Telefónica

Rebuttal of the mobile internet prices analysis using the incremental gigabyte

April 2015

SR Solchaga Recio
& asociados

CONTENTS:

SR

Executive Summary.

The aim of this analysis is the rebuttal of the conclusions of the reports published in the website Digital Fuel Monitor on the evolution of mobile Internet prices, since, as proved in the study, an erroneous methodology is employed.

The theoretical analysis links two clearly separated concepts, price levels of a carrier (traditionally measured by baskets) and price changes based on data volume (the metric price per incremental gigabyte). This conceptual confusion leads to inconsistent results as compared to the mobile Internet market reality and can lead to seriously misleading claims.

To observe these inconsistencies three specific examples extracted from real market studies are presented in this report. Applying their very same methodology we find that:

1. Following the introduction of the new price plan with more data and a lower price per gigabyte, this methodology would claim that the carrier has **increased its prices**.

2. The simplification of a tariff structure with reduced prices and an increase in the volume of data would lead to a **price increase**.

3. If we compare two carriers within the same country, where one of them is indisputably cheaper than the other, applying this methodology we would find that the carrier with lower prices is **more expensive**.

These results are due to the fact that when it takes the slope of the line as a measure of price comparison, is not the price level of a carrier per se, but rather the variation in the latter's prices in response to changes in the number of gigabytes provided as part of the different price plans.

In view of the methodological limitations, it is evident that the use of price per incremental gigabyte as a yardstick against which to compare prices is not methodologically sound and is in no way representative of reality.

1.   Introduction.

For some time now, Digital Fuel Monitor (DFM) has been conducting price analyses in the mobile telephony market in different countries of the European Union and the OECD and has typically found rising prices, especially in those countries where markets have consolidated.

Since the beginning, the DFM has generated much controversy. In this sense, several previously published reports have highlighted the weakness of the methodology used and the fragility of the segmentation and classification criteria of carriers and countries.[1]

Although DFM has partially taken into account the criticisms and has performed methodological changes, it continues to maintain a provocative communication strategy, which can be observed in several of their headlines. For example, in one of its most recent reports,[2] it claimed that Drillisch prices in Germany had risen by 138% since the merger of Telefónica and E-Plus and that O2's prices in that same country had increased by double digits during the same period.

Such statements are as surprising as they are inaccurate in view of the evolution of mobile internet prices in Germany. That is why Telefónica S.A. approached the consulting firm Solchaga Recio & asociados to conduct an analysis of the methodology used by DFM to calculate these changes in mobile internet prices.

The methodology used is publicly available and can be found on DFM website. It is based on the study of a metric called "price per incremental gigabyte". It analyses products that include mobile broadband with unlimited voice and SMS text messaging (at least 1,000 minutes and 1,000 national SMS messages) as its point of reference for this measurement.

This report describes how this metric is made and draws attention to the **conceptual inconsistencies** in its definition rendering it invalid as an indicator of price level or change over time, and how it detracts from the scientific rigour of the results published.

---

[1] These aspects have been highlighted in the reports published by Communications Chambers (Kenny, R. & Broughton, T. (2013). A critical analysis of the Rewheel paper: EU27 mobile data cost competitiveness report) on June 17, 2013 and, subsequently, by Frontier Economics for GSMA (Assessing the case for in-country mobile consolidation).

[2] "*Drillisch, the MVNO that helped clear Telefonica's acquisition of E-Plus in Germany raised mobile internet gigabyte prices by 138%".*
http://dfmonitor.eu/insights/2015_feb_premium_drillisch/

2. Analysis of "average price per incremental gigabyte" as a measure of price level in mobile internet access.

2.1. Traditional measurement of price levels.

Comparing price levels between different markets or points in time is a complex task which has its limitations. Many factors affect the evolution and makeup of prices. On the supply side, we have variations in production cost of the goods or services offered and differences in business strategy or specific business objectives. On the demand side, prices fluctuate according to the importance or utility that consumers attribute to a good or service. These considerations point to the importance of defining a methodology that optimally evaluates the evolution of commodity prices.

Indexes based on predefined baskets of commodities are generally used to measure price changes.[3]

The Consumer Price Index (CPI) is an example of a methodology based on baskets of products and services that is commonly used to measure prices in order to monitor changes in the cost of living in countries around the world.[4] CPI is calculated by using surveys to define the basket of goods and services most important to the average consumer and then applying a weighting system corresponding to the relative importance of each group of products and services. Thus, when comparing a fixed basket of goods and services at two different points in time, the quality of those goods and services remains constant and the price index only measures changes in price.

Another example could be the stock market indexes to measure the real time evolution of stock prices. These indexes are defined by brokerage firms mostly taking account the liquidity and the volume of stocks traded.[5]

While this is an established and generally accepted methodology used to identify price variations, it is not exempt from difficulties. Possible bias arising from substitution (baskets do not reflect consumer reactions to changes in relative prices), the introduction of new services or unmeasured changes in quality can all be limiting factors when considering the cost of a service.

