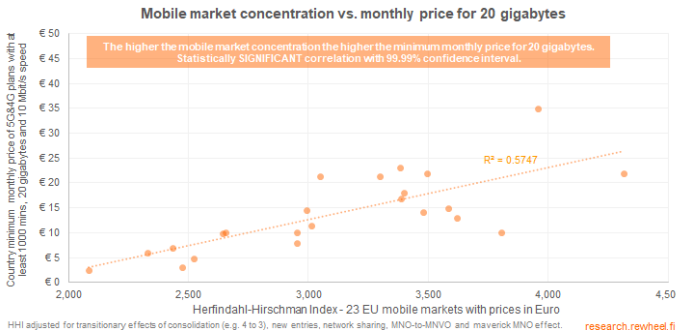
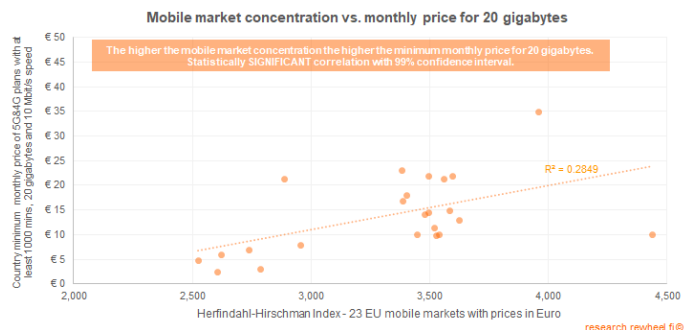
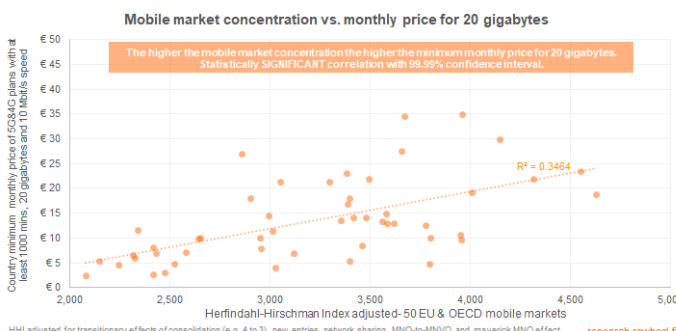
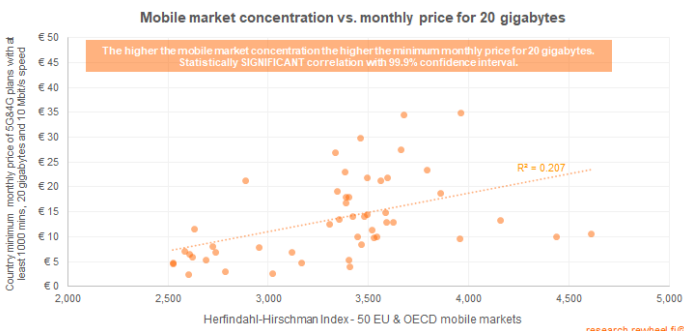
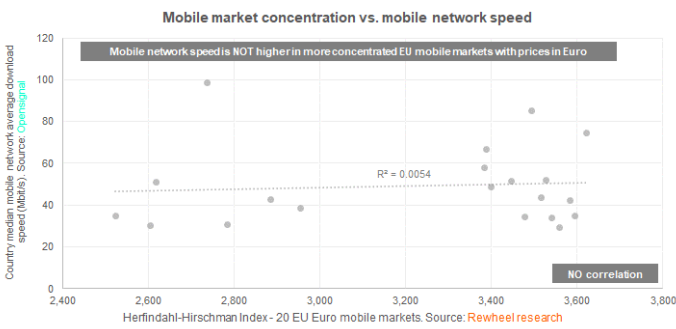
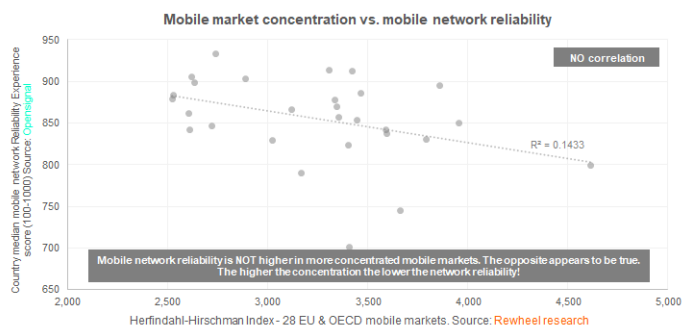
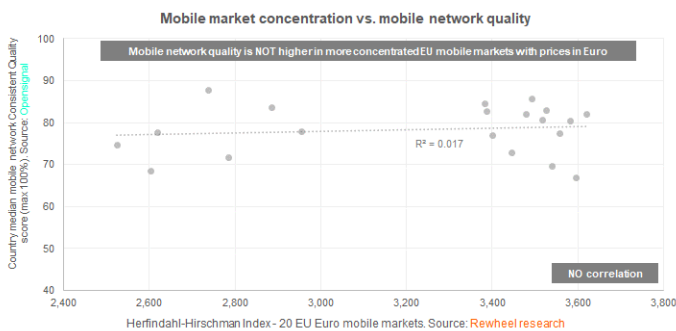
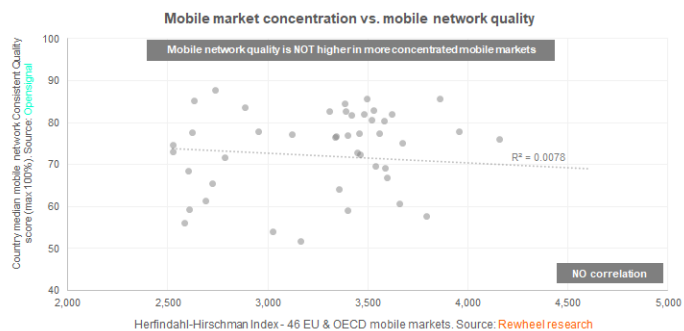


