub-1GHz should range between 45%-60%.

66. In 11/59 when we updated our benchmarking analysis, we found that new auction data available then did not provide any evidence to alter our proposed relative band value range of 45%-60%. Applying this range to our conservative estimates of market value for sub-1GHz of €15m-€26m as set out in 11/59, yielded a estimated market value for 1800MHz spectrum of €6.75m-€15.6m.

67. In Section 2.1.1 above, we describe the new auction data that has become available since our last analysis in 11/59. Below we describe the impact of new auction results on the relative value of 1800MHz and sub-1GHz spectrum and propose a relative band value in light of new information from these auction results.

3.2.1 Impact of new auction data to relative band value

68. Of the new auctions as described in Section 2.1.1, the Greek 900MHz and 1800MHz auction, Italian multiband auction and Portuguese multi-band auction provide new data to estimate the relative band value of 1800MHz versus sub-1GHz within a single award process. The average price per MHz per pop in the respective sub-1GHz and 1800MHz bands, as well as the derived relative band value in these auctions, is presented in Table 19 in Annex C . These auctions also generate a country relative band value listed in Table 20 in

Annex C. In addition, several of the new auctions present new or updated country relative band values which are presented in Table 20 in Annex C. These include updates to the sample in Report 11/59.

69. In 10/105a we established that we should only draw inferences from observations of competitive auctions where relative licence prices would more accurately reflect market value of sub-1GHz and 1800MHz spectrum rather than the relative reserve prices set by the regulator for these bands, which may not be a good indication of relative market value.

70. In Table 20 in Annex C, the following auctions were not competitive. In each of the following auctions the licences were awarded at the reserve price:

- Brazil GSM Auction in 2007 for the licence in Sao Paulo;
- Denmark 900MHz and 1800MHz auction in 2011;
- Greece 2G and 3G auction in 2001;
- Hong Kong CDMA auction in 2007;
- All Singapore auctions bar the 1800MHz award in 2011; and
- US auction 51 – Regional Narrowband in 2003.

The country relative band values obtained after the removal of these uncompetitive auctions are summarised in Table 9.

Table 9: Summary of country relative band values from competitive auctions

Country	Country relative band value
Brazil	0.50
Greece	0.44
Hong Kong	0.08
Italy	0.32
New Zealand	4.46
Sweden	0.68
United States	0.83

71. In addition, we note that the Greek 900MHz and 1800MHz auction in 2011, 1800MHz licences in the Italian auction, as well as the New Zealand Auction 5 in 2002 were borderline competitive. In the Greek auction, there was a small amount of competition for some 900MHz lots but all 1800MHz lots sold at the reserve price. In the Italian auction, prices for 1800MHz spectrum only rose 2% above the reserve price and in New Zealand Auction 5, prices only rose above the reserve price by 2.5%.

72. Therefore, if we disregard observations from those auctions that were borderline competitive or uncompetitive, the new auction data suggests that the relative band values between sub-1GHz spectrum and 1800 MHz spectrum should be higher than our previous results suggested (as exemplified by Sweden and the US) rather than lower (as suggested by Hong Kong). In Hong Kong, the relative band value is extraordinarily low as a result of the expensive 850MHz and 900MHz licences auctioned in 2011 that were outliers in our sample (see Figure 1). Therefore we do not believe that the relative band value suggested by the Hong Kong auction is an accurate reflection of likely relative band value in Ireland.

73. Overall, despite higher relative band values suggested by Sweden and the United States, we do not believe it is appropriate to increase the upper bound of our proposed relative band value range so as to maintain a conservative approach to setting minimum prices, particularly in light of the economic difficulties in Ireland and across Europe. Therefore we are of the view that it would be appropriate to maintain our proposed relative band value for 1800MHz spectrum of 45%-60% of the minimum price for sub-1 GHz spectrum.

4 Conclusions

74. In Section 3 above, we note that the benchmarks of sub-1GHz market value derived from our current analysis are lower than that presented in Report 11/59. In particular, the predicted licence value from the regression analysis has decreased substantially.

75. The regression models and their outputs are sensitive to the sample used and changes to the data will affect the regression results. As a result, the regression models have not provided a particularly stable forecast of spectrum value, particularly where the sample size is limited. Therefore, the approach we have adopted in this report has been to place more weight and focus on the largest sample we have which should be the most stable – the *global mobile auctions* sample which provides a value of €17.8m which is within our previous recommended range of €15-26m. To ensure that our results are robust, we use our averages benchmarks as well as perform regression analysis on different cuts of data with smaller sample sizes to cross check our results.

76. We also apply a pragmatic approach to considering the uncertainties surrounding the benchmarks when recommending a suitably conservative minimum price range. For instance where our *global mobile auctions* regression benchmark derived in 11/59 (as well as other benchmarks) were in our view not a conservative estimate of sub-1GHz market value, we revised our proposed minimum price range in 11/59 downwards rather than upwards considering other benchmarks and updated spectrum value from recent 800MHz auctions. Similarly to produce our conclusions below, we will evaluate and interpret our benchmark results by comparing them to the most up to date information available on awards of sub-1GHz spectrum in Europe which provides a more like-for-like comparison to the value of sub-1GHz spectrum in Ireland. In particular, recent sub-1GHz auctions Europe provide direct benchmarks against which to compare our recommended minimum price range set out in Report 11/59. Most of these sub-1GHz auction prices are within or exceed our recommended price range.

4.1 Conservative estimate of sub-1GHz spectrum market value

77. A summary of benchmarks derived from our current analysis is presented in Table 10 below.

Table 10: Summary of benchmarks from current analysis

	Averages benchmarks		Regression benchmarks	
	Price per MHz per head of population	**Licence value of 2x5MHz of sub-1GHz in Ireland**	**Price per MHz per head of population**	**Licence value of 2x5MHz of sub-1GHz in Ireland**
Global mobile	€0.554	€25.4m	€0.390	€17.8m
Europe	€0.474	€21.7m	€0.174	€7.98m
Sub-1GHz and 1800MHz	€0.396	€18.1m	€0.200	€9.14m
Europe 800MHz	€0.531	€24.3m	Not applicable	
3G	€0.641	€29.4m		
Countries with GDP per capita greater than €20,000	€0.499	€22.8m		

78. The overwhelming effect of the reductions in estimated sub-1GHz value for Ireland in our current analysis is to bring benchmark results that were previously out of range into the previously recommended range e.g. the *'All mobile'* and *'Sub-1GHz and 1800MHz'* averages and regression benchmark results were previously out of range. In other words, the inclusion of recent auction data has largely validated our recommended minimum price range of €15m-€26m from Report 11/59 and does not provide any significant evidence for revision of this range.

79. In particular, there has been a number of recent sub-1GHz auctions – US 700MHz, Spanish 800MHz and 900MHz, Italian 800MHz, Greece 900MHz and Portuguese 800MHz and 900MHz - that have been added to our sample that provide direct benchmarks against which to compare our recommended minimum price range set out in Report 11/59 (see Figure 2 below with recent auctions shaded in purple). *All* of these sub-1GHz auction prices are within or exceed our recommended price range. In Italy, where all incumbent operators participated as individual bidders in the auction (as with the German 2010 auction, but unlike the Spanish and Swedish auctions), the 800MHz licence prices exceeded our recommended range set out in 11/59.

80. We note that the Portuguese auction was not competitive with all licences awarded at reserve prices. Anacom set a reserve price of €24m for the 800MHz lots and €16m for 900MHz lots (adjusted for price differences using PPP as described in Section and 2.2.1 and to Irish population). These reserve prices are close to the upper end and lower bound respectively of our recommended range set out in 11/59 . Overall competition within the Portuguese auction appeared to be weak, which may have been as a result of strict spectrum caps. In addition to one unsold 900MHz lot, there were a number of unsold lots in the auction in the 450MHz, 1800MHz, 2.1GHz and 2.6GHz bands

81. In addition, we note that France awarded its 800MHz licence on the 22nd December 2011 in a hybrid process where tenders were evaluated based on a bid value and conditions offered for MVNO access. This award is not part of our benchmark sample as the tender is not an auction. However, the value of the licence, nonetheless provide a good cross check for our benchmarks. Four bidders took part in the beauty contest and three were awarded 2x10MHz licences. The average award price was €0.68 per MHz per head of population which is equivalent to €30.8m when adjusted for Irish population, well exceeding our recommended range set out in Report 11/59. SFR paid the most for its 10MHz duplex in the French tender - €0.82 per MHz per head of population or €37.3m adjusted to Irish population, more than €10m higher than the upper bound of our proposed range.

82. More recently, Switzerland has awarded spectrum in the 800MHz, 900MHz, 1800MHz, 2.1GHz and 2.6GHz bands using a Combinatorial Clock Auction (CCA) format similar to that proposed for Ireland. However unlike Ireland, there are only three existing players in the Swiss mobile market. All three players participated in the auction with fruitful outcomes – winning spectrum in all available frequency bands. As bidders made package bids in the CCA format, we are not able in infer from the auction results what the specific average price paid for each band was. Nonetheless, we note that given all the spectrum in the 800MHz, 900MHz and 1800MHz bands were awarded, bidders must have paid at least reserve prices for each band. In the Swiss auction, a common sub-1GHz reserve price was set for the 800MHz and 900MHz spectrum - this was equivalent to €0.23 per MHz per head of population and for the 1800MHz band, €0.08 per MHz per head of population which is equivalent to €10.5m and €3.5m per 2x5MHz respectively when adjusted to Irish population[16].

83. The auction average price in the Swiss auction was €0.19 per MHz per head of population which is equivalent to €8.5m adjusted to Irish population. Sunrise paid the most for the spectrum awarded to it in the auction – equivalent to €0.32 per MHz per head of population or €14.8m adjusted to Irish population while Orange paid the least with a package average price of €0.10 per MHZ per

[16] The Swiss auction reserve prices and results are adjusted using an estimate of Swiss population of 7655628 and a 1 year average of the exchange rate Swiss Franc to € calculated as 0.8204 (source: http://www.oanda.com/currency/historical-rates/).

head of population and Swisscom paid a package average price of €0.15 per MHz per head of population.

84. While the prices from the Swiss auction result are below our proposed range for sub-1GHz value in Ireland, we consider that this result does not necessarily reflect the competitive value of sub-1GHz spectrum. Given the superior propagation characteristics of sub-1GHz spectrum, sub-1GHz spectrum is likely to have a higher value than the other (higher) frequency bands included in the auction. Therefore, an auction average price or package average price containing both sub-1GHz and higher frequency spectrum is unlikely to be an accurate reflection of sub-1GHz market value, particularly when the auction is not competitive in all bands and majority of spectrum is awarded at reserve prices – which would seem plausible given the small number of bidders in the Swiss auction. This point is also obvious from observing that the auction average price of €0.19 per MHz per head of population and the package prices of Orange (€0.10) and Swisscom (€0.15) are below the sub-1GHz reserve price of €0.23 per MHz per head of population.

85. Overall, the benchmark that is most relevant as a cross check to our estimated value of liberalised sub-1GHz spectrum in Ireland is the new *European 800MHz* benchmark. The recent Spanish and Italian auction results have allowed us to create this sample for the first time. This should provide a conservative estimate to sub-1GHz market value in Ireland because: all the data points are fairly recent; all the licences are liberalised; the proposed coverage obligation for the sub-1GHz licence in Ireland is relatively less onerous compared to some other European countries[17]; and not all annual fees actually incurred by the licensee have been taken into account as described in Section 1.2. Therefore the Europe 800MHz sample provides an extremely relevant benchmark and is itself a conservative estimate of sub-1GHz spectrum in Ireland.

86. The average price of 800MHz spectrum in Europe adjusted for Irish population is €24.3m, which is at the upper end of our proposed range. This further substantiates our view that our recommended range provides a conservative estimate of liberalised sub-1GHz value in Ireland.

87. While our regression results in the case of the European auctions sample as well as the sub-1GHz and 1800MHz sample are below our estimated range of liberalised sub-1GHz value (see Section 3.1.2 for the motivations behind the lower predicted value from these regression models), all other benchmarks fall within our recommended range of €15m-€26m. Most relevantly, the most recent 800MHz and 900MHz auction results in Italy, Spain, Portugal, Greece and the French 800MHz licence prices all support this recommended range. In addition we have also explained why the Swiss auction result which is below our range is not a good benchmark for sub-1GHz value. Therefore, we maintain that our recommended range of €15m-€26m provides a conservative estimate for the value of 2x5MHz of liberalised sub-1GHz spectrum in Ireland.

[17] In Spain for instance, there is a joint obligation on the 800MHz licensees (similar to Germany) who win 2x10MHz to provide broadband access with access speeds of "at least 30 mpbs" to towns with less than 5000 inhabitants.