---

[3] See: International Monetary Fund (2006), the Consumer Price Index Manual: Theory and practice (https://www.imf.org/external/pubs/ft/cpi/manual/2004/esl/cpi_sp.pdf); J.Barro Robert (1997), Macroeconomics; Oliver Blanchard (2000), Macroeconomics; and N. Gregory Mankiw (2011), Principles of Economics.

[4] INE (National Statistics Institute). 2012. Consumer price index. Basis 2011. Note regarding methodology. (http://www.ine.es/metodologia/t25/t2530138.pdf). Similar calculations are used in the other EU countries. See Eurostat's Methodological Note.
(http://ec.europa.eu/eurostat/cache/metadata/EN/ei_cp_esms.htm).

[5] Sociedad de Bolsas, S.A. (2015). Rules and calculation of IBEX indexes.

However, it is important to draw attention to the fact that **the methodology followed is not based on baskets of products**, as it does not result in an absolute measure as will now be shown and therefore is completely divorced from the nature and purpose of this procedure.

2.2. Methodology followed by DFM*: Description of incremental gigabyte and price calculation.*

DFM's methodology uses price per incremental gigabyte as the main unit of measure for mobile broadband prices, considering it comparable to kWh (kilowatt-hour) which is the main unit of measure for prices in the electricity sector and generally serves as the basis for price comparisons.[6]

Pricing in the electricity sector is typically divided into two parts: a fixed part dependent on aspects such as contracted power, and a variable part per kWh consumed.[7] The variable part according to the incremental gigabyte terminology would be "price per incremental kWh".

However, the mobile Internet pricing structure is different from the two-part electricity tariff and usually consists of a fixed monthly fee which includes voice minutes, SMS messages and a limited volume of gigabytes. Most operators offer the possibility of purchasing additional gigabytes. For example in Spain, Yoigo offers its post-pay customers the possibility of adding 1GB for a monthly fee of € 6.[8] Similarly, for all of its post-pay plans Orange offers the possibility of adding 100 MB for € 1[9] while Tuenti Mobile offers an additional 300 MB for € 3, 500 MB for € 5 or 1 GB for € 8.[10]

This would be the price per incremental gigabyte according to the example of pricing in the electricity sector. An average price per incremental gigabyte could then be calculated from this incremental price with the proper weighting. However, the relevance of this calculation as an indicator of mobile internet prices is doubtful, given the limited number of users who actually contract this additional gigabyte over and above the basic plan.

---

[6] *"It is the smartphone and data-only tariff plans offered by mobile operators that are becoming the prime fuel of the internet economy. Thus the digital fuel price (€/GByte) is becoming as central metric to the competitiveness of the internet economy, as the energy price (€/kWh) is to the competitiveness of the conventional economy."* http://dfmonitor.eu/about/

[7] See the Annex appended hereto for a more detailed description of pricing in the electricity sector in Spain.

[8] http://www.yoigo.com/tarifas/tarifas-de-contrato/

[9] http://movil.orange.es/tarifas/?utm_source=orange&utm_medium=telco&utm_term=tarifascontrato&utm_content=pestanacontrato

[10] https://www.tuenti.com/movil/soporte/entrada?id=30135113

In any case, **this is not how DFM calculates what they call "price per incremental gigabyte"**.

The methodology of price per incremental gigabyte is based on a simple linear estimate using Ordinary Least Squares (OLS). The variables are the different prices for different data volumes (in €/GB) of each of the tariff plans. This method uses plans that include mobile broadband with unlimited voice and SMS text messaging (at least 1000 minutes and 1000 national SMS messages) as a yardstick.

Thus, the price per incremental gigabyte is the coefficient associated with the slope of the regression line.