Network performance and speed are NOT higher in more concentrated mobile markets. Mobile mergers do NOT lead to better networks, they only lead to higher prices.

While monthly prices are several times higher in more concentrated mobile markets – statistically significant correlations with confidence intervals as high as 99.99% – network performance and average download speed are NOT higher in more concentrated mobile markets.

Contrary to the claims that the consolidators and their consultants have been making during 4 to 3 mobile mergers – see latest dubious claims made by Compass Lexecon¹ in relation to Vodafone’s and Three’s 4 to 3 mobile merger in the UK and Rewheel’s rebut here² – mobile network performance (Consistent Quality and Reliability Experience) and average download speed, source OpenSignal³, are NOT higher in more concentrated mobile markets where monthly prices are 2-3x higher. Mobile mergers do NOT lead to better networks, they only lead to higher prices and consumer harm.



¹<https://static1.squarespace.com/static/5f9288b7ef71962ed2eac3c3t/656da7b27453d563a5a31a18/1701685174561/Four+to+three+mobile+mergers+meta+paper+%28Compass+Lexecon%29++November+2023.pdf>
²https://research.rewheel.fi/downloads/Predicted_price_increases_Vodafone_Hutchison_4_to_3_UK_mobile_merger_PUBLIC_VERSION.pdf
³<https://www.opensignal.com/>

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1 Study context and main findings

In February 2024, in a study⁴ titled ‘*The 4 to 3 Vodafone / Three mobile merger in the UK will lead to substantial 26% to 51% monthly price increases*’ we re-examined, by performing statistical and regression analysis, the dependency of mobile prices upon competition related factors with the dual aim of re-validating the findings of our previous studies⁵ (mobile prices are significantly higher in markets with higher concentration) and predicting the price increases from the 4 to 3 Vodafone / Three UK mobile merger.

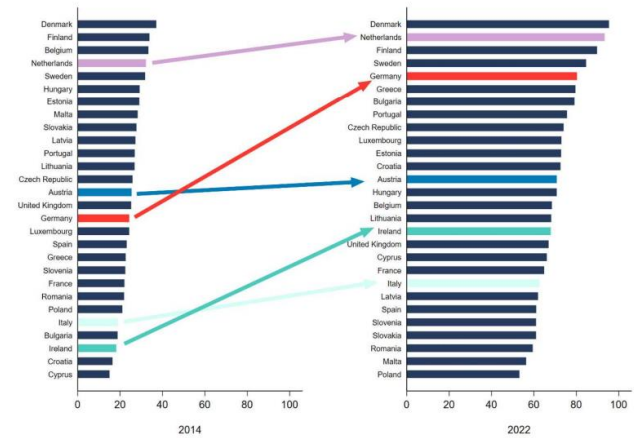
After re-examining the dependency of mobile monthly prices (2023 prices) upon mobile market concentration (Herfindahl-Hirschman Index, HHI) across a group of 50 European and OECD countries we concluded that mobile market concentration is causally linked with mobile market prices. The higher the mobile market concentration the higher the mobile market monthly prices.

