

Spectrum Benchmarking - additional information provided to Ofcom arising from a meeting 3rd May 2013 between Ofcom and Vodafone

In this document we supply, as requested, information that we possess in relation to the auctions of those countries discussed at the meeting where 800MHz and 900MHz spectrum was simultaneously auctioned, to identify the apparent price relativities between the two bands in those countries. As also discussed, due to confidentiality restrictions on private data that is only available to Vodafone as a result of our participation in some of these auctions, not all of the information can be publicly disclosed – such limitations are identified on a country by country basis below.

We preface this data with a brief discussion on the limitations of benchmarking.

Benchmark limitations

The acknowledged wide spread of international auction outcomes is one of the factors that limits the usefulness of international benchmarking to significantly aid the understanding of underlying long-run spectrum value for non-auctioned spectrum in the UK, particularly when the data has been taken from an extended time series. The wide spread of auction outcomes clearly indicates the strength of local factors in driving the prices.

International benchmarking is difficult particularly for 900MHz, since whilst there have been several auctions of 1800MHz spectrum either with or without auctions of 800MHz spectrum, there have been comparatively few examples of 900MHz spectrum auctions that have been simultaneous with 800MHz auctions.

There is always a substantial difficulty in translating auction outcomes from one country into the context of a different country's market value. A variety of different variables may have an impact on the local outcome for a particular band in a particular auction. These variables may then differ from their equivalent values in the UK. Unless the specific local context is understood, the data cannot be readily or usefully imported into the UK. Some of the local variations include: the existing and prospective mobile market conditions (competition, margins, traffic density, existing spectrum holdings etc.), the mix of spectrum being auctioned, the auction conditions (caps, reserve prices, type of auction, coverage requirements, reserved spectrum etc.) and how recently the auction was undertaken.

At the very best the international data can be used to suggest possibilities of relative valuation rather than of absolute valuation, but the data will still suffer with respect to the fact that any international comparison made will be between bands that have been simultaneously auctioned, whereas clearly that does not apply to, for example, any comparison between 800MHz and 900MHz that may be made in the UK. Here any long run 900MHz valuation can only be made on the basis of the spectrum holdings that have arisen as a result of the auction, rather than from the pre-auction position. In the UK it is clear that the mobile operators all now have, as a result of the auction, sufficient spectrum be it 800MHz, 1800MHz or 2600MHz to launch their 4G services and to provide national coverage – this obviously has an impact on the value of the non-auctioned spectrum.

Benchmark Data

Ireland

1. ComReg has published the following data from the 2012 spectrum auction. Bidders won slightly less in the short-term 1800MHz licences, but we will ignore that additional complication. The “Price” column does not include annual licence fees, as these were fixed in advance by the regulator (and not discovered by the auction).

| | 800MHz | 900MHz | 1800MHz | Price (€) |
|----------|--------|--------|---------|-----------|
| H3G | | 2x5 | 2x20 | 51.14m |
| Meteor | 2x10 | 2x10 | 2x15 | 144.78m |
| O2 | 2x10 | 2x10 | 2x15 | 124.93m |
| Vodafone | 2x10 | 2x10 | 2x25 | 160.85m |

To allocate prices by band, a natural approach is to try to fit a linear model. Let a be the price of 2x5 at 800MHz, b be the price of 2x5MHz at 900MHz, and c be the price of 2x5MHz at 1800MHz. We can then model:

$$\begin{aligned} \text{H3G:} & \quad \text{price} = b + 4c + e_1 \\ \text{Meteor:} & \quad \text{price} = 2a + 2b + 3c + e_2 \\ \text{O2:} & \quad \text{price} = 2a + 2b + 3c + e_3 \\ \text{Vodafone} & \quad \text{price} = 2a + 2b + 5c + e_4 \end{aligned}$$

...where the e_i are “error” terms (accounting for variations in bidder skill, 1800 short-term and liberalization prices, assignment fees and so on).

If we minimize the sum of squares of the errors (“least-squares”), then this has a unique solution. However it is a peculiar one:

$$\begin{aligned} a &= \text{€}48.78\text{m (price of 800MHz licences)} \\ b &= \text{-€}0.85\text{m (price of 900MHz licences)} \\ c &= \text{€}13.00\text{m (price of 1800MHz licences)} \end{aligned}$$

According to this “best fit”, ComReg were not just giving the 900MHz away; they were paying bidders to take it! Clearly that does not make much sense.