4.2 Recommended minimum price

4.2.1 Common minimum price for 800MHz and 900MHz spectrum

88. In Report 10/71b, we proposed that a common minimum price be set for 800MHz and 900MHz spectrum as the similar propagation characteristics of these bands suggest a similar market value in the long run. While there was uncertainty over the relative valuation of spectrum in these two bands, the lack of data to inform about this relative value led us to propose a common minimum price for the two bands as described in Section 1.1. The uncertainty over the relative valuation of the two bands should then be reflected in a more conservative common minimum price.

89. In Report 11/59, we maintained that it was still appropriate to set a common minimum price for the 800MHz and 900MHz spectrum as no new information available at that time provided evidence to the contrary.

90. Vodafone has suggested in its response to 11/75 that it is now of the view that a differential between minimum prices for 800MHz and 900MHz spectrum should be applied. In particular Vodafone notes that the recent Spanish auction result where 900MHz licences sold for 78% of the auction price of 800MHz licences provides evidence that a different minimum price should be used for 800MHz and 900MHz spectrum.[18]

91. We have stressed both in 10/71b and 11/59 that in proposing a common minimum price for 800MHz and 900MHz spectrum, we are not implying that the two bands are of identical market value. We acknowledge, particularly in the short run that the two bands could well have differing values as different technologies are deployed within these bands. However, the similar propagation characteristics of the bands suggest that these bands could be substitutes, perhaps to a lesser degree in the short run but more definitively in the medium to long run where equipment availability in both bands is no longer an issue.

92. In the Spanish multiband auction, a common reserve price was set for 800MHz and 900MHz spectrum. Only three of the four incumbents appear to have taken part in the auction (existing 900MHz holdings in brackets): Vodafone (2x10MHz); Orange (2x10MHz) and Telefónica (2x5MHz). Incumbents were subjected to a 2x20MHz sub-1GHz cap that took into account existing spectrum holdings. The sub-1GHz cap meant that of the participating incumbents, only Telefónica was able to acquire 2x10MHz of 800MHz and some 900MHz spectrum (up to 2x5MHz given the sub-1GHz cap and existing 900MHz holdings). Therefore it is not surprising that while there was some competition for 800MHz spectrum that resulted in the 800MHz licence prices exceeding the common reserve price, only one of two available lots at 900MHz was won uncontested by Telefónica at the common reserve price. Given the lack of competition for 900MHz spectrum in the Spanish auction, the Spanish

[18] 'Vodafone Response to the ComReg Consultation on the Multi-band Spectrum Release Draft Information Memorandum', November 2011, page 3.

auction result does not provide substantial evidence that 800MHz and 900MHz spectrum are of significantly different value.

93. In the Portuguese auction, Anacom choose to set a lower reserve price for 900MHz spectrum as compared to 800MHz spectrum. Nonetheless, the reserve prices for both bands were within our proposed range set of €15m-€26m. As the auction was uncompetitive, the eventual relative price between 800MHz and 900MHz spectrum was determined by the relative reserve prices of the two bands rather than their competitive market value.

94. Therefore, we maintain that there is insufficient evidence to suggest what the relative market value of 800MHz and 900MHz spectrum might be. Absent such evidence, we propose that a common minimum price be set for 800MHz and 900MHz spectrum. As long as a conservative common minimum price is set for these bands, demand will not be inefficiently choked off and the relative demand for the two bands in the auction will determine their eventual relative value.

95. We note that this approach was adopted in the Spanish auction, where a common reserve price of €17m adjusted for Irish population, was set for 800MHz and 900MHz spectrum. This reserve price falls in the lower half of our recommended range of €15m-€26m set out in 11/59. We note that as much available spectrum as the participating incumbents could bid for under the cap in the Spanish auction was sold, providing supporting evidence that a minimum price set within our proposed range would not inefficiently choke off demand for these bands.

4.2.2 Minimum price for sub-1GHz spectrum

96. Above we conclude that a common minimum price should bet set for 800MHz and 900MHz spectrum within the range of €15m-€26m. We note that in recent auctions across Europe, regulators have set minimum prices that fall within our recommended range of €15m-€26m:

- In Greece, the reserve price for 900MHz spectrum was €20m (for 2x5MHz adjusted for Irish population) and €10m for 1800MHz, exactly as ComReg is currently proposing for the Irish auction. In particular, DotEcon's previous benchmarking report was quoted in the consultation for the Greek 900MHz and 1800MHz auction in relation to appropriate reserve prices.[19] There were no unsold lots in either 900MHz or 1800MHz spectrum in the Greek auction, with the three incumbents paying slightly above reserve prices for all available lots.
- In the initial Spanish multi-band auction, a reserve price of €17m (for 2x5MHz adjusted for Irish population) was set for both 800MHz and 900MHz spectrum. While the 900MHz lot did not sell, the same reserve

[19] See page 5 of 'Liberalization of the use of 900MHz and 1800MHz spectrum bands and assignment of the relevant rights of use – Public Consultation Brief' Maroussi, January 2011, Hellenic Telecommunications & Post Commission.

price was set for the 900MHz lot in a follow up auction which was sold just above this reserve price.

- In Italy, reserve prices for 800MHz licences were set at just under €23m (for 2x5MHz adjusted for Irish population) which is at the upper end of our proposed range. All 800MHz licences in the Italian auction eventually sold for over €32m (for 2x5MHz, adjusted for Irish population) which well exceeds our recommended range.
- In the recently completed Portuguese multi-band auction, reserve prices for 800MHz were set at €24m (for 2x5MHz adjusted for Irish population) and reserve prices for 900MHz were set at €16m (for 2x5MHz adjusted for Irish population).

97. In Spain where both the 800MHz and 900MHz bands were auctioned and a common sub-1GHz reserve price was set, a more conservative reserve price was used, which falls in the low end of our proposed range was used. In other countries that auctioned off only 800MHz or 900MHz spectrum and a common sub-1GHz reserve price was not required, higher reserve prices were used which fall in the middle or upper end of our proposed range.

98. Therefore, the benchmarks derived from our current analysis, summarised in Table 10 above, substantiated by natural experiments from recent auction results that used reserve prices within our recommended range, provide strong evidence that our estimated conservative value of sub-1GHz spectrum of €15m-€26m is a suitable range for sub-1GHz minimum prices in the upcoming Irish auction. As the upcoming auction will include multiple frequency bands whose minimum price is derived from an estimate of sub-1GHz spectrum and due to the need as before to adopt a conservative approach (not least to reflect the current economic situation in Ireland) we would propose that a common minimum price be set for 800MHz and 900MHz spectrum in the lower half of our proposed range of €15m-€26m.

4.2.3 Minimum price of 1800MHz

99. In Section 3.2 above, we concluded that a relative band value of 45%-60% would be appropriate to derive a suitable minimum price for 1800MHz spectrum. Given our proposed sub-1GHz minimum price range of €15m-€26m, this yields a proposed minimum price range of €6.75m-€15.6m for 1800MHz spectrum.

100. We note that several of the mobile operators have proposed that we use central estimates of 1800MHz rather than our relative band approach to derive a suitable minimum price for 1800MHz spectrum. We re-iterate our position that using central estimates of 1800MHz is not in line with our proposed conservative lower bound approach that we have adopted for sub-1GHz spectrum. Nonetheless, to serve as a cross check we have derived a central estimate of 1800MHz spectrum based on the average benchmark approach described in Section 3.1.1. The average value of 2x5MHz of 1800MHz spectrum is €13.6m, adjusted for Irish population. This is at the upper end of our proposed minimum price range for 1800MHz spectrum providing additional support that our proposed minimum price range for 1800MHz is conservative.

101. In Figure 3 below, we compare the average 1800MHz spectrum value of auctions in our sample against our proposed range of €6.75m-€15.6m. We note that the market value of 1800MHz in auctions from the last five years largely fall within our recommended minimum price range. There are also a number of countries who have sold 1800MHz spectrum for prices above our recommended range. Auctions with 1800MHz value below our proposed range are mostly either uncompetitive (highlighted in red) hence licences were awarded at reserve price, or were not part of the main GSM band (the UK DECT guard band auction, and the 1785-1805MHz auctions in the UK (Northern Ireland) and Ireland highlighted in blue). We have also explained extensively in 10/105a why we do not regard the German 1800MHz licences auctioned in 2010 to be a good reflection of market value of 1800MHz spectrum.[20] Finally, in the recently completed Swiss Auction, it is not possible to infer a the price paid for the 1800MHz band given the nature of package bidding in the CCA format, but we note that bidders paid at least the reserve price of €3.5m per 2x5MHz adjusting for Irish population.

102. Therefore, we are of the view that €6.75m-€15.6m is a suitable minimum price range for 1800MHz spectrum in the upcoming Irish auction. Considering the uncertainties over the sub-1GHz market value estimates and the relative band value as well as taking into account the current economic climate in Ireland, we would recommend the minimum price for 1800MHz spectrum be set in the lower half of this range.

103. We note that this approach and recommendation is also consistent with that of other National Regulatory Authorities in Europe. Namely, in Greece, adjusting for population differences, reserve prices for 900MHz and 1800MHz spectrum in its recent auction were identical to that proposed by ComReg in 11/60 and in Italy, its 1800MHz reserve price was again identical to that proposed by ComReg in 11/60.

[20] See paragraphs 203-204 of Report 10/105a.

Figure 2: Sub-1GHz spectrum value

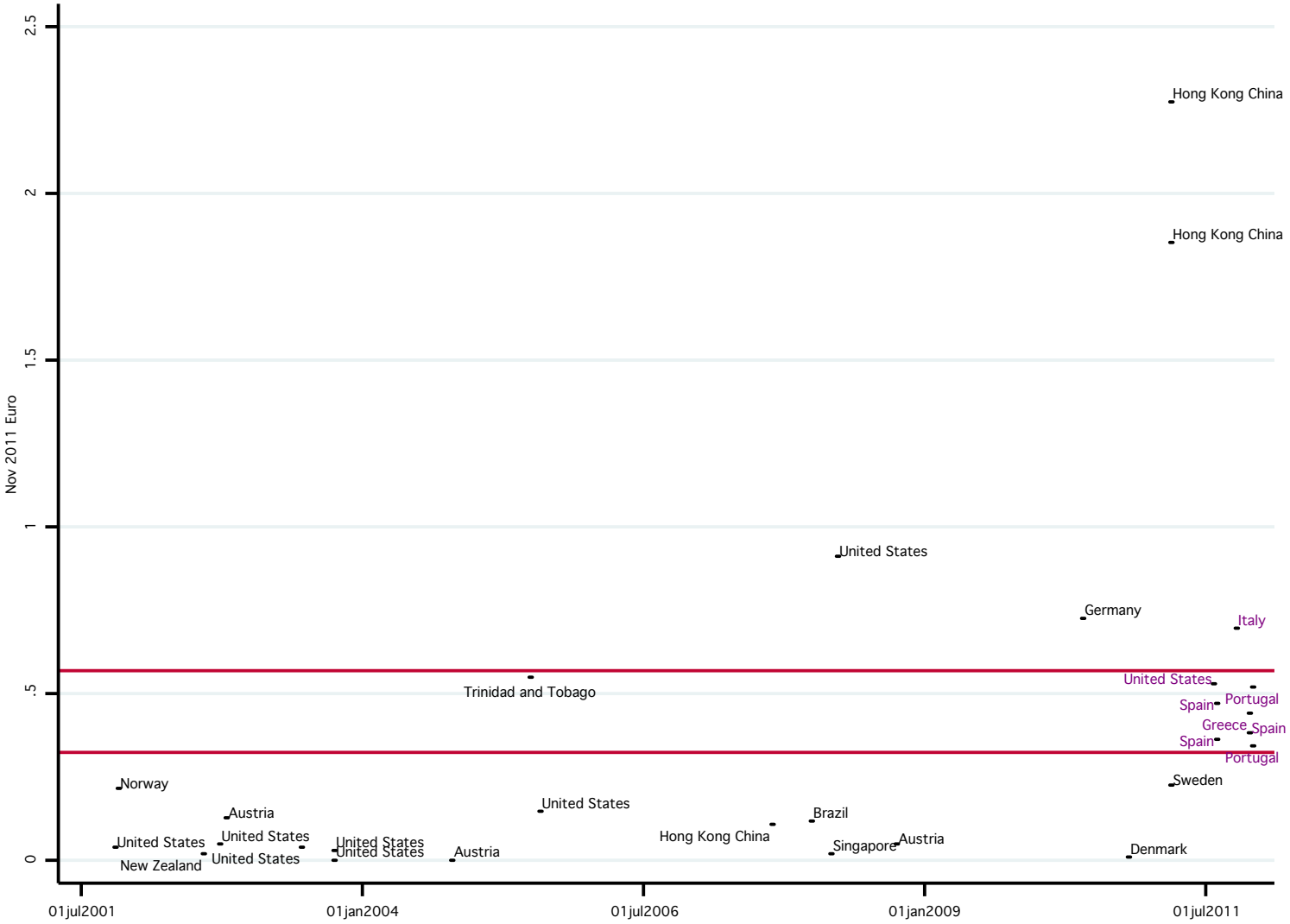
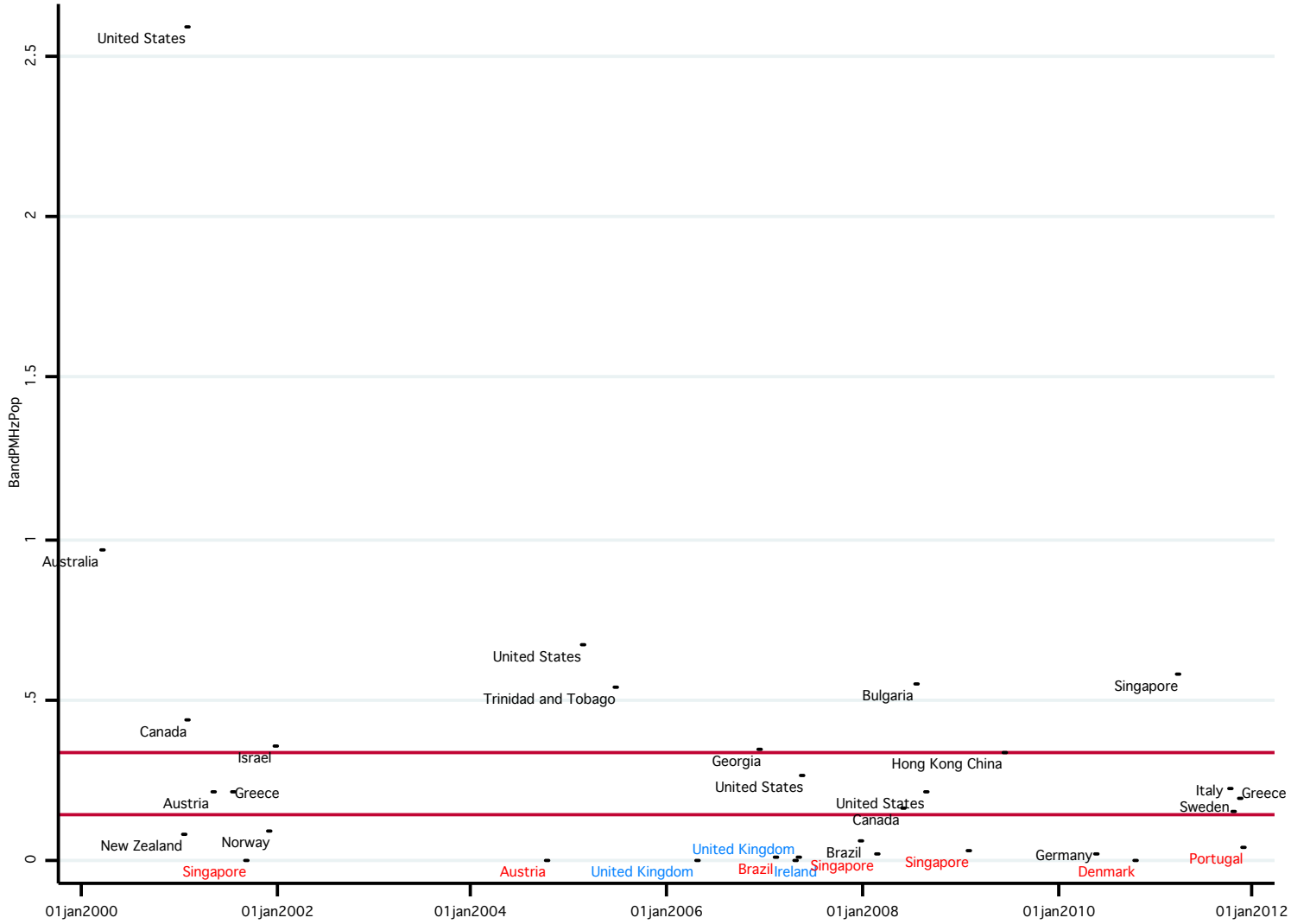