Graph 1. Price per incremental gigabyte methodology.
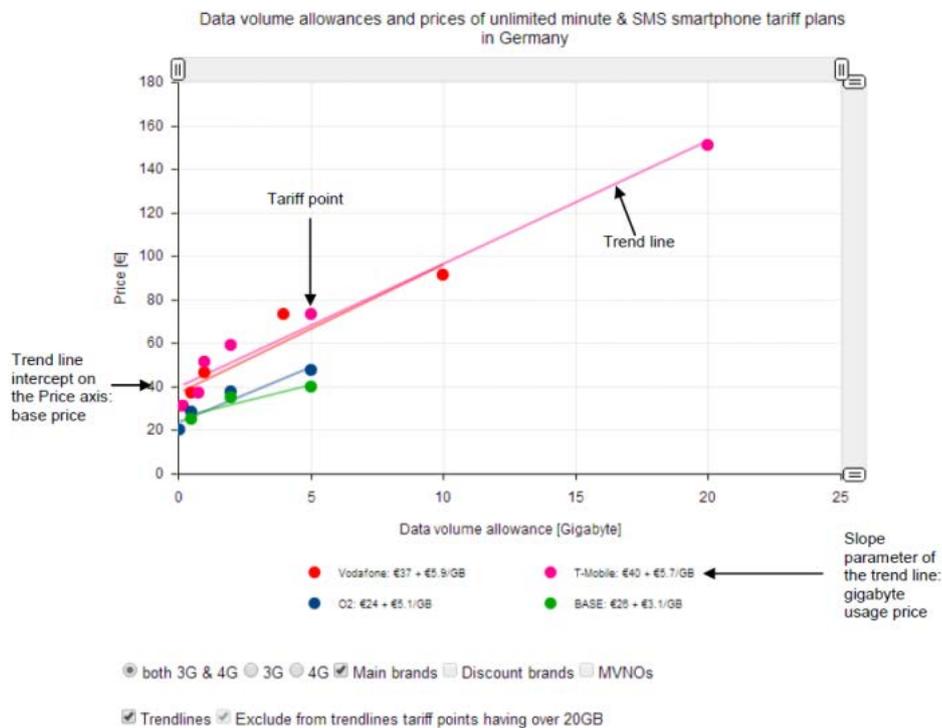
Source: Digital Fuel Monitor.

As we can see, price per incremental gigabyte is an expression of how prices change in response to a variation in the number of gigabytes offered by the different carriers and not a price level itself, as it would be in the case of electricity billing through €/kWh.

Apparently, the rationale behind equating that ratio to average price per incremental gigabyte lies in the comparison with the electricity tariff structure described above.

Graph 2. Mobile Internet Pricing vs. Electricity Sector Pricing.

y	=	a	+	b	·	x
Mobile Internet Price	=	Fixed part	+	Incremental gigabyte	·	GB consumed
Price electricity sector	=	Power contracted	+	Energy unit (€ / kWh)	·	kWh consumed

Source: Created in-house.

Before turning to the more fundamental critique of the methodology in the next section, it is important to draw attention to a critical aspect thereof: whereas in the electricity sector the price per incremental kWh forms part of the conditions of the product purchased by the consumer, the method uses different products in its calculation of the price per incremental gigabyte. While price per kWh is an existing measure that is accessible to consumers (they pay a fixed amount and a variable amount depending on kWh consumed), price per incremental gigabyte is a virtual, non-existent measure which makes no sense from the customer's viewpoint as it is calculated by combining independent non-combinable products.

2.3. Criticism of price per incremental gigabyte methodology.

DFM calculates incremental price (€/GB) by using an array of points plotted on a graph representing the mobile internet rates of each company based on price and gigabyte volume offered. With that, it calculates a regression line through those plotted points. Once the regression line is established, it then calculates price per incremental gigabyte from the slope of the line.

This is not an effective way to measure the concept they are trying to calculate, let alone to analyse or compare competitiveness between carriers or countries, as it lacks a solid mathematical basis upon which to accurately compare a rise or fall in mobile broadband prices.

Broadly speaking, the price comparison proposed consists of comparing the slopes of the regression lines obtained from the constellation of points representing the offers made by a carrier at a given point in time with those of the same carrier at a different

point in time or those of another carrier at the same time.

This method would do the following to calculate an alleged price increase of a carrier in the market:

1) Calculate the slope of the regression line based on the carrier's prices at an earlier baseline point.

2) Calculate the slope of the regression line based on the carrier's prices at a later point.

3) If the slope rises, it assumes that prices are rising; if the slope falls, it assumes that prices are falling.

Also, to compare price levels in countries, incremental gigabyte methodology calculates the slope of the regression line for each carrier and then assigns a weight to the different prices per incremental gigabyte obtained based on market share to give the average price in the country.

The following theoretical discussion will show that his method is flawed.

In general terms, let's suppose that $P(x_1, y_1)$ and $Q(x_2, y_2)$ are two points on a line. Based on these two known points, it is possible to determine their equation. Under these conditions, any point R (x, y) of the line meets the following,

$$m_{PQ} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m_{PR} = \frac{y - y_1}{x - x_1}$$

since the PQ and PR vectors must have the same slope.

Therefore, the equation of the line passing through points $P(x_1, y_1)$ and $Q(x_2, y_2)$ is:

$$\frac{y - y_1}{x - x_1} = \frac{y_2 - y_1}{x_2 - x_1}$$

which can also be expressed as:

$$y = \left(y_1 - \frac{y_2 - y_1}{x_2 - x_1} \cdot x_1\right) + \left(\frac{y_2 - y_1}{x_2 - x_1}\right) \cdot x$$

$$y = a + b \cdot x$$

where a is a constant and b is the slope of the line

$$b = \frac{y_2 - y_1}{x_2 - x_1} = \frac{dy}{dx}$$

In view of the above equation, what it is assuming when it takes the slope of the line as a measure of price comparison is not the price level of a carrier, but rather the variation in the latter's prices in response to changes in the volume of gigabyte supplied as part of the price plan. That would be like saying that the distance that a car travels is its speed. This is the degree of conceptual confusion caused by measuring mobile Internet prices using "price per incremental gigabyte".