Over a span of 12 years, we have consistently observed statistically significant uniformly positive linear correlations with very high confidence intervals (99.5% and higher) between mobile monthly prices and mobile market concentration.

Our February 2024 study also rebutted Compass Lexecon’s dubious 4 to 3 mobile merger claims. Vodafone and Three UK citing a review of the evidence – a meta-study⁶ of twenty-five empirical studies carried out by Compass Lexecon – claimed that the five 4 to 3 mobile mergers in Europe and the one in the US “*have had little impact on prices, typically having no effect at all, or increasing prices for some customers for a short period only.*” and that “*Many four-to-three mergers appear to have led to higher quality*”.

Compass Lexecon’s claim that 4 to 3 mobile mergers lead to higher network quality was based on GSMA’s network performance index⁷ data as seen in the screenshot that follows. GSMA’s network performance index is composed of performances in mobile download speed, mobile upload speed, and latencies collected by Ookla’s Speedtest Intelligence. The index is scaled between 0 and 100 with equal weight on each of the three performance indicators.

Figure 1: GSMA network performance index (countries with mergers over period improved network quality relative to the others)



Notes: Index is composed of performances in mobile download speeds, mobile upload speeds, and latencies collected by Ookla Speedtest Intelligence. Scaled between 0 and 100 with equal weight on each of the three performance indicators. 2014 chosen as base year as this is the earliest year reported by GSMA.
Source: GSMA Mobile Connectivity Index (available online [here](https://www.mobileconnectivityindex.com/index.html)).

In our February 2024 study we argued that “*that the average mobile network speed is affected by countless technical and commercial factors and/or limitations such as operator spectrum holdings, deployed sites, deployed carriers, carrier configuration, EMF limits, mobile network traffic data load (how congested or empty is the radio network) and end-user speed restrictions (speed tiers/caps etc)*”.

Mobile network average download speed is not a suitable metric of mobile network performance. **The main flaw of mobile network average download speed as a metric of mobile network performance is the fact that it does not measure what really matters; the end-user experience in mobile networks.**

Similarly, to another dubious metric – the “*average revenue per gigabyte of data*” – used by Compass Lexecon and the consolidators to claim that prices have fallen in 4 to 3 consolidated markets and which has in fact no relation⁸ to the actual price consumers pay every month, mobile network average download speed has in fact little or no relation to the end-user application experience quality, consistency and reliability.

⁴https://research.rewheel.fi/downloads/Predicted_price_increases_Vodafone_Hutchison_4_to_3_UK_mobile_merger_PUBLIC_VERSION.pdf
⁵https://research.rewheel.fi/downloads/Mobile_prices_2_to_5_times_lower_in_markets_with_4_MNOs_PUBLIC_VERSION.pdf

⁶<https://static1.squarespace.com/static/5f9288b7ef71962ed2eac3c3/t/656da7b27453d563a5a31a18/1701685174561/Four-to-three+mobile+mergers+meta+paper+%28Compass+Lexecon%29++November+2023.pdf>
⁷<https://www.mobileconnectivityindex.com/index.html>
⁸https://research.rewheel.fi/downloads/Predicted_price_increases_Vodafone_Hutchison_4_to_3_UK_mobile_merger_PUBLIC_VERSION.pdf

Consider the following simplified example. The mobile network average download speed of network A is 50 Mbit/s. Network A minimum download speed measured was 30 Mbit/s and maximum speed was 70 Mbit/s and all the rest of the measurements were evenly distributed around the average download speed of 50 Mbit/s.

Network B has an average download speed of 100 Mbit/s. Two times faster than the average speed of Network A. In many occasions Network B speed well exceeded 100 Mbit/s. However, 10% of the times Network B measured speed fell to just 1 Mbit/s.

Which of these two networks performs better? The one with the higher average download speed of 100 Mbit/s or the one with the lower average download speed of 50 Mbit/s?

Compass Lexecon and the consolidators will have you believe that Network B performance is superior since the average download speed of Network B is 2x higher than that of Network A. But that is wrong!

Network A is the superior network because network A consistently delivers what really matters; network speed that is sufficient to support consistent end-user application experience.