Figure 3: 1800MHz spectrum value



Annex A Datasets

A.1 Global mobile spectrum auctions

Table 11 Mobile spectrum auctions

Country	Award	Date
Australia	PCS 2000 auction	15-Mar-00
United Kingdom	3G Auction	27-Apr-00
Netherlands	3G Auction	24-Jul-00
Germany	3G Auction	18-Aug-00
Italy	3G Auction	23-Oct-00
Austria	3G Auction	03-Nov-00
Switzerland	3G Auction	06-Dec-00
Bulgaria	2nd GSM Licence Auction	18-Dec-00
New Zealand	Auction 3: 1710 - 2300 MHz	18-Jan-01
Nigeria	GSM Auction	19-Jan-01
United States	Auction 35 - C and F Block Broadband PCS	26-Jan-01
Canada	Additional PCS Auction	01-Feb-01
Belgium	3G Auction	02-Mar-01
Australia	3G Auction	22-Mar-01
Singapore	3G Auction	11-Apr-01
Austria	GSM 1800 Auction	07-May-01
Greece	3G Auction	13-Jul-01
Greece	2G	17-Jul-01
Singapore	2G Auction	11-Sep-01
Denmark	3G Auction	20-Sep-01
Hong Kong China	3G Auction	26-Sep-01
United States	Auction 41 Narrowband PCS	18-Oct-01
Norway	E-GSM Auction	31-Oct-01
Norway	GSM 1800 Auction	06-Dec-01
Czech Republic	3G Auction	07-Dec-01
Israel	2G/3G Auction	26-Dec-01
New Zealand	Auction 5 WLL and LMP and Cellular (900MHz)	01-Aug-02
Nigeria	SNO (Digital Mobile License)	12-Aug-02
United States	Auction 44 - Lower 700 MHz Band	18-Sep-02
Austria	GSM 2002 Auction	14-Oct-02
United States	Auction 49 - Lower 700 MHz Band	13-Jun-03
Norway	3G Auction 2	02-Sep-03
United States	Auction 51 Regional Narrowband PCS	25-Sep-03
United States	Auction 50 Narrowband PCS	29-Sep-03
Norway	450 MHz Auction	08-Jun-04
Austria	GSM 2004 Auction	11-Oct-04
United States	Auction 58 - Broadband PCS	15-Feb-05
Sweden	450 MHz Auction	17-Feb-05
Bulgaria	3G Auction	30-Mar-05
Latvia	2G/3G Auction	01-Apr-05

Trinidad and Tobago	GSM Auction	23-Jun-05
United States	Auction 60 - Lower 700 MHz Band Auction	26-Jul-05
Denmark	3G Auction 2	02-Dec-05
Indonesia	3G auction	14-Feb-06
Austria	450 MHz Auction	18-Apr-06
United Kingdom	DECT Guard Block Auction	20-Apr-06
Georgia	3G Auction	23-May-06
Egypt	2G/3G Auction	04-Jul-06
United States	Auction 66 - Advanced Wireless Services	18-Sep-06
Georgia	GSM 1800 MHz	15-Dec-06
Estonia	3G Tender	18-Jan-07
Macedonia FYR	Third GSM licence	05-Feb-07
Brazil	GSM Auction 1800MHz	07-Feb-07
Nigeria	3G Auction	16-Mar-07
Ireland	1785-1805 MHz	27-Apr-07
United Kingdom	1785-1805 MHz	09-May-07
United States	Auction 71 – Broadband PCS	21-May-07
Saudi Arabia	Saudi 3rd GSM license and 3rd 3G license	07-Jul-07
Hong Kong China	Hong Kong CDMA	15-Aug-07
Norway	2.6 GHz	13-Nov-07
Norway	3G 4th licence	12-Dec-07
Brazil	3G Licences	20-Dec-07
Brazil	2G Licences	27-Dec-07
Singapore	Public Cellular Mobile Telecommunications Services Auction	22-Feb-08
Norway	Residual 2.6GHz	28-Feb-08
Sweden	1900-1905MHz	18-Mar-08
United States	Auction 73- 700MHz	18-Mar-08
Sweden	2.6GHz	08-May-08
Canada	AWS auction	27-May-08
Bulgaria	Bulgaria 4th GSM License	18-Jul-08
Qatar	Qatar second mobile licence	29-Jul-08
United States	Auction 78 - Broadband PCS and AWS licences	20-Aug-08
Austria	900 MHz Auction	29-Sep-08
Turkey	3G	24-Nov-08
Hong Kong China	BWA Auction	22-Jan-09
Singapore	1800MHz auction	04-Feb-09
Hong Kong China	1800MHz auction (expansion)	10-Jun-09
Finland	2.6GHz	22-Nov-09
Netherlands	2.6 GHz band	26-Apr-10
Denmark	2.5GHz Auction	10-May-10
India	3G Auction	19-May-10
Germany	Auction of spectrum in the 800MHz, 1800MHz, 2.1GHz and 2.6GHz bands	21-May-10
Austria	2.6GHz Auction	20-Sep-10
Denmark	900MHz Auction	18-Oct-10

Denmark	1800MHz Auction	18-Oct-10
Singapore	3G Auction	25-Oct-10
Hong Kong	850MHz, 900MHz and 2GHz Auction	03-Mar-11
Sweden	800MHz	04-Mar-11
Singapore	1800MHz	28-Mar-11
Belgium	3G Auction	16-May-11
United States	Auction 92 – 700MHz band	25-Jul-11
Spain	800MHz, 900MHz and 2.6GHz	29-Jul-11
Italy	4G Auction	29-Sep-11
Sweden	1800MHz	17-Oct-11
Spain	Second 4G Auction	10-Nov-11
Greece	900MHz and 1800MHz	14-Nov-11
Belgium	2.6GHz	28-Nov-11
Portugal	450MHz, 800MHz, 900MHz, 1800MHz and 2.6GHz	28-Nov-11

A.2 European mobile spectrum auctions

Table 12 European mobile spectrum auctions

Country	Award	Date
United Kingdom	3G Auction	27-Apr-00
Netherlands	3G Auction	24-Jul-00
Germany	3G Auction	18-Aug-00
Italy	3G Auction	23-Oct-00
Austria	3G Auction	03-Nov-00
Switzerland	3G Auction	06-Dec-00
Bulgaria	2nd GSM Licence Auction	18-Dec-00
Belgium	3G Auction	02-Mar-01
Austria	GSM 1800 Auction	07-May-01
Greece	3G Auction	13-Jul-01
Greece	2G	17-Jul-01
Denmark	3G Auction	20-Sep-01
Norway	E-GSM Auction	31-Oct-01
Norway	GSM 1800 Auction	06-Dec-01
Czech Republic	3G Auction	07-Dec-01
Austria	GSM 2002 Auction	14-Oct-02
Norway	3G Auction 2	02-Sep-03
Norway	450 MHz Auction	08-Jun-04
Austria	GSM 2004 Auction	11-Oct-04
Sweden	450 MHz Auction	17-Feb-05
Bulgaria	3G Auction	30-Mar-05
Latvia	2G/3G Auction	01-Apr-05
Denmark	3G Auction 2	02-Dec-05
Austria	450 MHz Auction	18-Apr-06
United Kingdom	DECT Guard Block Auction	20-Apr-06
Estonia	3G Tender	18-Jan-07

Macedonia FYR	Third GSM licence	05-Feb-07
Ireland	1785-1805 MHz	27-Apr-07
United Kingdom	1785-1805 MHz	09-May-07
Norway	2.6 GHz	13-Nov-07
Norway	3G 4th licence	12-Dec-07
Norway	Residual 2.6GHz	28-Feb-08
Sweden	1900-1905MHz	18-Mar-08
Sweden	2.6GHz	08-May-08
Bulgaria	Bulgaria 4th GSM License	18-Jul-08
Austria	900 MHz Auction	29-Sep-08
Turkey	3G	24-Nov-08
Finland	2.6GHz	22-Nov-09
Netherlands	2.6 GHz band	26-Apr-10
Denmark	2.5GHz auction	10-May-10
Germany	Auction of spectrum in the 800MHz, 1800MHz, 2.1GHz and 2.6GHz bands	21-May-10
Austria	2.6GHz Auction	20-Sep-10
Denmark	900MHz Auction	18-Oct-10
Denmark	1800MHz Auction	18-Oct-10
Sweden	800MHz	04-March-11
Belgium	3G Auction	16-May-11
Spain	800MHz, 900MHz and 2.6GHz	29-Jul-11
Italy	4G Auction	29-Sep-11
Sweden	1800MHz	17-Oct-11
Spain	Second 4G Auction	10-Nov-11
Greece	900MHz and 1800MHz	14-Nov-11
Belgium	2.6GHz	28-Nov-11
Portugal	450MHz, 800MHz, 900MHz, 1800MHz and 2.6GHz	28-Nov-11

A.3 Mobile spectrum auctions of countries with comparable GDP per capita to Ireland