Suppose that points P and Q represent mobile telephony price plans where the only difference between them is that P offers 1 GB and Q offers 2 GB of mobile data: $P(1GB, p_1)$ and $Q(2GB, p_2)$.

The equation of the line will be:

$$y = \left(p_1 - \frac{p_2 - p_1}{2 - 1} \cdot 1\right) + \left(\frac{p_2 - p_1}{2 - 1}\right) \cdot x$$

$$y = (2p_1 - p_2) + (p_2 - p_1) \cdot x$$

and therefore, the slope of line b will be:

$$b = p_2 - p_1$$

Now suppose that a price reduction is applied to the plan offering 1 GB, so that $p_1' < p_1$. The new point on the line will be $P'(1GB, p_1')$ and therefore, the new slope b' will be:

$$b' = p_2 - p_1' > b = p_2 - p_1$$

In consequence, when there is a decrease in the price of the mobile telephony plan, the slope of the line increases.

The above discussion can be summarised by the following graph.

Graph 3. Results obtained using incremental gigabyte methodology in the case of lower prices.
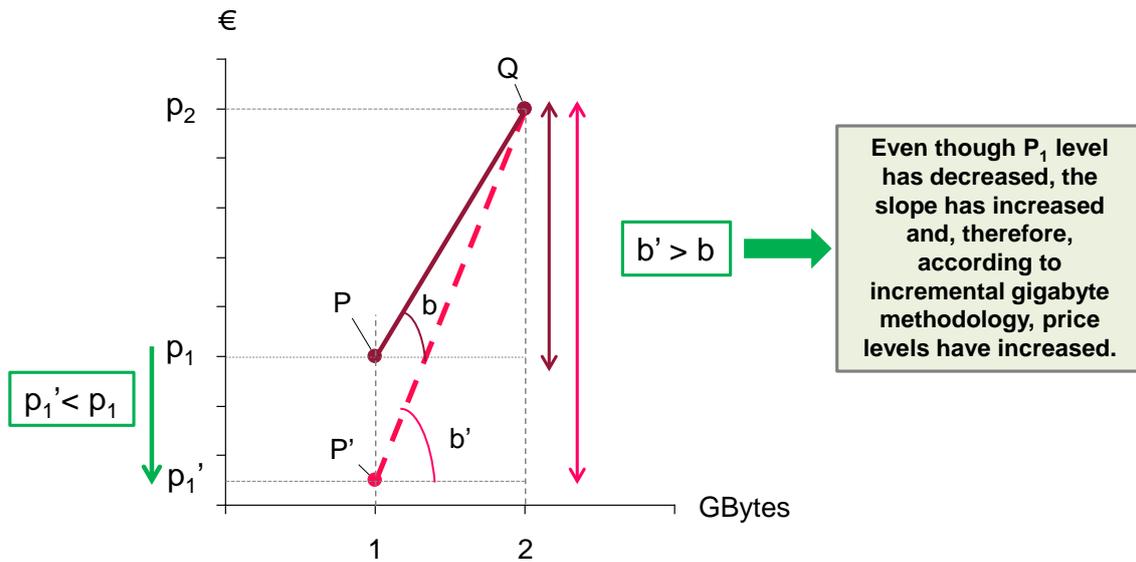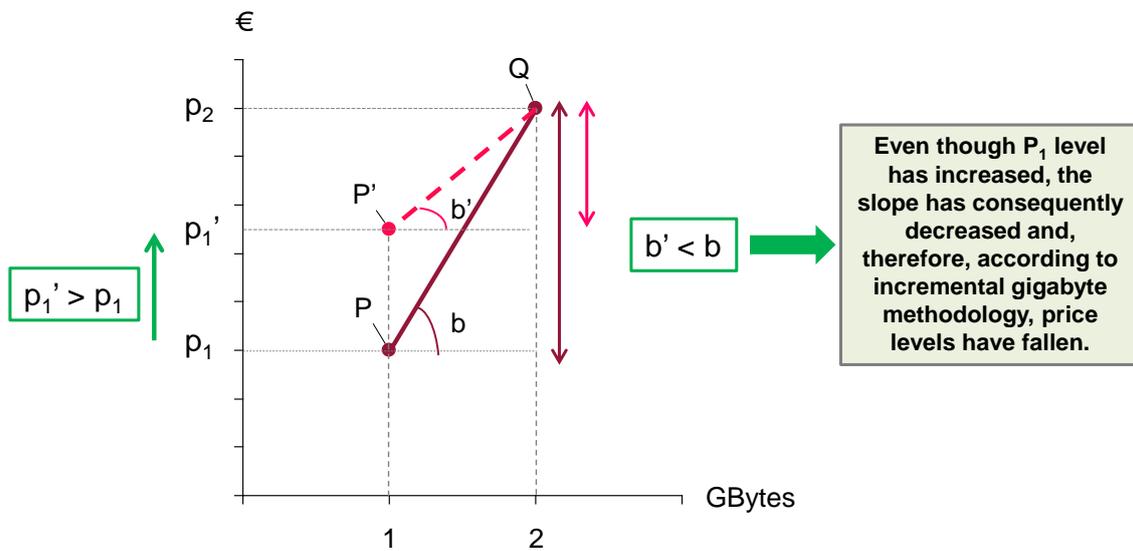