While in the network with the higher average download speed (Network B) 10% of the times the end-user download speed fell below the minimum speed for delivering a smooth and seamless HD video streaming experience (5 Mbit/s minimum speed is required in small screens) in the network with the lower average download speed (Network A) 100% of the times the network speed was sufficient to support smooth and seamless operation of common applications such as HD video streaming or video games. And HD video streaming is by far the most common application in mobile networks today used by almost all end-users.

End-users truly value consistent quality when they use mobile services. That is how often their experience on the mobile network was sufficient to support smooth and seamless operation of common applications such as HD video streaming or video games.

Opensignal, the leading global provider of independent insights integrating network experience and market performance across converged, wireless and broadband operators, measures and reports consistent quality in mobile networks. Opensignal Consistent Quality⁹ metric measures how often user's experience on a network was sufficient to support common applications' requirements.

Opensignal's Consistent Quality metric measures six key performance indicators; average download speed, upload speed, latency, jitter, packet loss and time to first byte. The metric takes into account the percentage of tests attempted which did not succeed due to a connectivity issue on either the download or server response component and is represented as a percentage in Opensignal reports, translating to the percentage of user tests that have met the minimum recommended performance thresholds.

In February 2024 Opensignal introduced a new end-to-end mobile network performance metric called Reliability Experience. Opensignal stated in their report¹⁰ that **"according to the Opensignal US Household Survey of 55,322 individuals, mobile users attribute greater value to reliable network services than to faster speeds and considered reliability second only to cost."**

Opensignal's Reliability Experience metric measures to what extent users stay consistently connected to their mobile network and whether they can continue to do typical tasks like email, watching videos, and using navigation apps while connected. Opensignal's Reliability Experience metric measures every aspect of the user's experience of their operators' mobile data network: when it's working flawlessly, when it's working erratically and when you can't connect at all.

The Reliability Experience metric calculated on a scale of 100-1000 – with higher scores indicating better experience – Reliability Experience consists of the following components; Signal Availability, Data Connectivity, Task Completion and Sufficiency.

Opensignal's analysis showed that past 50 Mbit/s, faster speeds do little to improve reliability. Opensignal observed a diminishing influence of average overall download speeds on the overall Reliability experience scores.

⁹<https://www.opensignal.com/2022/08/10/consistent-quality-explained>

¹⁰<https://www.opensignal.com/2024/02/08/the-opensignal-global-reliability-experience-report>

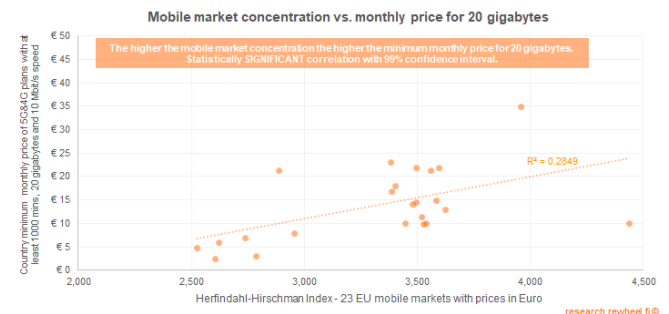
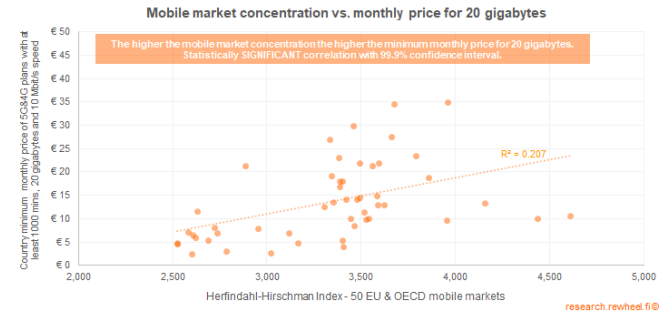
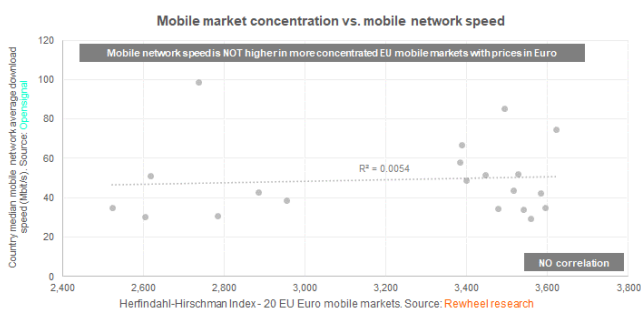
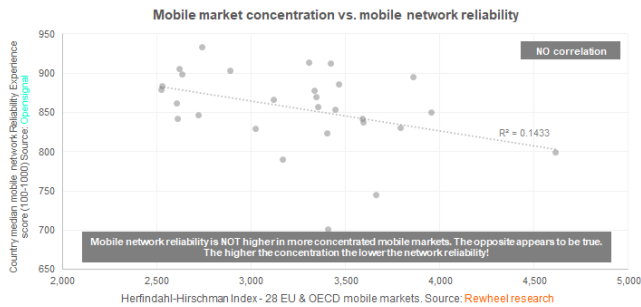
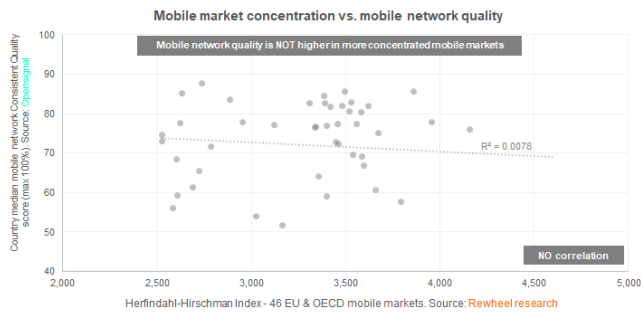
In this study for the first time, we examine the dependency of mobile network performance – using Opensignal’s Consistent Quality and Reliability Experience metrics – upon mobile market concentration (Herfindahl-Hirschman Index, HHI) by performing statistical and regression analysis across a group of 50 European and OECD mobile markets.