Table 13: Mobile spectrum auctions in countries with comparable GDP per capita

Country	Award	Date
Australia	PCS 2000 auction	15-Mar-00
United Kingdom	3G Auction	27-Apr-00
Netherlands	3G Auction	24-Jul-00
Germany	3G Auction	18-Aug-00
Italy	3G Auction	23-Oct-00
Austria	3G Auction	03-Nov-00
Switzerland	3G Auction	06-Dec-00
New Zealand	Auction 3: 1710 - 2300 MHz	18-Jan-01
United States	Auction 35 - C and F Block Broadband PCS	26-Jan-01
Canada	Additional PCS Auction	01-Feb-01
Belgium	3G Auction	02-Mar-01

Australia	3G Auction	22-Mar-01
Singapore	3G Auction	11-Apr-01
Austria	GSM 1800 Auction	07-May-01
Singapore	2G Auction	11-Sep-01
Denmark	3G Auction	20-Sep-01
Hong Kong China	3G Auction	26-Sep-01
United States	Auction 41 Narrowband PCS	18-Oct-01
Norway	E-GSM Auction	31-Oct-01
Norway	GSM 1800 Auction	06-Dec-01
Israel	2G/3G Auction	26-Dec-01
New Zealand	Auction 5 WLL and LMP and Cellular	01-Aug-02
United States	Auction 44 - Lower 700 MHz Band	18-Sep-02
Austria	GSM 2002 Auction	14-Oct-02
United States	Auction 49 - Lower 700 MHz Band	13-Jun-03
Norway	3G Auction 2	02-Sep-03
United States	Auction 51 Regional Narrowband PCS	25-Sep-03
United States	Auction 50 Narrowband PCS	29-Sep-03
Norway	450 MHz Auction	08-Jun-04
Austria	GSM 2004 Auction	11-Oct-04
United States	Auction 58 - Broadband PCS	15-Feb-05
Sweden	450 MHz Auction	17-Feb-05
United States	Auction 60 - Lower 700 MHz Band Auction	26-Jul-05
Denmark	3G Auction 2	02-Dec-05
Austria	450 MHz Auction	18-Apr-06
United Kingdom	DECT Guard Block Auction	20-Apr-06
United States	Auction 66 - Advanced Wireless Services	18-Sep-06
Denmark	450 MHz	15-Dec-06
Denmark	870 MHz	06-Feb-07
Ireland	1785-1805 MHz	27-Apr-07
United Kingdom	1785-1805 MHz	09-May-07
United States	Auction 71 – Broadband PCS	21-May-07
Hong Kong China	Hong Kong CDMA	15-Aug-07
Norway	2.6 GHz	13-Nov-07
Norway	3G 4th licence	12-Dec-07
Singapore	Public Cellular Mobile Telecommunications Services Auction	22-Feb-08
Norway	Residual 2.6GHz	28-Feb-08
Sweden	1900-1905MHz	18-Mar-08
United States	Auction 73- 700MHz	18-Mar-08
Sweden	2.6GHz	08-May-08
Canada	AWS auction	27-May-08
Qatar	Qatar second mobile licence	29-Jul-08
United States	Auction 78 - Broadband PCS and AWS licences	20-Aug-08
Austria	900 MHz Auction	29-Sep-08
Hong Kong China	BWA Auction	22-Jan-09
Singapore	1800MHz auction	04-Feb-09
Hong Kong China	1800MHz auction (expansion)	10-Jun-09

Finland	2.6GHz	22-Nov-09
Netherlands	2.6 GHz band	26-Apr-10
Denmark	2.5GHz auction	10-May-10
Germany	Auction of spectrum in the 800MHz, 1800MHz, 2.1GHz and 2.6GHz bands	21-May-10
Austria	2.6GHz Auction	20-Sep-10
Denmark	900MHz Auction	18-Oct-10
Denmark	1800MHz Auction	18-Oct-10
Singapore	3G Auction	25-Oct-10
Hong Kong	850MHz, 900MHz and 2GHz Auction	03-March-11
Sweden	800MHz	04-March-11
Singapore	1800MHz	28-Mar-11
Belgium	3G Auction	16-May-11
United States	Auction 92 – 700MHz band	25-Jul-11
Spain	800MHz, 900MHz and 2.6GHz	29-Jul-11
Italy	4G Auction	29-Sep-11
Sweden	1800MHz	17-Oct-11
Spain	Second 4G Auction	10-Nov-11
Greece	900MHz and 1800MHz	14-Nov-11
Belgium	2.6GHz	28-Nov-11
Portugal	450MHz, 800MHz, 900MHz, 1800MHz and 2.6GHz	28-Nov-11

A.4 Sub-1GHz and 1800MHz spectrum auctions

Table 14: Sub-1GHz and 1800MHz spectrum auctions

Country	Award	Date
Australia	PCS 2000 auction	15-Mar-00
Bulgaria	2nd GSM Licence Auction	18-Dec-00
New Zealand	Auction 3: 1710 – 2300 MHz	18-Jan-01
Nigeria	GSM Auction	19-Jan-01
United States	Auction 35 - C and F Block Broadband PCS	26-Jan-01
Canada	Additional PCS Auction	01-Feb-01
Austria	GSM 1800 Auction	07-May-01
Greece	2G (900MHz)	17-Jul-01
Greece	2G (900MHz and 1800MHz)	17-Jul-01
Singapore	2G Auction	11-Sep-01
United States	Auction 41 Narrowband PCS	18-Oct-01
Norway	E-GSM Auction	31-Oct-01
Norway	GSM 1800 Auction	06-Dec-01
Israel	2G/3G Auction	26-Dec-01
New Zealand	Auction 5 WLL and LMP and Cellular (900MHz)	01-Aug-02
Nigeria	SNO (Digital Mobile License)	12-Aug-02
United States	Auction 44 - Lower 700 MHz Band	18-Sep-02
Austria	GSM 2002 Auction	14-Oct-02

United States	Auction 49 - Lower 700 MHz Band	13-Jun-03
United States	Auction 51 Regional Narrowband PCS	25-Sep-03
United States	Auction 50 Narrowband PCS	29-Sep-03
Austria	GSM 2004 Auction (900MHz)	11-Oct-04
Austria	GSM 2004 Auction (1800MHz)	11-Oct-04
United States	Auction 58 - Broadband PCS	15-Feb-05
Trinidad and Tobago	GSM Auction (800MHz)	23-Jun-05
Trinidad and Tobago	GSM Auction (1900MHz)	23-Jun-05
United States	Auction 60 - Lower 700 MHz Band Auction	26-Jul-05
United Kingdom	DECT Guard Block Auction	20-Apr-06
Georgia	GSM 1800 MHz	15-Dec-06
Macedonia FYR	Third GSM licence	05-Feb-07
Brazil	GSM Auction 1800MHz	07-Feb-07
Ireland	1785-1805 MHz	27-Apr-07
United Kingdom	1785-1805 MHz	09-May-07
United States	Auction 71 – Broadband PCS	21-May-07
Hong Kong	Hong Kong CDMA - 850MHz	15-Aug-07
Brazil	2G Licences (800MHz)	27-Dec-07
Brazil	2G Licences (1800MHz)	27-Dec-07
Singapore	Public Cellular Mobile Telecommunications Services Auction (900MHz)	22-Feb-08
Singapore	Public Cellular Mobile Telecommunications Services Auction (1800MHz)	22-Feb-08
United States	Auction 73- 700MHz	18-Mar-08
Sweden	1900-1905MHz	18-Mar-08
Canada	AWS Auction	27-May-08
Bulgaria	Bulgaria 4th GSM License	18-Jul-08
United States	Auction 78 - Broadband PCS	20-Aug-08
Austria	900 MHz Auction	29-Sep-08
Singapore	1800MHz auction	04-Feb-09
Hong Kong China	1800MHz auction (expansion)	10-Jun-09
Germany	Auction of spectrum in the 800MHz, 1800MHz, 2.1GHz and 2.6GHz bands (800MHz)	21-May-10
Germany	Auction of spectrum in the 800MHz, 1800MHz, 2.1GHz and 2.6GHz bands (1800MHz)	21-May-10
Denmark	900MHz Auction	18-Oct-10
Denmark	1800MHz Auction	18-Oct-10
Hong Kong	850MHz, 900MHz and 2GHz Auction	03-March-11
Sweden	800MHz	04-Mar-11
Singapore	1800MHz	28-Mar-11
United States	Auction 92 – 700MHz band	25-Jul-11
Spain	800MHz	29-Jul-11
Spain	900MHz	29-Jul-11
Italy	800MHz	29-Sep-11

Sweden	1800MHz	17-Oct-11
Spain	900MHz	10-Nov-11
Greece	900MHz	14-Nov-11
Greece	1800MHz	14-Nov-11
Portugal	800MHz	28-Nov-11
Portugal	900MHz	28-Nov-11
Portugal	1800MHz	28-Nov-11

A.5 3G spectrum auctions

Table 15: 3G spectrum auctions

Country	Award	Date
United Kingdom	3G Auction	27-Apr-00
Netherlands	3G Auction	24-Jul-00
Germany	3G Auction	18-Aug-00
Italy	3G Auction	23-Oct-00
Austria	3G Auction	03-Nov-00
Switzerland	3G Auction	06-Dec-00
New Zealand	Auction 3: 1710 - 2300 MHz	18-Jan-01
Belgium	3G Auction	02-Mar-01
Australia	3G Auction	22-Mar-01
Singapore	3G Auction	11-Apr-01
Greece	3G Auction	13-Jul-01
Denmark	3G Auction	20-Sep-01
Hong Kong China	3G Auction	26-Sep-01
Czech Republic	3G Auction	07-Dec-01
Israel	2G/3G Auction	26-Dec-01
Norway	3G Auction 2	02-Sep-03
Bulgaria	3G Auction	30-Mar-05
Denmark	3G Auction 2	02-Dec-05
Indonesia	3G auction	14-Feb-06
Georgia	3G Auction	23-May-06
United States	Auction 66 - Advanced Wireless Services	18-Sep-06
Estonia	3G Tender	18-Jan-07
Nigeria	3G Auction	16-Mar-07
Norway	3G 4th licence	12-Dec-07
Brazil	3G Auction	20-Dec-07
Canada	AWS auction	27-May-08
Turkey	3G	24-Nov-08
United States	Auction 78 - AWS licences	20-Aug-08
India	3G auction	19-May-10
Germany	800MHz, 1800MHz, 2.1GHz and 2.6GHz bands (2.1GHz)	21-May-10
Singapore	3G Auction	25-Oct-10
Belgium	3G Auction	16-May-11

A.6 European 800MHz spectrum auctions

Table 16: European 800MHz spectrum auctions

Country	Award	Date
Germany	800MHz, 1800MHz, 2.1GHz and 2.6GHz bands	21-May-10
Sweden	800MHz	04-Mar-11
Spain	800MHz, 900MHz and 2.6GHz bands	29-Jul-11
Italy	4G Auction	29-Sep-11
Portugal	Multiband (450MHz, 800MHz, 900MHz, 1800MHz and 2.6GHz)	28-Nov-11

Annex B Regression analysis for European sub-1GHz and 1800MHz auctions

B.1 Auctions in Europe

Table 17: Results of regression analysis using all European mobile licences sold in auctions in Europe

Coefficient for	Estimated coefficient	Standard Error
GDPpc	0.00000439	0.00000465
ApPop	-7.27**	1.82
WtB	-0.567**	0.111
invNMNOs	7.93**	0.662
national	-0.244*	0.121
twopointsix	-0.0824	0.0731
preIT	1.68**	0.139
yearD_01	-1.01**	0.118
yearD_0203	-0.833**	0.165
yearD_0405	-0.900**	0.138
yearD_0607	-1.14**	0.134
yearD_0809	-0.890**	0.139
yearD_1011	-0.922**	0.118
Constant (β_0)	0.137	0.321

Note: Coefficients which are significant at the 5% and 1% level are marked with one and two stars, respectively.

B.2 Sub-1GHz and 1800MHz auctions

Table 18: Results of regression analysis using all sub-1GHz and 1800MHz auctions

Coefficient for	Estimated coefficient	Standard Error
GDPpc	-0.0000163**	0.00000270
PopDen	0.0000805**	0.00000947
WtB	-0.957**	0.0690
invNMNOs	-2.19**	0.319

national	-0.623**	0.0495
AFME	-0.217**	0.0911
preIT	-3.83**	0.182
yearD_01	-3.78**	0.148
yearD_0203	-4.97**	0.159
yearD_0405	-4.36**	0.153
yearD_0607	-5.01**	0.150
yearD_0809	-4.64**	0.152
yearD_1011	-4.31**	0.151
Constant (β_0)	6.83**	0.205

Note: Coefficients which are significant at the 5% and 1% level are marked with one and two stars, respectively.

Annex C Relative band values

104. The average price per MHz per pop in the respective sub-1GHz and 1800MHz bands, as well as the derived relative band value in these auctions, is presented in Table 19 below. These auctions also generate a country relative band value listed in Table 20 below. In addition, in Table 20 below, we present the several new auctions which yield or update country relative band values relative to our sample in Report 11/59.