Source: Created in-house.

This shows how a fall in the price of one of the products implies an increase in the slope of the regression line and therefore higher prices on the market according to this methodology.

Similarly, suppose now that the opposite is true, i.e. an increase in the price of the 1 gigabyte plan such as $p_1' > p_1$. The new point on the line will be $P'(1GB, p_1')$ and therefore, the new slope b' will be:

$$b' = p_2 - p_1' < b = p_2 - p_1$$

Therefore, an increase in a product's price will cause the slope of the line to decrease and, according to this methodology that is tantamount to saying that prices have fallen for this carrier. The above discussion can be summarised by the following graph.

Graph 4. Results obtained using incremental gigabyte methodology in the case of a rise in prices.

Source: Created in-house.

Therefore, not only does price per incremental gigabyte harbour conceptual errors, the methodology is also mathematically flawed: where the portfolio of products is indisputably cheaper (the price of one of the products is lowered while all others remain the same), the result obtained indicates a rise in prices and vice versa.

2.4. Examples.

The following examples taken from real markets analysed by DFM clearly show these inconsistencies.

The first example will show how the introduction of a new offer by a carrier is considered as a price increase. Example 2 shows how a reduction in prices by a carrier is interpreted as a price increase according to incremental gigabyte methodology. Lastly, example 3 shows how a carrier with lower prices is considered to be more expensive than another with higher prices. Example 3 also clearly illustrates how this methodological inconsistency remains if price per incremental gigabyte is used to compare prices between countries.

▪ **Example 1: A carrier introduces a new rate.**

In this first example, we propose a scenario where, according to the methodology analysed, a carrier is considered more expensive simply for marketing a new product offering more data. This scenario is particularly relevant today as carriers, in response to an increase in demand for data, are offering additional plans with greater data

capacity without raising prices.

**Table 1. Introduction of a new product offering more gigabyte.**

GB	Prices Period T1[1]	Prices Period T2[1]
0.05	€ 19.99	€ 19.99
0.5	€ 28.49	€ 28.49
2	€ 37.99	€ 37.99
5	€ 47.49	€ 47.49
10	-	**€ 77.49**

(1) Monthly quota. All offers include Mobile Broadband with unlimited voice minutes and SMS messages.

Source: Created in-house.

Following is the graphic representation of the plans in a scatter plot showing the volume of gigabyte contracted on the abscissa axis and the price of the plan on the ordinate axis:

Graph 5.Introduction of a new pricing plan.
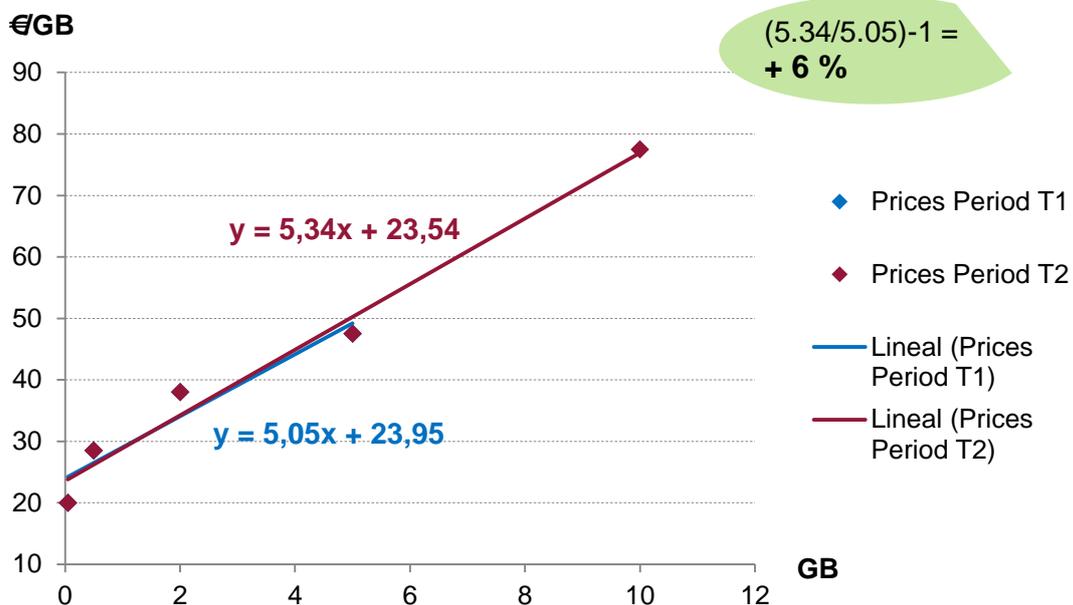
Source: Created in-house.