Furthermore, to dispel any doubts – claims by the consolidators that that mobile mergers lead to better and faster networks we also examine the direct dependency of mobile network average download speed (source Opensignal) upon mobile market concentration.

Our analysis shows that mobile network performance (Consistent Quality and Reliability Experience) and as well average download speed are NOT higher in more concentrated mobile markets where prices are 2-3 times higher.

On the contrary, our latest analysis shows that mobile monthly prices are significantly higher in more concentrated (e.g., 3-MNO vs. 4-MNO) mobile markets.

Using the latest¹¹ mobile prices data set – mobile prices from the 1H2024 versus the 1H2023 prices we used in our February study¹² – we once again observe statistically significant uniformly positive linear correlations with confidence intervals as high as 99.99% between mobile monthly prices and mobile market concentration.



4 to 3 mobile mergers increase concentration in mobile markets. Increased concentration in mobile markets is causally linked with higher monthly prices while no such link exists between higher mobile market concentration and higher mobile network performance or speed.

Mobile mergers do NOT lead to better or faster network performance as the consolidators claim. They only lead to higher prices and consumer harm.

¹¹https://research.rewheel.fi/downloads/The_state_of_mobile_and_broadband_pricing_1H2024_PUBLIC_REDACTED_VERSION.pdf

¹²https://research.rewheel.fi/downloads/Predicted_price_increases_Vodafone_Hutchison_4_to_3_UK_mobile_merger_PUBLIC_VERSION.pdf

2 Input data and detailed methodology

The study is divided in two parts. The first part that examines the dependency of mobile network performance and speed (Opensignal's measurements) upon mobile market concentration (Rewheel's data) is presented in Sections 2, 3, 4 and 5 of the report and is publicly available in Rewheel's website. The second part that examines the dependency of mobile monthly prices upon mobile market concentration – based solely on Rewheel's data – is presented in Section 6 of the report and it is available to subscribers of Rewheel's PRO reports service.

In the table below we present the input data we used herein to analyse and determine the dependency of mobile network performance and speed upon mobile market concentration (i.e., in the first public part of the study).