Table 19: Award relative band value

	Frequency band	Band average price per MHz per pop (Nov 2011 Euros)	Relative band value
Italy	800MHz	€0.70	0.32
	1800MHz	€0.23	
Greece	900MHz	€0.44	0.44
	1800MHz	€0.19	
Portugal	800MHz and 900MHz	€0.40	0.091
	1800MHz	€0.036	

Table 20: Country relative band value

Country	Auction (frequency band)	Date	Relative band value in 10/105a	Current relative band value
Brazil	GSM Auction, Sao Paulo (1800MHz)	7 Feb 2007	0.501	0.29
	2G (1800MHz)	27 Dec 2007		
	2G (800MHz)	27 Dec 2007		
Denmark	900MHz	18 Oct 2010	NA	0.26
	1800MHz	18 Oct 2010		
Greece	2G and 3G (1800MHz)	17 Jul 2001	0.58*	0.41
	900MHz	14 Nov 2011		
	1800MHz	14 Nov 2011		
Hong Kong	CDMA (850MHz)	15 Aug 2007	NA	0.12
	1800MHz expansion band	10 Jun 2009		
	Multiband (850MHz)	3 Mar 2011		
	Multiband (900MHz)	3 Mar 2011		
Italy	Multiband (800MHz)	29 Sep 2011	NA	0.32
	Multiband (1800MHz)	29 Sep 2011		
New Zealand	Auction 3 (1800MHz)	18 Jan 2001	NA	4.47
	Auction 5 (900MHz)	1 Aug 2002		
Portugal	800MHz and 900MHz	28 Nov 2011	NA	0.09
	1800MHz	28 Nov 2011		
Singapore	2G (1800MHz)	11 Sep 2001	1	6.79
	PCMTS (900MHz)	22 Feb 2008		
	PCMTS (1800MHz)	22 Feb 2008		
	1800MHz	4 Feb 2009		
	1800MHz	28 Mar 2011		
Sweden	800MHz	4 Mar 2011	NA	0.68

Country	Auction (frequency band)	Date	Relative band value in 10/105a	Current relative band value
	1800MHz	17 Oct 2011		
United States	Auction 1 – Nationwide Narrowband (900MHz)	29 Jul 1994	0.588	0.92
	Auction 3- Regional Narrowband (900MHz)	10 Nov 1994		
	Auction 4 – Broadband PCS A and B Block (1900MHz)	13 Mar 1995		
	Auction 5- Broadband PCS C Block (1900MHz)	6 May 1996		
	Auction 10 – PCS C Block Re-auction (1900MHz)	16 Jul 1996		
	Auction 11 – Broadband PCS D and E & F block (1900MHz)	14 Jan 1997		
	Auction 22 – C, D, E and F block Broadband PCS (1900MHz)	15 Apr 1999		
	Auction 35 – C and F block Broadband PCS (1900MHz)	26 Jan 2001		
	Auction 41 – Narrowband PCS (900MHz)	18 Oct 2001		
	Auction 44 – Lower 700MHz (700MHz)	18 Sep 2002		
	Auction 49 – Lower 700MHz (700MHz)	13 Jun 2003		
	Auction 51 – Regional Narrowband PCS (900MHz)	25 Sep 2003		
	Auction 50 – Narrowband PCS (900MHz)	29 Sep 2003		
	Auction 58 – Broadband PCS (1900MHz)	15 Feb 2005		
	Auction 60 – Lower 700MHz (700MHz)	16 July 2005		
	Auction 71 – Broadband PCS (1900MHz)	21 May 2007		

Country	Auction (frequency band)	Date	Relative band value in 10/105a	Current relative band value
	Auction 73 700MHz	18 Mar 2008		
	Auction 78 – Broadband PCS (1900MHz)	20 Aug 2008		
	Auction 92 (700MHz)	25 Jul 2011		

*It was not possible to derive a country relative band value in 10/105a but it was noted that a premium of 58% was paid for the licence with 900MHz and 1800MHz spectrum relative to the 1800MHz-only licence in the 2001 Greek auction.

Annex D Stakeholder responses to ComReg 11/59

105. In this Annex we present the responses received in respect of our last update to the benchmarking analysis published as ComReg document 11/59. The respondents raised a number of issues with the benchmarking analysis. The respondents' views are set out under the following headings:

- Benchmark methodology and modelling issues;
- The Irish economy;
- Conservative approach to setting minimum prices;
- Collusion issues and minimum prices;
- Relative benchmark for 1800MHz.

D.1 Benchmark methodology and modelling issues

Table 21: Respondents' views on the benchmarking methodology

Respondent	View on the benchmarking methodology
Vodafone	Vodafone continues to consider that a benchmarking approach is not appropriate to use in setting the minimum price. The minimum licence price should be set at a low but non-trivial level that would be sufficient to deter spurious bidders, with the determination of the licence prices being left to the auction outcome of competitive bidding in the auction process. Vodafone find it difficult to find any justification for ComReg's claims that NRAs in other countries - when they set prices at a low but non-trivial level - have different objectives from ComReg and that this somehow justifies ComReg setting minimum prices in the manner and at the level the now propose. Vodafone consider the objectives of all EU NRAs regarding spectrum to be principally and similarly driven by the EU Communications Regulatory Framework.[21]
Telefónica Ireland - O2	As stated in response to previous consultation documents, Telefónica has concerns about the use of benchmarks as a means to determine pricing. In order to be useful, they must produce a relevant set of data from situations that are directly comparable to that in Ireland at the current time. This is never completely possible and as a consequence benchmark results can have a significant error margin that renders them unreliable. This is recognised by DotEcon as they have included a number of adjustments and corrections to the source data in order to attempt to account for the individual characteristics of auction results. Telefónica's view is that the benchmark results are little more than an indicator, that should be used cautiously.[22]

[21] 'Vodafone response to the ComReg Draft Decision on Release of the 800 MHz, 900 MHz and 1800 MHz Radio Spectrum Bands' October 2011, page 7.

[22] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 42.

	Considers that DotEcon should produce a table or graph showing the results produced by the model compared with the actual results achieved in the 12 most recent auctions. [23] Telefónica has previously proposed that DotEcon should produce a benchmark of minimum prices as another indicator for ComReg, however this does not seem to have been considered.[24]
eircom Group	Benchmarking analyses are always fraught with difficulties in trying to generate indicators that are comparable with national circumstances. Criticism of DotEcon's approach has included the time series over which the potential comparators have been drawn and the manner in which adjustments have been made to seek to adjust for the particular circumstances of the Irish economy.[25]
H3GI	In response to ComReg document 11/60 H3GI states that whilst it welcomes the reduction in the proposed minimum reserve price, it still regards the minimum reserve price as too high and that it will have a negative impact on demand and the efficient use of spectrum.[26] It considers that ComReg should implement a minimum reserve price in line with minimum reserve prices elsewhere. [27]

[23] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 46.

[24] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 41.

[25] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 16.

[26] 'Response by Hutchison 3G Ireland Limited in respect of ComReg Document No. 11/60 Multi-Band Spectrum Release – Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands' 14 October 2011, page 4.

[27] 'Response by Hutchison 3G Ireland Limited in respect of ComReg Document No. 11/60 Multi-Band Spectrum Release – Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands' 14 October 2011, page 5.

Table 22: Respondents' arguments in favour of using GNP rather than GDP as an explanatory variable in the regression analysis

Respondent	**Arguments in favour of** using **GNP** rather than GDP as an explanatory variable in the regression analysis
Vodafone	Vodafone does not accept, the use of GDP rather than GNP as an independent variable in the benchmarking regression equation is the optimal approach. Vodafone continues to consider that the use of GDP per capita, rather than GNP per capita, is fundamentally flawed in the Irish context. The latter it claims is clearly superior to the use in terms of reflecting the income actually available to Irish residents. The key distinction it argues is that GDP is a geographically based measure of the value of output in contrast to GNP which is a resident based measure. It argues that - in the case of Ireland the GDP figure is exceptionally distorted through the use of transfer pricing the many large multi-national companies based in Ireland. While in many countries GDP and GNP may closely match, in Ireland's case they do not even closely approximate to each other. It further states that in its view, it is the GNP level which reflects the income level of residents as measured by GNP per capita, with its direct implications for consumption patterns. This is therefore, in its view the relevant factor in the context of spectrum valuation and not the value of national output (GDP) – much of which may be attributable to foreign owners of factors of production located in the country. It claims DotEcon is aware of the issue of the large difference between GDP and GNP in Ireland but claims that the former has been chosen over the latter as: "… it is a better reflection of the domestic value of output in a country which in turn is a closer proxy factors that may affect spectrum valuations such as the level of development in a country and the potential willingness to pay for telecommunications services." Vodafone believe this interpretation of the relative value of GDP versus GNP is mistaken. In its view - GNP is clearly a superior reflection of the level of income earned by citizens in a country and better reflects the potential for spending on domestic telecommunication services. [28]
Telefónica Ireland -	Remain of the view that GDP is not a useful comparator for the

[28] 'Vodafone response to the ComReg Draft Decision on Release of the 800 MHz, 900 MHz and 1800 MHz Radio Spectrum Bands' October 2011, page 8.

O2	Irish economy because of the large distorting effect of non-national trade. GDP in Ireland is currently over 22% greater than GNP, and where there is such a divergence, GNP is a more relevant comparator for the value of a spectrum licence in its view. The value of the licence is derived almost exclusively from anticipated revenue generated by servicing Irish consumers. According to Telefónica, the consumption and revenue generated will be determined by the welfare of those consumers, and on the contrary will be minimally influenced by the value of non-national but domestically located production. Neither ComReg nor DotEcon have adequately answered this point of criticism in documents 11/58, 11/59, or 11/60 in its view. State agencies including Forfás have repeatedly stated (e.g. in its Annual Competitiveness Reports) that GNP is a better measure of Irish living standards than GDP. In its most recent quarterly bulletin, the Central Bank forecasts a continuing divergence between GDP and GNP, with the latter having slower growth. According to Telefónica, DotEon appears to have dismissed this consideration on the basis of cursory examination, and must now re-examine the impact that a change to use of GNP would have on its benchmark report. Telefónica notes that ComReg itself has used GNP rather than GDP as an indicator of overall revenues in the communications markets, for example in document 10/73r. [29]
IBEC Telecommunications and Internet Federation	Considers that in the case of Ireland GNP represents a much more accurate indicator of income earned and accrued to Irish citizens. TIF states that it regularly recognised by Irish Government and International agencies that in the case of Ireland, GNP is a much more accurate reflection of the income available to Irish citizens. In this respect TIF presents the OECD and Forfás as examples. It claims that using GDP in the analysis instead of GNP would constitute a significant technical error and would be inconsistent with the views of a range of government and international agencies.[30]

[29] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 42-43.

[30] Letter from Mr. Alex Chisholm on behalf of IBEC Telecommunications and Internet Federation – 'TIF Submission on Spectrum Minimum Price' 14 October 2011.

eircom Group	Eircom states that there is widespread agreement that it is necessary to consider domestic income levels as a proxy for willingness to pay for mobile communications services. However Eircom maintains that Dotecon is simply wrong when it asserts that GDP is the better explanatory variable. Eircom states that expert economic analysts acknowledge that GDP is not the most appropriate variable to consider Ireland's domestic economy. For example, it cites the Central Statistics Office (CSO) report "Measuring Ireland's Progress 2010". The CSO reports Gross National Income (GNI) along with GDP because "Ireland, along with Luxembourg, are exceptions in the EU with a wide divergence between GDP and GNI." IT further states that "The relationship between GDP and GNI in Ireland is exceptional among EU countries, with Luxembourg the only other country where the difference between the two measures is more than 10% of GDP. The gap reflects the importance of foreign direct investment to the Irish economy. Luxembourg had a GNI/GDP ratio of 71.2 compared with 82.9 for Ireland in 2010, while the average for the EU countries was 99.9."[31]

[31] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 21.

Table 23: Respondents' views on other data inputs

Respondent	Views on other data inputs
Vodafone	Vodafone believes that the benchmark report must continue to adhere to the principle of using the most up to date national income data available where possible and, as data on GNP per capita for 2010 may well be available prior to the holding of the proposed spectrum award process for the 800 MHz and 900 MHz bands in 2011, 2010 data should if possible be used in the regression equation to obtain a more accurate estimate of the optimal minimum licence price. Vodafone note that the latest preliminary census estimate from the CSO website indicates a slightly higher population figure than used in the study. This would further reduce the per capita income independent variable and provided that there is no population size element in the regression equation this could reduce the licence price further and should be taken into account. [32]
Telefónica Ireland - O2	Telefónica has repeated its previous arguments that pricing for spectrum in larger countries is not an accurate reflection of the value of spectrum in smaller countries, where the smaller market means that there is less opportunity to generate revenue. According to Telefónica, ComReg has failed to respond to this submission. [33] Telefónica also maintains DotEcon's report on the winner to bidder ratio issue is unclear. It states that, in paragraphs 97-101, , having previously used a winners to bidders ("WTB") ratio of 0.86, DotEcon used a WTB ratio of 0.77 in its most recent calculations. This change it contends has a significant impact on the benchmark range – had DotEcon maintained its original 0.86 ratio, the minimum price according to table 11 would have been several million euro lower – with the bottom end dropping from €15 million to €12 million. Telefónica speculates that this change in WTB ratio seems to have been motivated by the observation that recent auctions in other jurisdictions had proven competitive, resulting in a lower WTB ratio in its auction dataset.