As we have seen, the methodology analysed determines the increase or decrease in

price based on the rise or fall of the slope of the regression line. The new slope is comparable with the original situation:

$$Slope\ variation = \frac{5.34}{5.05} - 1 = 5.7\%$$

The result is that, following the introduction of the new 10 GB plan, the carrier in question has increased its prices by 5.7% according to this methodology.

This result is completely erroneous as consumers with 0.5 GB to 5 GB plans experienced no price change. The only thing that happened was that a new plan offering more data with lower price per gigabyte was put on the market.

- **Example 2: A carrier lowers its prices.**

We will now analyse the effect that a reduction in prices accompanied by an increase in data capacity will have on price per incremental gigabyte method.

As one would expect in the light of the theoretical analysis, this price reduction will increase the slope of the carrier's regression line thus indicating an increase in price according to the methodology analysed, an increase in price. However, the reality is very different insofar as this price modification means that consumers get more gigabyte at a comparatively lower price than with the previous plans. These consumers would benefit while the rest remain the same.

The case in question is that of a mobile carrier that decides to simplify its portfolio of products by reducing the number of its offerings from 5 to 4. In so doing, it replaces its 0.2 GB offering with a 0.5 GB product at a lower price. Similarly, it replaces its 0.75 and 1 GB products with a single 1.5 GB plan at a price significantly lower than the previous two. It then adds a new 3 GB mobile internet product replacing the previously existing 2 GB product at a much lower price. Lastly, the 5 GB product remains intact.

These figures are listed in the following table.

Table 2. Price reduction together with an increase in data capacity.

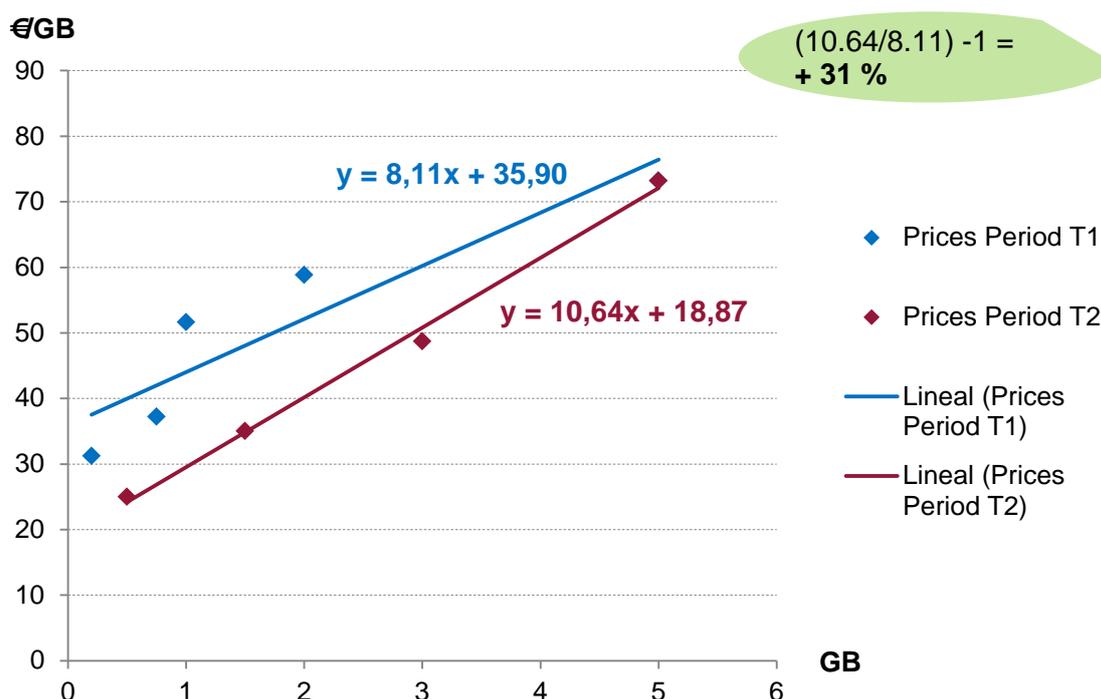| Prices Period 1		Prices Period 2	
GB	Monthly quota 1[(1)]	GB	Monthly quota 1[(1)]
0.2	€ 31.20	0.5	€ 25.00
0.75	€ 37.22	1.5	€ 35.00
1	€ 51.62	3	€ 48.70
2	€ 58.82	5	€ 73.22
5	€ 73.22		

[(1)]All offers include Mobile Broadband with unlimited voice minutes and SMS messages.
Source: Created in-house.