2. A more careful analysis takes into account some of the particular auction rules, especially the caps and the second-price rule, and the fact that only *one* of the 900MHz licences was effectively free to each bidder. This is because if any individual bidder is excluded from the auction, the others win six 800MHz and six 900MHz licences, leaving one of the 900MHz licences unsold. Hence each bidder pays an opportunity cost of zero to win one of their 900MHz licences, and pays a relatively expensive opportunity cost b' to win a second. The model then becomes like this:

$$\begin{aligned} \text{H3G:} & \quad \text{price} = 4c + e_1 \\ \text{Meteor:} & \quad \text{price} = 2a + b' + 3c + e_2 \\ \text{O2:} & \quad \text{price} = 2a + b' + 3c + e_3 \\ \text{Vodafone:} & \quad \text{price} = 2a + b' + 5c + e_4 \end{aligned}$$

Unfortunately, this time the model does not have a unique least-squares solution: we can identify the price paid for 1800MHz, and the price paid for 800/900MHz together, but we cannot split apart the relative contributions of 800MHz and 900MHz:

$$2a + b' = \text{€}96.53\text{m} \text{ (price of two 800MHz licences plus one "expensive" 900MHz licence)}$$

$$c = \text{€}12.82\text{m} \text{ (price of 1800MHz licences)}$$

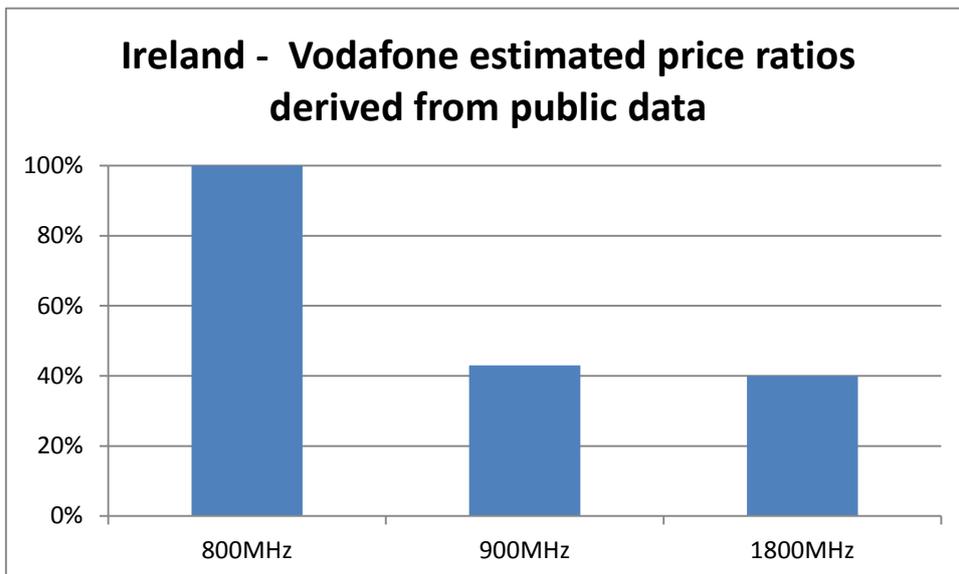
3. One approach to resolve this is to assume that the price for the "expensive" 900MHz block was roughly the same as the price for an 800MHz block, so that $a=b'$. This allows us to solve with $a = b' = \text{€}32.18\text{m}$.

From this it follows that the price paid on average for a 900MHz block would be $b = 3/7 \times b' = \text{€}13.8\text{m}$ (because three of them sold at b' and four went for free). This gives a 43% ratio for price 900MHz: price 800MHz and a 40% ratio for price 1800MHz: price 800MHz.

4. Another approach is to compare the ratios of clock prices at which demand matched supply. This is not public data: however Comreg have given Vodafone permission to outline our best estimate of the price ratios that can be derived from this data. We do so below showing on a single chart both the view that can be obtained from the publicly available data from the above calculations and **on a confidential basis** Vodafone's best estimate that can be made from the confidential data and would refer Ofcom to ComReg if they wish to verify this analysis.

[REDACTED CONFIDENTIAL INFORMATION]

For Ofcom's convenience we show below the view from the public data only:



Netherlands

The Netherlands spectrum auction took place in Q4 2012. The auction, which included the 800, 900, 1800, 2100 and 2600 MHz bands, led to payments totalling €3.8 billion. Contrary to the UK, specific information on the prices per band is not available, as details of bids made during the auction will not be made public.