[32] 'Vodafone response to the ComReg Draft Decision on Release of the 800 MHz, 900 MHz and 1800 MHz Radio Spectrum Bands' October 2011, page 9.

[33] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 44.

	Telefónica further claims that there is simply no analysis of whether this would translate into greater demand in the Irish market. Again, for such a significant price increase (a 25% increase in the bottom end of the range), Telefónica believes that ComReg and DotEcon are required to provide actual substantiation. Otherwise they are open to the allegation that the WTB is being manipulated to push the price back up again, when other recent changes, such as the drop in GDP had pushed it down slightly. Further, as noted below, ComReg's stance in altering the WTB ratio (perceived increased competitiveness) contradicts the position it is taking on tacit collusion, where it strongly asserts the risk that the auction will not be competitive. That the output of the benchmark model is so sensitive to a single variable that it can be adjusted by DotEcon without analysis of specific local market conditions essentially gives ComReg and DotEcon, according to Telefónica, a free-hand to adjust the output arbitrarily. This calls into question the credibility of the entire model as an objective means to determine minimum prices. [34] Telefónica further claims that DotEcon has selectively excluded a number of recent auctions, without strong justification. For example, recent 2.6 GHz auctions are excluded. According to DotEcon these prices "depressed price predictions", however they are excluded owing to a subjective analysis that the rules and the caps were "flawed"; but with no substantiating data provided to justify this. Telefónica also notes the exclusion of other auctions which would have reduced the predicted price, including the Danish auction on the basis that it was "uncompetitive" and the Swedish 800 MHz auction on the basis that several of the blocks were less valuable than others, impacting price. Telefónica disputes these exclusions as not being sufficiently justified and having the effect of keeping the predicted price up. [35]

[34] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 44-45.

[35] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 45.

eircom Group	The time series includes all spectrum auctions since 2000. The early 2000s saw a significant number of 3G auctions. Eircom states that it is wrong to assume that the factors informing bidder valuations in the 3G auctions are the same as today. In eircom Group's view it is constructive to consider European auctions undertaken over the last few years to assess the reasonableness of ComReg's proposals. Whilst this is a relatively small dataset it has the benefit of reflecting current factors informing bidder valuations including the economic climate. Furthermore a European focus, it argues is also likely to capture the non-trivial impact of the economic regulatory regime. In addition to a common regulatory framework, International Roaming services are regulated directly by European Regulation and European Commission policy has a significant impact on the national regulation of wholesale mobile voice termination rate services. [36] eircom Group compare ComReg's current proposed minimum fee with the average €/MHz/pop achieved at recent European auctions for sub 1GHz spectrum (chart 1) and notes that ComReg's proposed minimum price appears to be at the lower end of outcomes in respect of European 800MHz auctions. However, if the minimum price for the Swedish auction had been set at ComReg's proposed level it is arguable that the Swedish auction could not have proceeded in an efficient manner. While eircom Group acknowledges that there are significant differences between a particular national spectrum auction and the Irish circumstances it considers that this highlights the need to apply extreme caution when using the results of DotEcon's analysis to inform a decision in respect of minimum fees to be applied in Ireland. [37] Eircom also submits that it is also notable that DotEcon appears to put more reliance on outcomes that exclude new entrant bidders. This claimed bias in DotEcon's thinking appears to be at odds with ComReg's objective of not precluding new entrant participation in the award process. [38]

[36] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 16.

[37] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 17.

[38] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 17.

D.2 The Irish Economy

Table 24: Views on the state of the Irish economy and the impact on spectrum valuation

Respondent	Views on the state of the Irish economy and the impact on spectrum valuation
Telefónica Ireland - O2	Telefónica claims that not enough account has been taken of the current state of the Irish economy and the impact it will have on valuations. According to Telefónica, all expert analysis states that the Irish economy will continue to struggle for several years, with the current unprecedented uncertainty making it impossible to obtain a consensus prediction for recovery. The market for mobile services it claims is currently shrinking by approximately 10% per annum. Bidders are now preparing their valuations for spectrum, it states, will take into account recent trends in overall market revenue, and predicted future revenue, which is dependent on the overall national economic performance. In Telefónica's view ComReg must accept that consequentially the current difficult circumstances of the Irish economy will have a significant impact in reducing bidder valuations. This it claims has not been adequately taken into account in the benchmarking report (Document 11/59). The only response to this issue, it claims, is DotEcon's statement that "including recently completed auctions in the dataset used for our analysis will be informative on spectrum valuations in the current economic climate" (Doc 11/59, paragraph 36). Telefónica argues that, none of these auctions took place in countries undergoing a recession of the severity and length of that in Ireland, and cannot be taken as a substitute for taking into account the actual state of the Irish economy, particularly when it believes there is plenty of data available on this subject. Telefónica continues by also taking issue with the assertion in paragraph 37 (Document 11/59), based on studies in other countries that consumer demand for telecommunications services is more resilient than other services implying that the downturn is not having a serious effect on mobile operators business. Telefónica also states that DotEcon emphasises the long term nature of the licences and argue that therefore the transient component of shifts in GDP should not have much effect on the value of long-lived assets. This according to Telefónica ignores the fact that the bulk of the valuation of

	spectrum is based on their short term value, given the impossibility of predicting the state of the telecommunications market over a longer period. [39]

[39] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 43-44.

D.3 Conservative approach to setting minimum prices

Table 25: Respondents' arguments in support of a more conservative approach to minimum price setting

Respondent	Arguments in support of a more conservative approach to minimum price setting
Vodafone	Considers that ComReg's proposal to reduce the minimum licence prices of both sub-1GHz and 1800MHz as a positive move that somewhat mitigates the risks of spectrum inefficiently going unallocated in the award process. [40] In addition, in its response to ComReg document 11/75 Vodafone states that it "now believe[s] that there should be a differential between the 800 & 900 spectrum minimum prices. This was shown in recent auctions in Spain, where the final auction price of 900 MHz spectrum was only 78% of the 800MHz spectrum." [41]
Telefónica Ireland - O2	Strongly objects to ComReg's failure to propose minimum prices at the lower end of the value range identified by its advisors for the following reasons: 1. middle of the range is contrary to ComReg's objectives i.e. efficiency of spectrum allocation 2. benchmarks are prone to error 3. implications of setting price to high are more serious than setting it too low 4. setting a price from within the benchmark contradicts ComReg's stated objectives – ComReg states that the benchmark methodology does not set reserve prices at market value however the benchmark report does make an estimate of market value (lower bound estimate). To avoid setting the reserve price at a possible market price it should set the minimum price below the bottom of the benchmark price range.

[40] 'Vodafone response to the ComReg Draft Decision on Release of the 800 MHz, 900 MHz and 1800 MHz Radio Spectrum Bands' October 2011, page 7.

[41] 'Vodafone Response to the ComReg Consultation on the Multi-band Spectrum Release Draft Information Memorandum', November 2011, page 3.

	5. uncertainty related to the benchmark argues for a cautious approach 6. impact of the addition of CPI - ComReg selects a headline price of €20 million for sub-1 GHz spectrum (lower end of DotEcon's range). However, applying average CPI to this price over the proposed term produces a minimum price of €24 million, which is the higher end of DotEcon's range. [42]
eircom Group	Welcome ComReg's downward revision of the proposed minimum price to €20m for sub 1GHz spectrum. Whilst it sees this as a positive move in the right direction there remains, in its view considerable risk that the minimum price proposals will negatively impact on the efficiency of the proposed award process. [43] In eircom Group's view minimum prices for sub 1GHz spectrum should be set no higher than the lower end of DotEcon's lower bound estimate (currently €15m) so as not to preclude potential outcomes. Given that the establishment of a minimum price is not to predict the final price in the proposed award process, Eircom argues that a price no higher than the lower end of DotEcon's lower bound estimate would appear to meet all relevant criteria to ensure that the level meets ComReg's objectives to maximise the efficiency of the award process. [44]

D.4 Collusion issues and minimum prices

Table 26: Respondents' views on the consideration of tacit collusion issues when setting minimum prices

Respondent	Respondents' views on the consideration of tacit collusion issues when setting minimum prices

[42] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 45-47.

[43] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 15.

[44] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 18.

Vodafone	The proposal to address tacit collusion issues through the setting of the minimum price is unnecessary and continues to pose a significant risk of spectrum going unallocated. The measures which ComReg now propose such as the limited transparency during the award process, anonymisation of bidder identities etc. are sufficient in Vodafone's view to effectively address concerns regarding tacit collusion. Therefore according to Vodafone, the proposal to address these through the setting of the minimum price is unnecessary and continues to pose a significant risk of spectrum going unallocated. [45]
H3GI	H3GI is of the view that ComReg's primary concern would appear to be to minimise the risk of tacit collusion or strategic behaviour and considers this to also be echoed by DotEcon's updated report on benchmarking. H3GI takes issue with ComReg's and DotEcon's approach to the minimum reserve price. It considers that actual collusive behaviour is sufficiently dealt with by: (i) the threat of expulsion from the award process; and (ii) prosecution under the Competition Act, 2002 for entering into an agreement or concerted practice contrary to section 4 of that Act. [46]
Telefónica Ireland - O2	ComReg's selection of €20 million as the minimum price for sub-1GHz spectrum rests entirely on, in Telefónica's view, the unsubstantiated claim that this auction is vulnerable to tacit collusion amongst bidders. The tacit collusion "premium" over the minimum price recommended by DotEcon alone is in excess of €100m across all lots, accounting for a quarter of the total price of all lots at the reserve price (the total being €410 million). Telefónica considers that ComReg's position on this issue is wrong, unsubstantiated and runs contrary to its legal and regulatory objectives. Telefónica submits that ComReg should revisit its position on this issue before it proceeds to a final decision. It considers that the following factors are relevant: 1. ComReg's claims on the likelihood of collusion are

[45] 'Vodafone response to the ComReg Draft Decision on Release of the 800 MHz, 900 MHz and 1800 MHz Radio Spectrum Bands' October 2011, page 7.

[46] 'Response by Hutchison 3G Ireland Limited in respect of ComReg Document No. 11/60 Multi-Band Spectrum Release – Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands' 14 October 2011, page 4.

unsubstantiated.

2. Choking off demand – unsubstantiated assertions

3. ComReg wrongly conflates "natural outcomes" with collusion and seeks to penalise legitimate outcomes (see quote below).

4. Fears of collusion focus on 900MHz in T1 as a result of the new sub-cap. ComReg is required to act proportionately. A more proportionate response is to deal with the issue by deploying measures affecting only the specific spectrum giving concern.

5. ComReg is taking a contradictory stance on the competitiveness of the auction – in the benchmark model DotEcon reduce the winner to bidder ratio on the basis of an assumption that the auction will be more competitive than previously anticipated.

6. ComReg's prioritisation of tacit collusion over other objectives to such a remarkable extent is both contrary to its statutory objectives and stands out amongst other NRAs which have not seen a requirement to elevate the issue to such an extent.

7. ComReg appear to be taking a contradictory position on the issue of whether the proposed minimum price represents the estimated market value.

8. Auction format should prevent collusion. [47]

Natural outcomes vs. collusion

Telefónica considers that *"an outcome that results from low demand is indeed a natural outcome but it is also an entirely legitimate and legal one. It is not collusion, tacit or otherwise, it is simply the logical consequence of there being more spectrum available than there is demand for it, and represents efficient allocation of spectrum via open auction."* [48]

It states that *"ComReg is not entitled, under its statutory objectives and obligations, to seek to penalise or prevent such legitimate*

[47] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 48-54.