The table clearly shows that along with portfolio simplification, prices were lowered for all consumer plans with the sole exception of the 5 GB plan whose price remained the same. The immediate consequence of this is an indisputable reduction in mobile Internet prices for this carrier's customers. However, these are not the results obtained by applying the "price per incremental gigabyte" calculation in accordance with incremental gigabyte methodology.

Below is a scatter plot of prices and price per incremental gigabyte for the two periods. As in the previous example, this graph represents the volume of gigabyte contracted and the price of each product.

Graph 6. Variation in the carrier's portfolio of products.

€/GB

y = 8,11x + 35,90

y = 10,64x + 18,87

(10.64/8.11) -1 =
+ 31 %

◆ Prices Period T1

◆ Prices Period T2

—— Lineal (Prices Period T1)

—— Lineal (Prices Period T2)

GB

Source: Created in-house.

In this graph we see that the slope corresponding to the Period 2 price plans or price per incremental gigabyte (10.64) is greater than the slope of Period 1 (8.11), due to the variation and lower price of the new products.

The method links the coefficient associated with the slope to incremental gigabyte and calculates the variation in the slopes of the lines to obtain the increase or decrease in observed prices:

$$\text{Slope variation} = \frac{10.64}{8.11} - 1 = 31.2\%$$

The post-modification result in a price hike of 31.2% over the previous period.

Again, this highlights the methodological flaw in this approach in analysing and comparing the evolution and changes in the prices charged by carriers, both from a theoretical standpoint and on the basis of the results obtained: when measured with incremental gigabyte methodology, an objective price reduction results in a price increase of 31.2%.

▪ **Example 3: Comparison between carriers.**

In our third example we find that even though a carrier within a country offers lower prices, that carrier is considered more expensive than the competition.

The table shows the product portfolios of the three carriers operating in an EU country. In this case we observe that, for any volume of gigabyte contracted, Carrier C has lower rates than Carriers A and B.

Table 3.Tariff plans within a country.

Prices Carrier A		Prices Carrier B		Prices Carrier C	
GB	Monthly quota 1[1]	GB	Monthly quota 1[1]	GB	Monthly quota 1[1]
1	€ 31.4	1	€ 14.16	2	€ 11.67
3	€ 37.82	2	€ 18.82	5	€ 17.67
5	€ 45.15	4	€ 20.82	12	€ 25.67
6	€ 47.72	5	€ 24.81		
8	€ 55.05	6	€ 25.82		
10	€ 75.73	7	€ 26.81		
		9	€ 31.81		
		14	€ 30.81		
		16	€ 35.81		
		24	€ 35.81		
		26	€ 40.81		

[1]All offers include Mobile Broadband with unlimited voice minutes and SMS messages.
Source: Created in-house.

Following is the graphical representation of the rates of the three carriers in a scatter plot:

Graph 7. Price comparison among carriers within a country.
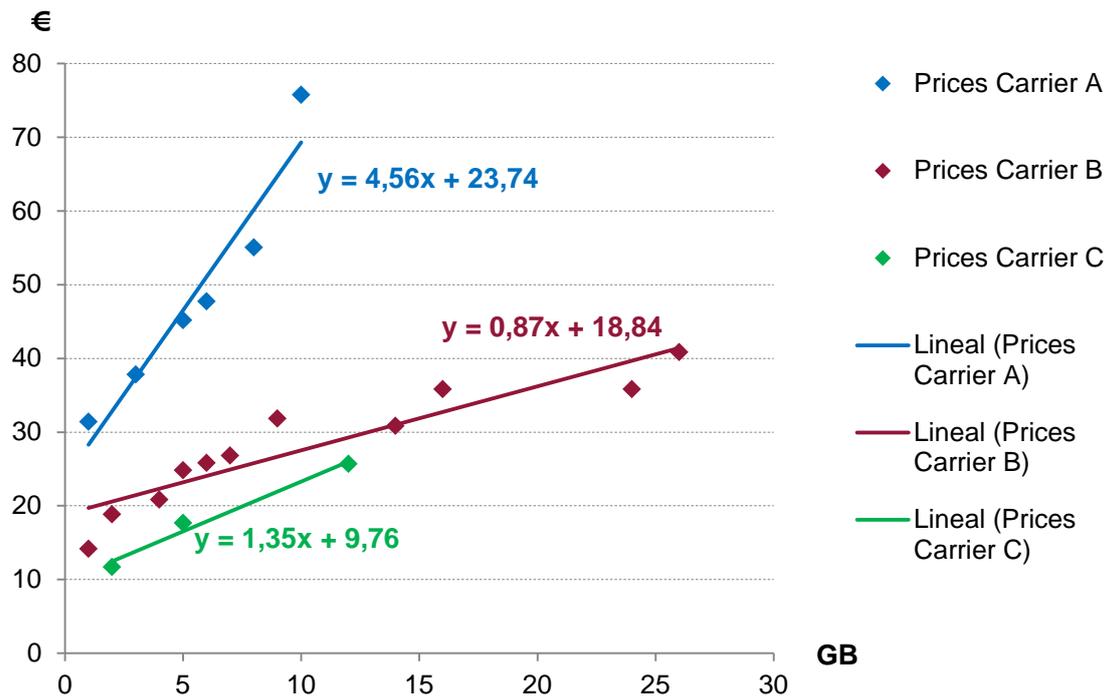
Source: Created in-house.