OECD	EU	EUR	Code	Country name	Download speed (Mbit/s)	Consistent Quality %	Realibility experience (0-1000)	Herfindahl-Hirschman Index (HHI)	Herfindahl-Hirschman Index adjusted (HHIa)
OECD	EU	EUR	AT	Austria	52.2	82.9	N/A	3,526	2,645
OECD			AU	Australia	57.9	78.0	851	3,954	3,954
OECD	EU	EUR	BE	Belgium	42.5	80.4	N/A	3,582	3,582
	EU	EUR	BG	Bulgaria	67.0	82.7	N/A	3,386	3,386
			BR	Brazil	26.2	59.1	824	3,398	3,398
OECD			CA	Canada	75.7	76.9	870	3,341	4,009
OECD			CH	Switzerland	57.0	76.2	N/A	4,154	3,560
OECD			CL	Chile	24.4	59.5	843	2,606	2,316
OECD			CO	Colombia	12.3	34.5	702	3,406	3,028
	EU	EUR	CY	Cyprus	N/A	N/A	N/A	4,436	3,802
OECD	EU		CZ	Czechia	37.2	77.5	N/A	3,457	4,149
OECD	EU	EUR	DE	Germany	51.6	72.9	854	3,444	2,952
OECD	EU	EUR	DK	Denmark	98.9	87.8	934	2,737	2,433
OECD	EU	EUR	EE	Estonia	34.5	82.1	N/A	3,478	3,478
OECD	EU	EUR	EL	Greece	35.1	66.9	838	3,594	4,313
OECD	EU	EUR	ES	Spain	34.9	74.8	884	2,524	2,524
OECD	EU	EUR	FI	Finland	58.2	84.7	N/A	3,382	3,382
OECD	EU	EUR	FR	France	51.4	77.8	906	2,618	2,327
	EU	EUR	HR	Croatia	74.7	82.0	N/A	3,621	3,621
OECD	EU		HU	Hungary	38.8	75.1	N/A	3,672	3,672
OECD	EU	EUR	IE	Ireland	34.0	69.8	N/A	3,539	2,654
OECD			IL	Israel	32.3	61.4	N/A	2,686	2,149
			IN	India	21.1	54.1	830	3,021	2,417
OECD			IS	Iceland	N/A	N/A	N/A	3,387	2,903
OECD	EU	EUR	IT	Italy	30.6	68.5	862	2,603	2,083
OECD			JP	Japan	47.5	82.8	914	3,305	3,777
OECD			KR	Korea	137.3	81.8	913	3,418	3,418
			KW	Kuwait	55.0	64.1	857	3,354	3,354
OECD	EU	EUR	LT	Lithuania	44.0	80.6	N/A	3,516	3,014
OECD	EU	EUR	LU	Luxemburg	N/A	N/A	N/A	3,957	3,957
OECD	EU	EUR	LV	Latvia	29.7	77.4	N/A	3,558	3,050
	EU	EUR	MT	Malta	N/A	N/A	N/A	3,493	3,493
OECD			MX	Mexico	23.2	34.9	800	4,610	3,951
			MY	Malaysia	31.1	51.9	790	3,165	3,797
OECD	EU	EUR	NL	Netherlands	85.2	85.7	N/A	3,492	2,993
OECD			NO	Norway	99.5	85.8	896	3,856	4,628
OECD			NZ	New Zealand	39.8	69.2	842	3,587	3,587
			PE	Peru	16.4	56.1	N/A	2,583	2,583
OECD	EU		PL	Poland	30.5	73.2	880	2,522	2,242
OECD	EU	EUR	PT	Portugal	49.1	77.1	N/A	3,399	3,399
	EU	EUR	RO	Romania	30.8	71.8	N/A	2,784	2,475
			SA	Saudi Arabia	43.6	60.8	745	3,658	3,658
OECD	EU		SE	Sweden	58.6	85.4	899	2,631	2,339
			SG	Singapore	74.0	77.3	867	3,118	3,118
OECD	EU	EUR	SI	Slovenia	38.7	77.9	N/A	2,953	2,953
OECD	EU	EUR	SK	Slovakia	42.7	83.6	904	2,884	3,296
OECD			TR	Turkey	25.1	72.4	886	3,462	3,462
OECD			UK	United Kingdom	31.2	65.5	847	2,719	2,417
OECD			US	United States	45.5	76.6	878	3,334	2,858
			ZA	South Africa	54.1	57.9	831	3,791	4,549

The first five columns list alphabetically, using the two-letter country short code, the 50 countries included in the comparison. This is the same group of countries included in Rewheel's latest mobile and broadband price comparison study¹³ "*The state of mobile and broadband pricing – 1H2024*". The first column lists the country OECD (Organisation for Economic Co-operation and Development) membership information, the second column lists the EU (European Union) membership information and the third column lists information regarding the country's national currency (EUR if Euro is the country's national currency or if the country's national currency is pegged or has a fixed exchange rate with the Euro).

The seventh and eighth columns list two mobile network performance metrics: the country median mobile network Consistent Quality score and the country median mobile network Reliability Experience score. The sixth column lists the country median mobile network average download speed. The source for these three metrics is Opensignal¹⁴.