[48] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 49-50.

	outcomes simply because they result in lower prices; …Further, neither ComReg nor Dotecon are legally entitled to structure the auction to "disincentivise" legitimate "pre-auction consolidation" as Dotecon suggest – as is set out in more detail in the section on joint bidding. Both are contrary to ComReg's statutory objectives." [49]

D.5 Relative benchmark for 1800MHz

Table 27: Respondents' views on the relative benchmark for 1800MHz

Respondent	Views on the relative benchmark for 1800MHz
Telefónica Ireland - O2	Telefónica believes ComReg has overestimated the value of a lot of 1800MHz spectrum in Ireland and is running a significant risk of choking off demand. It is unclear to Telefónica why ComReg and DotEcon maintain the current relative price approach as it offers no advantage over determining the minimum price for 1800MHz independently. According to Telefónica, if there is a scarcity of benchmark prices for the 1800MHz band, this will be even more so the case where data is required for both 800MHz/900MHz and 1800MHz sold together – further reducing the number of reference points. Telefónica views the approach of locking the minimum price for 1800MHz relative to that for 800MHz and 900MHz is unreliable and likely to produce an erroneous result. ComReg should set the 1800MHz minimum price independently. Telefónica also considers that, should ComReg persist with its relative benchmarking for 1800MHz that a more detailed analysis is required than has been done to date. It states that in selecting the lower end of the DotEcon range, ComReg is mitigating the risk of not getting the relativity analysis right. By way of example, it states that if ComReg used the ratio of 1:4 used by the Danish authorities in a recent auction, this would bring the price down to €5 million from €10 million. Telefónica speculates that in setting the relative reserve prices to match the proposed eligibility points ratio ComReg and Dotecon have lost sight of the fact that holding an auction is a means to an end, not an end in itself. It claims that it is not justifiable,

[49] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 49-50.

	under any of ComReg's objectives or obligations to charge a higher price for 1800 MHz spectrum simply to allow for "neat" auction set up on eligibility points, particularly when as Telefónica claims, the spectrum in question is acknowledged not to be substitutable so that any such switching is unlikely. Telefónica also takes issue with the blanket claim that the relative value of sub 1GHz and above 1GHz spectrum has remained constant (argued by Dotecon to justify the use of pre-2000 auctions). This, it claims is not sustainable, given the technology changes and the much greater range of spectrum bands now available for use. In particular, it states that the 800 MHz spectrum was not previously available for use, and the greater availability of sub-1GHz spectrum with its superior propagation characteristics must have an impact on the relative value of 1800 MHz, decreasing its value. Dotecon provides no data to justify this assertion. [50]

[50] Telefónica 'Release of the 800 MHz, 900 MHz and 1800 MHz radio spectrum bands - Comments on Document 11/60', page 54-55.

eircom Group	Eircom maintains that in the three multiband auctions in Europe (Germany, Spain and Italy) it is clear that none of the outcomes in respect of higher frequency spectrum value relative to 800MHz conform to ComReg's proposed relativity factor. The nearest outcome to ComReg's theoretical relationship it claims is the Italian auction (November 2011) in respect of the 1800MHz band. Here, it states that the 1800MHz outcome was 32% of the 800MHz outcome. As such it maintains that ComReg should amend its adjustment factor to no more than 30%.[51] Taking into account its position in respect of the Sub-1GHz minimum price and assuming the lower end of DotEcon's lower bound estimate, currently proposed at €15m, eircom Group believes the minimum prices cannot objectively be set higher than €15 million per block of sub-1GHz spectrum and €4.5million per block of €1800MHz. [52]
Vodafone	In response to ComReg document 11/75 Vodafone states its view that the proposed 1800MHz minimum price (at 50% of the proposed 800MHz and 900 MHz minimum prices) is based on a flawed valuation methodology and must be revisited. [53]

[51] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 18-20.

[52] 'eircom Group Response to ComReg Consultation Paper: Response to Consultation and Draft Decision – Multi-Band Spectrum Release Release of the 800 MHz, 900 MHz and 1800 MHz spectrum bands ComReg Document 11/60', 14 October 2011, page 19.

[53] 'Vodafone Response to the ComReg Consultation on the Multi-band Spectrum Release Draft Information Memorandum', November 2011, page 2.

Annex E DotEcon's response to stakeholder comments

E.1 Benchmark methodology and modelling issues

E.1.1 Respondents' views on the benchmarking methodology

106. Respondents in general disagree with the use of benchmarking to set minimum prices. They argue that it is difficult to make like-for-like comparisons to derive an accurate estimate of spectrum value in Ireland. In addition, Vodafone argues that ComReg is out of step with other NRAs that set low but non-trivial reserve prices.

107. An appropriate reserve price is driven by the objectives of the NRA in the auction, therefore, a market value reflecting reserve price is more appropriate than a low but non-trivial reserve price if a regulator had the objective to reduce the risks of tacit collusion particularly in low competition scenarios.

108. While we acknowledge that there is no perfect benchmark model, and benchmark estimates would consequently have a margin of error, we have set out to estimate a conservative lower bound value of sub-1GHz spectrum. We have iterated through out our report how we have adopted a conservative approach and our recommended range has been validated by relevant recent auction results as described in Section 4.1.

109. In addition, we note that the recent European auctions in Italy, Spain, Greece and Portugal have all set sub-1GHz reserve prices within our recommended range rather than opting for a low but non-trivial reserve price. Furthermore, the UK which is currently planning its multiband auction (including 800MHz), and Switzerland which has successfully concluded its multiband auction (including 800MHz) recently have also moved away from using low but non-trivial reserve prices towards reserve prices that reflect market value.

E.1.2 Respondents' arguments in favour of GNP

110. A number of the respondents' to ComReg's consultation document 11/60 and our updated benchmarking report 11/59 remain of the view that GNP better reflects domestic income and expenditure in Ireland and therefore they object to the use of GDP as an explanatory variable in our regression analysis. For example, Vodafone asserts that "it is the GNP level which reflects the income level of residents as measured by GNP per capita, with its direct implications for consumption patterns. This is therefore the relevant factor in the context of spectrum valuation and not the value of national output (GDP) – much of which may be attributable to foreign owners of factors of production located in the country."

111. Furthermore, eircom Group states that "expert economic analysts acknowledge that GDP is not the most appropriate variable to consider Ireland's domestic economy" and makes a reference to a Central Statistics Office report which acknowledges the divergence between GDP and GNP in Ireland.

112. GDP is used in our regression analysis as an explanatory variable of spectrum value. However, GDP is not used to derive our averages benchmarks. It is only

used to define the sample of countries with a certain level of GDP (i.e. GDP per capita lower than €20,000).

113. GDP is used in our regression analysis as it is a wide spread measure used to reflect domestic income levels in a wide range of applications. It is a reasonable metric for national income in cross-sectional analysis across countries, as well as a proxy for the level of development in a country. GDP data is generally more readily available than GNP given the more common use of GDP as a national output measure. Therefore, the quality of available GDP data is often better than GNP data and using GDP rather than GNP data would lower risks of measurement errors in our analysis.

114. We note however that in some countries such as Ireland and Luxembourg, there is a significant discrepancy between GNP and GDP, as pointed out by the respondents. We fully acknowledge that in the case of Ireland, GNP may more accurately reflect domestic income of residents than GDP does, as GDP may be inflated by the profits of multinational firms domiciled in Ireland, whereas the profits of Irish firms located abroad – which is included in GNP – may be much smaller. However, countries such as Ireland and Luxembourg where this is issue is significant are a small minority within our sample.

115. Further, demand for telecommunications arises from businesses as well as consumers. Therefore, it is far from clear that national income per head (better measured by GNP) is a stronger influence on demand than domestic economic activity (measured by GDP). Given that telecommunications is a service provided within the geographical bounds of a country and given the benefits of GDP generally as a more commonly used national output measure explained above, we maintain that it is more appropriate to use a measure of domestic economic activity as an explanatory variable in our main analysis, rather than national income as such. This argument suggests that GDP is a more appropriate explanatory variable than GNP for telecoms demand within the borders of a country, and hence spectrum value.

116. Nonetheless, to take into account the impact of using GNP instead of GDP as an explanatory variable, we have run an alternative version of our regression analysis using Gross National Income (GNI) as a proxy for GNP. GNP data across our sample is not available from the World Development Indicators database which is the source of our economic data. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. GNI is similar to GNP except that in measuring GNP, indirect business tax is not deducted.

117. The table below compares the predicted licence values for Ireland from our regression models when using GNI instead of GDP. Irish GNI per capita in 2011

is estimated at €26,865 (from the Central Statistics Office of Ireland)[54]. Note that this is approximately 21% lower than our estimate of GDP per capita of €34,128 in 2011.[55]

Table 28: GNI sensitivity analysis

	GDP per capita	GNI per capita
Global mobile	€17.8m	€17.3m
Europe	€7.98m	€6.7m
Sub-1GHz and 1800MHz	€9.14m	€14.5m

118. The use of GNI as an explanatory variable in our regression analysis rather than GDP lowers the predicted sub-1GHz spectrum value in Ireland for the *global mobile* and *European* samples as expected but increases it for the *sub-1GHz and 1800MHz* sample. Both the GDP per capita and GNI per capita coefficients are negative in the *sub-1GHz and 1800MHz* regression model. Therefore, applying a GNI that is lower than GDP as in the case of Ireland would result in a higher predicted licence value in the case of GNI relative to GDP. In the *global mobile* regression, the predicted licence price decreased by roughly 3% with the use of GNI where as in the *European* regression model this proportion is much larger at 23%.

119. The regression outputs of the *European* and *sub-1GHz and 1800MHz* samples are below our proposed range when GNI is used. However, the predicted spectrum value from the *global mobile* regression model (which we put most weight and focus on as the sample size is the largest, see paragraph 75) using either GDP or GNI falls within our proposed range of €15m-€26m. Therefore having considered the impact on using GNI rather then GDP, we do not find grounds to alter our recommended range of €15m-€26m.

[54] The GNI data for Q1, Q2 and Q3 2011 is taken from the IMF data summary page on the Central Office of Statistics website (source: http://www.cso.ie/en/statistics/imfsummarydatapage/). This is the only available estimates of Q1,Q2 and Q3 GNI from the Central Office of Statistics and is subject to revision. Given that only estimates up to quarter 3 2011 are available from the Central Office of Statistics we have estimated overall 2011 GNI for Ireland by assuming Q4 GNI at the average of Q1-Q3 levels i.e. GNI 2011 is calculated by taking the sum of (Q1(€30,336m) + Q2(€31,118m) + Q3(30,854m) + Q4(30,769)) = €123,077m. This is then divided by the latest estimate of Irish population (4,581,269) also from the Central Statistics Office of Ireland to obtain GNI per capita of €26,865.

[55] At the time of analysis, estimates for GDP up to quarter 3 2011 are available from the Central Statistics Office Ireland (source: Central Statistics Office Ireland document 'Quarterly National Accounts, Quarter 3, 2011', 16 December 2011 available at: http://www.cso.ie/en/media/csoie/releasespublications/documents/economy/2011/qna_q32011.pdf). These are estimates and therefore are subject to revision. Using this data we have estimated overall 2011 GDP for Ireland by assuming Q4 GDP at the average of Q1-Q3 level i.e. GDP is calculated by taking the sum of (Q1(€38,484m) + Q2(€39,682m) + Q3(€39,096m) + Q4(€39,087m)) = €156,349m.

E.1.3 Respondents' views on other data inputs

120. Eircom Group claims that "DotEcon appears to put more reliance on outcomes that exclude new entrant bidders…" and provides the following quote from the DotEcon 11/59 report:

> *"The existing mobile operators in Sweden constituted only three bidders in the auction with 2x30MHz of available spectrum and a spectrum cap of 2x10MHz per bidder. Hence, the marginal bidders driving competition in this auction were Com Hem and Netett Sverige, neither of which were established mobile operators in Sweden at the time of the auction. In contrast, the marginal bidder for 800MHz spectrum in the German auction, E-Plus, was an established mobile operator in Germany at the time of the German auction."*[56]

121. Eircom Group states that this bias in DotEcon's thinking is at odds with ComReg's objective of not precluding new entrant participation in the award process.

122. In DotEcon Report 11/59 we noted that the Swedish 800MHz auction-band average price is below our recommended range, and sought to explain the reasons why the average price was lower than our recommended range. We noted several good reasons for not considering that the Swedish 800MHz auction is fully reflective of the competitive market value of sub-1GHz spectrum comparable with that which will be available in the proposed multi-band auction in Ireland.[57]

123. One of the reasons for the lower average price in the Swedish auction in comparison to other auctions, such as the German auction, was the fact that the marginal bidders were entrants. Other reasons include the presence of aggregation risks in the auction causing a 'cheaper edge block' effect and the fact that H3GI actually paid more for its 2.6GHz spectrum in the Swedish auction held in 2008 than its 800MHz spectrum. In addition, in taking into account the Swedish 800MHz auction results, we had in any case reduced the lower end of our recommended range (from €18m previously in 10/71b to €15m) on account of the lower predicted licence price from our *European* regression model. Therefore our analysis is not biased in favour of auctions that exclude new entrants.

E.2 The Irish Economy and a conservative approach

E.2.1 The Irish Economy

124. Telefónica claims that not enough account has been taken of the current state of the Irish economy and the impact it will have on valuations. According to Telefónica, all expert analysis states that the Irish economy will continue to

[56] Quote taken from DotEcon Report 11/59 paragraph 124.

[57] See paragraphs 119-127 of DotEcon Report 11/59.

struggle for several years, with the current unprecedented uncertainty making it impossible to obtain a consensus prediction for recovery. In Telefónica's view ComReg must accept that consequentially the current difficult circumstances of the Irish economy will have a significant impact in reducing bidder valuations. Telefónica believes that it has not been adequately taken into account in the benchmarking report (Document 11/59). Telefónica argues that none of the auctions included in our previous benchmark took place in countries undergoing a recession of the severity and length of that in Ireland, and therefore it claims they cannot be taken as a substitute for taking into account the actual state of the Irish economy.