Below please find the public data that does exist regarding the outcome of the Dutch auction.

| <i>Number of Licenses</i> | 800MHz Rsrvd | 800 MHz | 900 MHz | 1800 MHz | 2100 MHz | 1900 MHz | 2600 TDD | Total Payment |
|---------------------------|--------------|---------|---------|----------|----------|----------|----------|----------------|
| <i>Available</i> | 2 | 4 | 7 | 14 | 2 | 1 | 10 | |
| Vodafone | | 2 | 2 | 4 | 1 | | | €1,380,800,000 |
| KPN | | 2 | 2 | 4 | 1 | | 5 | €1,351,852,000 |
| T-Mobile | | | 3 | 6 | | 1 | 5 | €910,681,000 |
| Tele2 | 2 | | | | | | | €160,813,000 |

Unlike in Ireland, it is not possible to fit a useful linear model to this data (there are too many price variables, too few data points, and the spectrum reservation complicates the 800MHz pricing). In the absence of detailed bid information we can use the publicly available analysis of New Street Research to give a high level view of relative valuation:

| Price/MHz.pop (US\$) | 800MHz | 900MHz | 1800MHz | 2.0GHz FDD | 2.0GHz TDD | 2.6GHz TDD | Total |
|-------------------------------|--------|--------|---------|------------|------------|------------|-------|
| KPN | 2.34 | 1.48 | 0.49 | 0.39 | | 0.19 | 0.88 |
| Vodafone | 2.45 | 1.56 | 0.58 | 0.39 | | | 1.19 |
| T-Mobile | | 1.64 | 0.29 | | 0.03 | 0.16 | 0.55 |
| Tele2 | 0.62 | | | | | | 0.62 |
| Overall | 1.80 | 1.57 | 0.43 | 0.39 | 0.03 | 0.17 | 0.82 |
| EU average price paid to date | 0.88 | 0.43 | 0.16 | 0.29 | 0.01 | 0.07 | 0.32 |
| Dutch premium | +105% | +265% | +169% | +34% | 165% | 147% | +157% |

Source: New Street Research estimates. Note that in a CCA auction bidders do not bid by band, but for different combinations of bands, so this breakdown is just one of many that could add to the same totals that were actually bid.

In terms of relative valuation the New Street Research table suggests that 900MHz might be considered to have approximately 65% of the 800MHz value.

This analysis also shows that the prices paid in the Dutch auction are much higher than the EU average and also much higher than would be expected based on bid history and patterns found in similar auctions in other countries. Vodafone has asked the Dutch government to carry out a detailed analysis into the auction design (including the reservation of 2 x 10 MHz in the 800 MHz band for a new entrant) and bidding behaviour in order to understand why prices were so extreme, but so far the government has declined to do so. Vodafone will continue its efforts to ensure a full inquiry into the auction takes place.

We thus regard the Netherlands auction as very much an outlier in absolute terms but it may be able to give some indication of relative values in a simultaneous auction between 800MHz and 900MHz.

Romania

The following public information is available from the 2012 auction. Our breakdown from the main auction is:

| Bidders | 800 MHz | 900 MHz | 900 MHz | 1800 MHz | 1800 MHz | 2600 MHz | 2600 MHz | Total Bid Value (M EURO) | Total Bid % increase vs. reserve price |
|---------------------|----------|-----------|----------|----------|-----------|----------|----------|--------------------------|--|
| Vodafone RO | 2 | 5 | 2 | 3 | 6 | 0 | 1 | 227.8 | 1.8% |
| Orange | 2 | 5 | 2 | 3 | 4 | 4 | 0 | 219.0 | 1.0% |
| Cosmote | 1 | 0 | 2 | 0 | 5 | 2 | 0 | 175.5 | 1.4% |
| RCS & RDS | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 40.0 | 0.0% |
| 2K Telekom | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6.6 | 10.0% |
| Total blocks | 5 | 10 | 7 | 6 | 15 | 6 | 3 | 668.9 | |
| Unsold spectrum | 1 | 0 | 0 | 0 | 0 | 8 | 0 | | |

| | Vodafone | Orange | Cosmote | RCS & RDS | 2K Telekom | TOTAL |
|--|----------|--------|---------|-----------|------------|--------|
| Total BID Value (MEuro) | 228.52 | 227.14 | 179.88 | 40 | 6.6 | 682.14 |
| Out of which: Assignment Value (MEuro) | 0.7 | 8.12 | 4.38 | - | - | 13.2 |
| Total Bid % increase vs. reserve price | 2% | 5% | 4% | 0% | 10% | |