More information regarding the two mobile network performance metrics and the mobile network speed metric follows in the sub-sections below.

The last two columns list the mobile market concentration as measured by the Herfindahl-Hirschman Index (HHI) and Herfindahl-Hirschman Index adjusted (HHIa) for the factors that are shown to effect competition in mobile markets (i.e., transitional effects of consolidation e.g. 4 to 3 mobile mergers, new entries, network sharing, MNO-to-MNVO and maverick MNO effect). The source for the mobile market concentration metrics is earlier Rewheel studies; the '*The 4 to 3 Vodafone / Three mobile merger in the UK will lead to substantial 26% to 51% monthly price increases*' study¹⁵ the '*Wireless market and operator competitiveness – 2023*' study¹⁶ and the '*Mobile prices are 2x to 5x lower in markets with 4 or more MNOs*' study¹⁷.

More information regarding these two mobile market concentration metrics follows in the sub-sections below.

¹³https://research.rewheel.fi/downloads/The_state_of_mobile_and_broadband_pricing_1H2024_PUBLIC_REDACTED_VERSION.pdf

¹⁴<https://www.opensignal.com/>

¹⁵https://research.rewheel.fi/downloads/Predicted_price_increases_Vodafone_Hutchison_4_to_3_UK_mobile_merger_PUBLIC_VERSION.pdf

¹⁶https://research.rewheel.fi/downloads/Wireless_market_operator_competitiveness_2023_PUBLIC.pdf

¹⁷https://research.rewheel.fi/downloads/Mobile_prices__2_to_5_times_lower_in_markets_with_4_MNOs_PUBLIC_VERSION.pdf

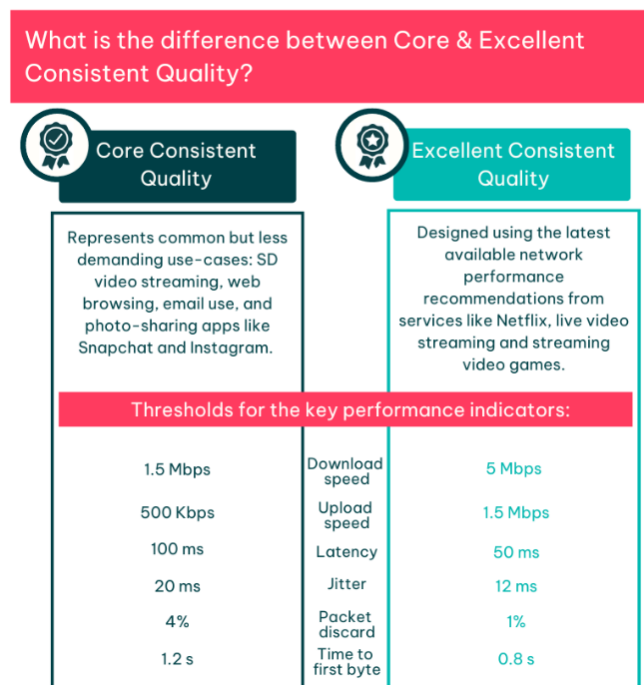
2.1 Mobile network performance metrics – Opensignal’s Consistent Quality and Reliability Experience scores

2.1.1 Consistent Quality score

Opensignal, the leading global provider of independent insights integrating network experience and market performance across converged, wireless and broadband operators, measures¹⁸ and reports consistent quality in mobile networks. Opensignal Consistent Quality metric measures how often user’s experience on a network was sufficient to support common applications’ requirements.

Opensignal’s Consistent Quality metric measures six key performance indicators; average download speed, upload speed, latency, jitter, packet loss and time to first byte. The metric takes into account the percentage of tests attempted which did not succeed due to a connectivity issue on either the download or server response component and is represented as a percentage in Opensignal reports, translating to the percentage of user tests that have met the minimum recommended performance thresholds.

According to Opensignal, the Consistent Quality metric thresholds have been designed using the latest available network performance recommendations from services like Netflix, or Skype, as well as live video streaming on services like YouTube and streaming videogames. The metrics are represented as a percentage in Opensignal reports, translating to the percentage of user tests that have met the minimum recommended performance thresholds. Users can interpret these metrics to mean the proportion of the occasions when they go to use their devices for typical applications that the connection will support that usage.



Opensignal periodically measures and reports Consistent Quality in mobile networks in its Markets Insights section¹⁹.