125. In each of our benchmarking reports we have updated our analyses with results of auctions that have taken place recently, reflecting the current economic climate in Europe and have also used most up to date demographic and economic data available to us. In this report for instance, we take into account auctions recently concluded in Portugal, Spain, Italy and Greece that have taken place under an economic climate comparable to that in Ireland at present and thus inform on the valuation of spectrum in countries undergoing a recession. We note that tour predicted prices in this report has been depressed relative to our estimates in Report 11/59.

126. Considering our estimated licence values, we have maintained our recommendations (from Report 11/59) on suitable minimum prices for the upcoming Irish auction. We note in fact that the auctions in Portugal, Spain, Italy and Greece have set reserve prices within or over our recommended range. In fact, Greece used identical minimum prices (adjusted for Greek population) to those proposed by ComReg in Draft Decision Document 11/60 and awarded all available lots in its auction.

127. Telefónica also states that DotEcon emphasises the long term nature of the licences and argue that therefore the transient component of shifts in GDP should not have much effect on the value of long-lived assets. This according to Telefónica ignores the fact that the bulk of the valuation of spectrum is based on their short term value, given the impossibility of predicting the state of the telecommunications market over a longer period.

128. To our knowledge, there is no conclusive evidence that consumption of telecommunications services are particularly sensitive to changes in income levels. In particular, ComReg notes that there has been a year or year growth in date volumes in the Irish data market despite the recession. Therefore, as we have mentioned in earlier benchmarking reports, it is important to recognise that radio spectrum licences are long-run assets whose value should be expected to change less than proportionately with changes in contemporaneous GDP. Therefore the transient component of shifts in GDP should not have much effect on the value of long-lived assets. The long-term nature of these licences means that operators will base their valuations on the revenue stream of these licences throughout the term of the licence. We do not expect Irish GDP to be decreasing throughout the 15 year period of the licence and therefore we do not consider that it is appropriate to depress the minimum prices further than what is required to reflect the current state of the Irish economy which we have already taken into account.

E.2.2 Conservative approach

129. The benchmark models used in our previous analyses and even more so in our current analysis produce conservative estimates of the market value of liberalised spectrum in the upcoming Irish auction. As set out previously in paragraph 13 above, our approach to finding a conservative estimate includes:

a) Using the average value of all mobile frequencies as a conservative lower bound estimate for sub-1GHz value. Sub-1GHz, being prime spectrum for mobile telephony applications, should be worth more than an average of different mobile spectrum bands.

b) Using a mix of liberalised and unliberalised mobile licences in our sample. Liberalised spectrum should entail a premium given the greater flexibility. Our estimates should therefore be a conservative estimate of the value of liberalised sub-1GHz spectrum.

c) In our Spectrum Awards Database, we have only included information on annual fees where this information is available. Therefore, there may be licences for which annual licence fees are applicable that we have not accounted for. As a result, our estimates may underestimate the actual overall amounts paid for spectrum (upfront price paid in an auction plus the stream of annual fees over the term of the licence).

d) The proposed coverage obligations for the licences to be auctioned by ComReg are relatively modest as opposed to other auctions, particularly when compared with the coverage obligations of 800MHz licences across Europe that have been ear-marked to improve broadband availability in rural areas. Therefore, the average value of 800MHz auctions across Europe should provide a reasonable lower bound estimate to sub-1GHz spectrum in Ireland.

e) In this report we have adopted a conservative Purchasing Price Parity (PPP) rate to convert prices from USD to euro in 2011 that is 5% lower than the PPP rate for 2011 (see Section 2.2.1).

130. In addition, specifically in this report, we have modified our approach relative to our earlier reports in how we define relevant samples of data for the band specific samples. This results in the exclusion of some outliers, which should then in turn yield a more precise, but still conservative estimate of spectrum value for the band specific benchmarks (see section 2.2.2). This is possible with the greater amount of more relevant benchmark data now available.

131. Therefore, to a larger extent than our previous reports, our estimates in this report should yield *conservative* lower bound estimates for sub-1GHz spectrum.

132. We consider that the merits of using benchmarking to identify a conservative lower bound estimate of licence value are greater than the alternative methods proposed by a number of respondents such as a low but non-trivial minimum price and a benchmark of minimum prices. We considered these

two alternative approaches in DotEcon Report 11/59 and previous documents.[58]

E.3 Collusion issues and minimum prices

133. As mentioned in our previous reports one of ComReg's objectives for the auction is to balance the risk of tacit collusion with the risk of choking off efficient demand. In particular, the auction rules and minimum prices should not incentivise tacit collusion or strategic behaviour. In line with this objective it is important to set minimum prices that would not create the incentive for bidders to collude. While the auction format and other aspects of the auction as pointed out by Vodafone and Telefónica in their responses to ComReg Document 11/60 should go some way towards minimising the risk of tacit collusion, there is no reason not to set a minimum price that would further discourage strategic behaviour so long as the risk of choking off demand is managed.

134. In this respect Telefónica claims that ComReg's emphasis on tacit collusion concerns "stands out amongst other NRAs which have not seen a requirement to elevate the issue to such an extent". However as noted in our previous documents whilst NRAs had in the past set reserve prices at a low but non-trivial level they are moving away from this approach to one that is in line with a conservative estimate of market value. As mentioned above the Greek NRA is an example but there are also others such as the Portuguese NRA which set its 800MHz spectrum reserve price within our proposed range (although it set 900MHz spectrum below our proposed range). Furthermore, the Italian NRA chose reserve prices at the upper end of our range whilst the Spanish NRA chose a common minimum price for sub-1GHz spectrum at the lower end of our range. Therefore our minimum prices have been in line with those of other European NRAs in similar recent awards across Europe. These awards have been successful and evidence suggests that demand has not been choked off. This trend is set to continue in upcoming auctions with Ofcom, the UK NRA, stating, in its consultation on the upcoming UK 800MHz and 2.6GHz auction, that it is considering setting reserve prices that reflect the market value of spectrum so as to manage strategic incentives of potential bidders.[59]

135. We have set out to recommend a minimum price that conservatively reflects market value therefore the risk that efficient demand is choked off at this minimum price is low (see Sections 1.2 and 4.2.2). As discussed above, this is in line with practices of other NRAs across Europe. On the other hand, there is arguably greater uncertainty over the extent to which the risk of tacit collusion is eliminated with the proposed auction format and rules. Given the low risk of

[58] See Annex D of DotEcon Report 11/59 and paragraphs 480-487 and 471-475 in Part C of DotEcon Report 09/99c for a discussion of the recent trends away from setting low but non-trivial minimum prices and why setting a low but non-trivial or benchmark of minimum prices would not be appropriate in Ireland.

[59] Ofcom, 'Consultation on assessment of future mobile competition and proposals for the award of 800MHz and 2.6GHz spectrum and related issues', 22 March 2011.

choking off demand, it would be appropriate that the minimum price be set to reflect market value in order to guards against the risk of tacit collusion in low competition scenarios.

136. Further, in response to the issue of tacit collusion Telefónica also argues that the lower winner to bidder ratio of 0.77 used in our last analysis (11/59) contradicts, *"the entire tacit collusion argument [which] is based on the assumption that the auction will not be competitive."* The winner to bidder ratio used in our last analysis (11/59) was lower than the previous winner to bidder ratio used because it reflected the winner to bidder ratio in the data sample. We consider that it is appropriate to use the sample winner to bidder ratio as we can not prescribe what the actual level of competition in the auction might be and to do so would be speculative. We have been consistent with our approach to set the winner to bidder ratio for Ireland to the sample average throughout our reports when predicting licence value. The fact that the sample average winner to bidder ratio has decreased from our previous reports purely reflects the increasing competitiveness of auctions within the sample. Using the sample's mean winner to bidder ratio allows us to derive what the mean spectrum value is with average auction competitiveness.

137. Furthermore, in our last benchmark report (11/59) we considered different levels of competition within the auction – including a non-competitive outcome with a winner to bidder ratio of 1- and set our range of minimum prices accordingly.[60]

E.4 Relative benchmark for 1800MHz

138. In the responses to the ComReg's Consultation document 11/60, both Telefónica and eircom group expressed concerns about the reserve price proposed and methodology used to recommend the reserve price of 1800MHz spectrum in the upcoming auction. Both Telefónica and eircom Group consider that ComReg's proposed reserve price for 1800MHz spectrum is too high and may choke off demand in the auction. In its response to ComReg document 11/75 Vodafone raises its concern with the 1800MHz spectrum valuation stating that it is "based on a flawed valuation methodology and must be revisited."

139. Telefónica argues that the reserve price for 1800MHz should be set independently rather than using the relative prices approach as it considers "locking the minimum price for 1800MHz relative to that for 800MHz and 900MHz is unreliable and most likely produces an erroneous result." Furthermore, Telefónica considers that the relative value of sub-1GHz spectrum such as 800MHz and 1800MHz will have changed over the years "given the technology changes and the much greater range of spectrum bands now available for use. In particular, 800 MHz spectrum was not previously available for use, and the greater availability of sub-1GHz spectrum with its superior propagation characteristics must have an impact on the relative value

[60] See paragraphs 98-101 of DotEcon Report 11/59.

of 1800 MHz, decreasing its value." Thus Telefónica considers that our analysis of relative prices, which contains pre-2000 auctions, is not representative of the likely prevailing relative prices and overestimates the relative value of 1800MHz spectrum.

140. Eircom Group on the other hand does not object to the relative price approach used to set the 1800MHz spectrum reserve price however it considers that the relative price should be set at a lower point of 30% as opposed to 50%. Eircom group presents data from three auctions in Europe (Germany, Spain and Italy) to make its case that the relative reserve price for 1800MHz spectrum should be no more than 30%.

141. Our proposed methodology to setting the minimum prices in the upcoming Irish auction has always been to derive a conservative lower bound to market value that would ensure that minimum prices set within this range would have relatively low risk of choking off demand in the auction. The recommended sub-1GHz spectrum minimum price is conservative for a number of reasons outlined in Section 1.2. One main reason is that the average value of all mobile frequencies is used in the benchmarking analysis and sub-1GHz spectrum should be worth more than the mobile spectrum on average due to its superior propagation characteristics.

142. However, whilst sub-1GHz spectrum may be more valuable than average mobile spectrum, the same argument may not hold true for 1800MHz spectrum as it does not necessarily offer superior technical characteristic relative to other frequency bands. Thus if we had applied the same methodology as we used for our sub-1GHz analysis, this would have produced a central estimate of the market value of 1800MHz spectrum rather than a conservative lower bound estimate.

143. In addition, in Report 10/105a, we noted that the relative prices within the auction should not distort bidders' choice between spectrum hence the 1800MHz reserve price should in some way take into account the differences between the likely value of sub-1GHz and 1800MHz spectrum. We also acknowledged that including the 1800MHz band in a joint auction creates additional uncertainty that may need to be reflected in a more cautious approach to setting the level of minimum prices.

144. As a result of these considerations and concerns we decided to adopt the approach of determining an appropriate minimum price for 1800MHz spectrum by using auction data to estimate the relative value of 1800MHz to sub-1GHz spectrum which we then apply to the conservative estimate of sub-1GHz spectrum. This approach allows us to set minimum price for 1800MHz spectrum on a similar conservative lower bound basis.

145. Based on the results from our analysis in 10/105a and maintained from our analysis in 11/59 we recommend that the minimum price of 1800MHz spectrum be set between 45% to 60% of the proposed sub-1GHz minimum price. Thus we recommended that the minimum price for 1800MHz spectrum be set within a range of €6.75m - €15.6m.

146. In Section 3.2 we have established why it is appropriate to maintain our recommended price range in light of new auction data that has become available. We believe that newly available data suggest an upward revision of

the upper bound of our proposed range. Nonetheless we do not deem this to be appropriate. In addition, we note in Section 4.2.3 above that central estimates of 1800MHz spectrum has confirmed that our propose minimum price range for 1800MHz is conservative.

147. In addition, current trends suggest that 1800MHz will become increasingly more valuable given the band's increasing prominence as a LTE band. Recent evidence of technological developments in LTE deployment suggests that 1800MHz spectrum will play a vital role in LTE deployment. For example, a recent report by the Global mobile Suppliers Association (GSA) estimates that deploying LTE in the 1800MHz band can be as much as 60% cheaper than covering the same area with LTE using higher frequency bands. The report[61] concludes that from a practical, economic and business perspective 1800MHz will emerge as a prime band for LTE deployments in virtually all regions of the world, and be important for international roaming. Thus the inclusion of higher frequency bands and older 1800MHz spectrum auctions - which are therefore likely to have resulted in lower values for 1800MHz spectrum compared to more recent auctions for this spectrum - within the data set for benchmarking sub-1GHz spectrum further supports a conservative estimate of 1800MHz spectrum.

[61] Innovation Observatory for the GSA, 2011, *Embracing the 1800MHz opportunity: Driving mobile forward with LTE in the 1800MHz band*.