From the second of these tables we can see that the final payments were at or very close to the reserve prices. We do not know the breakdown per band from the others' bids in the assignment round, but these bids are a fairly small percentage of the overall sum so we will ignore these for this analysis. So using the values from the main auction only and summing the values for the short and long term licences, this breaks down into the following prices paired 5MHz per band:

| Romania | 800MHz | 900MHz | 1800MHz | 2.6GHz | 2.6GHz (unpaired) |
|------------|--------|--------|---------|--------|-------------------|
| Price (€m) | 35 | 43.4 | 11.6 | 4 | 1.1 |

The auction results in Romania clearly reflect the reserve prices set by the regulator rather than any relative prices determined by bidding. This outcome therefore sheds no useful light on operator relative valuation between 800MHz and 900MHz.

Portugal

The 2011 auction in Portugal also ended at reserve prices. But in fact, one of the 900MHz lots remained unsold, even though a 25% discount was offered on this spectrum to a new entrant.

| | | | 800 2x5MHz | 900 2x5MHz | 1800 2x5MHz | 1800 2x4MHz | 2600 2x5MHz | 2600TDD 25MHz | Value (mEUR) |
|------------------------------|------|--------------------------------|---------------|---------------|----------------|----------------|----------------|------------------|-----------------|
| Round # | 9 | Total blocks | 6 | 2 | 9 | 3 | 14 | 2 | |
| | | Vodafone (PWBs) | 2 | 1 | 2 | 1 | 4 | 1 | 146,0 |
| Activity Level | 100% | Other MNOs (estimate) | 4 | 0 | 4 | 2 | 8 | 0 | 226,0 |
| | | New Entrants (estimate) | 0 | 0 | 0 | 0 | 0 | 0 | 0,0 |
| Waivers Available | 4/4 | Value of PWBs (mEUR) | 270,0 | 30,0 | 24,0 | 9,0 | 36,0 | 3,0 | 372,0 |
| | | Vodafone Price / Reserve Price | 1,00 x | 1,00 x | 1,00 x | 1,00 x | 1,00 x | 1,00 x | |
| Withdrawals Available | 5/5 | Avg Price / Reserve Price | 1,00 x | 1,00 x | 1,00 x | 1,00 x | 1,00 x | 1,00 x | |
| | | Demand / Supply | 6/6 | 1/2 | 6/9 | 3/3 | 12/14 | 1/2 | |

| Portugal | 800MHz | 900MHz | 1800MHz | 2.6GHz | 2.6GHz (unpaired) |
|------------|--------|--------|---------|--------|----------------------|
| Price (€m) | 45 | 30 | 3.9 | 3 | 0.6 |

This is a 67% ratio for price 900MHz: price 800MHz and an 8.7% ratio for price 1800MHz: price 800MHz.

Spain

In Spain, in 2011, the 800MHz band was awarded through an auction that also included 2600MHz and 900MHz spectrum. For 800MHz, 30MHz of paired spectrum was auctioned and sold in 2*5MHz lots, for an average of around €218m per lot. For 900MHz, one lot of 2*5MHz and one of 2*4.8MHz was offered. Only the former was purchased, for €169m, which was the reserve price. The implied discount was thus 78%.

Overview of European auctions

Summarising the information above to give relative auction prices per MHz indexed against 800MHz spectrum, we can see the following:

| | 800MHz | 900MHz | 1800MHz | 2.6GHz | 2.6GHz (unpaired) |
|--------------|--------|--------|---------|--------|----------------------|
| Ireland | 100% | 43% | 40% | | |
| Netherlands* | 100% | 63% | 24% | | |
| Romania | 100% | 124% | 33% | 11% | 6% |
| Portugal | 100% | 67% | 9% | 7% | 3% |
| Spain | 100% | 78% | | | |

* New Street Research. Assumed prices for Vodafone.

New Street also quote a European average price of 0.88 \$/MHz/pop for 800MHz, 0.43 \$/MHz/pop for 900MHz and 0.16 \$/MHz/pop for 800MHz (excluding NL and UK). This might suggest a relative 800/900MHz auction valuation of around 50%.

The fact that there is such a range in the ratios between the different bands in different auctions highlights the difficulties in using such benchmarks. Clearly the Romanian result, driven by the structure of the reserve prices, is an outlier and should be disregarded. There would seem however to be a general indication that where 900MHz and 800MHz are sold simultaneously in auction, 900MHz would appear to have been sold at a considerable discount to 800MHz.

Vodafone Ltd
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