As already shown above, according to the incremental gigabyte methodology the slopes of the lines determine incremental gigabyte and for comparison purposes, the rate of change between the two. Although we initially saw that Carrier C offers lower prices for all price plans, the method analysed reached the opposite conclusion, i.e. the incremental gigabyte of Carrier C is higher than that of Carrier B, its conclusion being that Carrier C's mobile internet is 55.2% more expensive than Carrier B's.

$$\text{Slope variation} = \frac{1.35}{0.87} - 1 = 55.2\%$$

This result completely contradicts reality, since Carrier C is substantially cheaper than all of Carrier B's plans. This again shows how confusing it is to measure price differences between carriers using price per incremental gigabyte (the slope of the line).

Lastly, we would point out that DFM's methodology represents the price level of a country as the average of price per incremental gigabyte of each of the carriers, weighted by their respective market shares. To illustrate this, the calculation made for the country under review is expressed in the following table.

Table 4. Calculation of price per incremental gigabyte within a country.

	Market share	Price per incremental gigabyte
Carrier A	43.3%	4.56
Carrier B	33.8%	0.87
Carrier C	22.9%	1.35
Average country price		2.58

Source: Created in-house.

As demonstrated in the foregoing, the use of "price per incremental gigabyte", defined as price levels associated with a carrier's portfolio, is both irrelevant and inconsistent and it therefore stands to reason that the results of the proposed comparison between the prices of the different countries following this methodology, is equally misguided.

3.   Conclusions

This analysis clearly shows the conceptual limitations of the methodology used by DFM to analyse the evolution of prices in the mobile Internet market.

The methodology analysed links clearly separate concepts: price levels of a carrier (traditionally measured by baskets) and price changes based on data volume, which is what "price per incremental gigabyte" really measures. As a result of this conceptual confusion, the results obtained by applying this methodology to the mobile Internet market are erroneous and inconsistent and can lead to seriously and misleading claims.

This has been illustrated by applying this methodology to three real examples of carriers and countries monitored by the consultant.

First of all, we have seen how the methodology interprets the appearance of a new data plan offering greater data volume at a higher price than those previously offered, as a price increase. This result runs contrary to what one would logically expect; the plans available in Period 1 are the same as those offered in Period 2, except that under the new plan the demand for data is higher.

Secondly, we have shown how a price decrease by a carrier is interpreted as an increase in price in light of the steeper slope of the line, leading us to conclude that the carrier has raised prices when the complete opposite is actually the case.

Lastly, the methodology would indicate that carriers with lower prices are more expensive than others whose prices are actually higher. Of course, these results remain contradictory if used to compare prices between countries.

As already mentioned, what this methodology is assuming when it takes the slope of the line as a measure of price comparison is not the price level of a carrier per se, but rather the variation in the latter's prices in response to changes in the number of gigabytes provided as part of the different price plans. That would be like saying that the distance that a car travels is its speed.

In view of the methodological limitations noted, it is evident that the use of price per incremental gigabyte as a yardstick against which to compare prices is not methodologically sound and is in no way representative of reality.

Annex. Pricing in the electricity sector in Spain.

Breakdown of the domestic tariff in the electricity sector is similar in most EU countries, i.e. cost of electricity is basically broken down into two categories: energy generation and/or supply (depending on how the sector is organised) and transport and/or distribution (depending on the grid). Energy excise duties and indirect taxes on consumption are not described.

The retail electricity bill is broken down into:

- **Power contracted.** This is the fixed price paid for a certain level of electrical power. It is calculated by multiplying contracted kW by the number of billing days and by the access fee determined by the Ministry of Industry, Energy and Tourism.

  Power contracted in the electricity sector would be comparable to payment of a fixed amount for bandwidth contracted in the telecom sector.

- **Energy consumed.** This is the price you pay according to the energy consumed. It is calculated by multiplying kWh of energy consumed by the price stipulated in the contract.

  The comparable unit in the telecom industry would be payment per gigabyte consumed.

Thus, the total electricity bill and other concepts would be the sum of power contracted and energy consumed. Then you would have to add excise duties on electricity and indirect taxes applied in Spain.