In the 3-MNO German and 4-MNO French mobile markets Opensignal reported the Consistent Quality scores of the mobile network operators, seen in the screenshots below taken from Opensignal’s Markets Insights section, in November 2023. The Consistent Quality scores reported by Opensignal for the four French mobile network operators are higher (relative to the market position, e.g., no.1 MNO Telekom in Germany vs. no.1 MNO Orange in France) than their German counterparts.

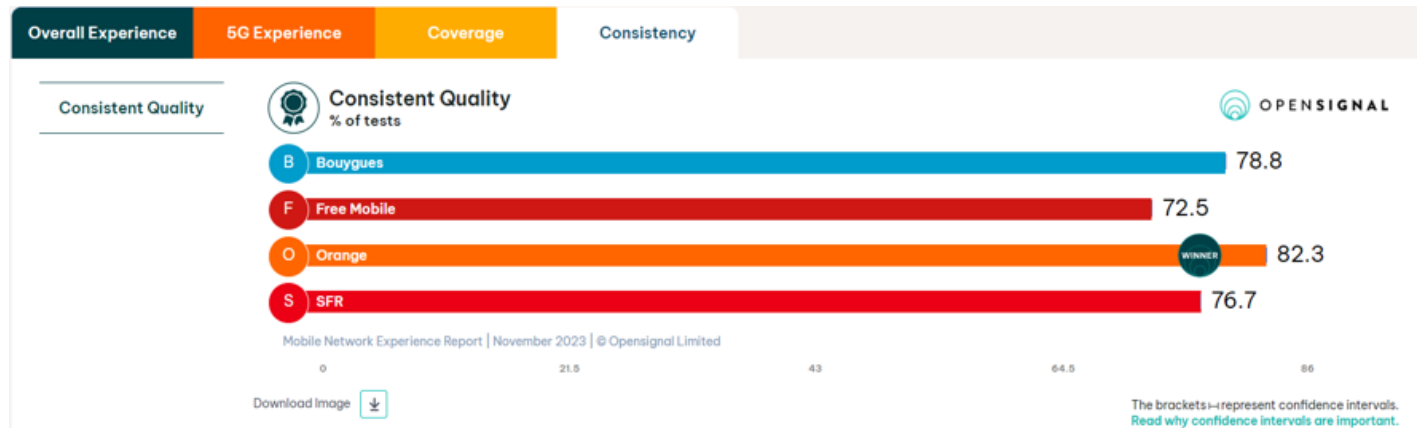
Opensignal reports Consistent Quality scores for 46 out of the 50 countries included in Rewheel’s latest pricing comparison study²⁰. No Consistent Quality scores were reported by Opensignal for mobile network operators in Cyprus, Iceland, Luxemburg and Malta.

The Consistent Quality scores seen in the table above represent the country median Consistent Quality score. Opensignal reported for the three German MNOs Consistent Quality scores of; Vodafone 72.8%, O2 72.9% and Telekom 79.6% yielding a 72.9% country median value while for the four French MNOs it reported Consistent Quality scores of; Free Mobile 72.5%, SFR 76.7%, Bouygues 78.8% and Orange 82.3% yielding a 77.8% country median value.

¹⁸<https://www.opensignal.com/2022/08/10/consistent-quality-explained>

¹⁹<https://www.opensignal.com/market-insights>

²⁰https://research.rewheel.fi/downloads/The_state_of_mobile_and_broadband_pricing_1H2024_PUBLIC_REDACTED_VERSION.pdf



With the exception of Latvian and Lithuanian operators (September 2022) the Consistent Quality values for the rest of the operators that are present in the 46 countries scores were reported by Opensignal between September 2023 and April 2024.

We used the operator Consistent Quality score values that are presented in sub-section 2.2 to calculate the country median Consistent Quality scores which are depicted in the table in page 6 above.

Please note in calculating the country median Consistent Quality score and as well the country median average download speed for Malaysia and South Africa we averaged the Consistent Quality scores and speeds reported by Opensignal for Cellcom and Digi in Malaysia (single operator after their merger) and for MTN and CellC in South Africa (CellC has been operating as an MVNO on MTN's network).

2.1.2 Reliability Experience score

In February 2024 Opensignal introduced a new end-to-end mobile network performance metric called Reliability Experience. Opensignal stated in their report²¹ that “according to the Opensignal US Household Survey of 55,322 individuals, mobile users attribute greater value to reliable network services than to faster speeds and considered reliability second only to cost.”

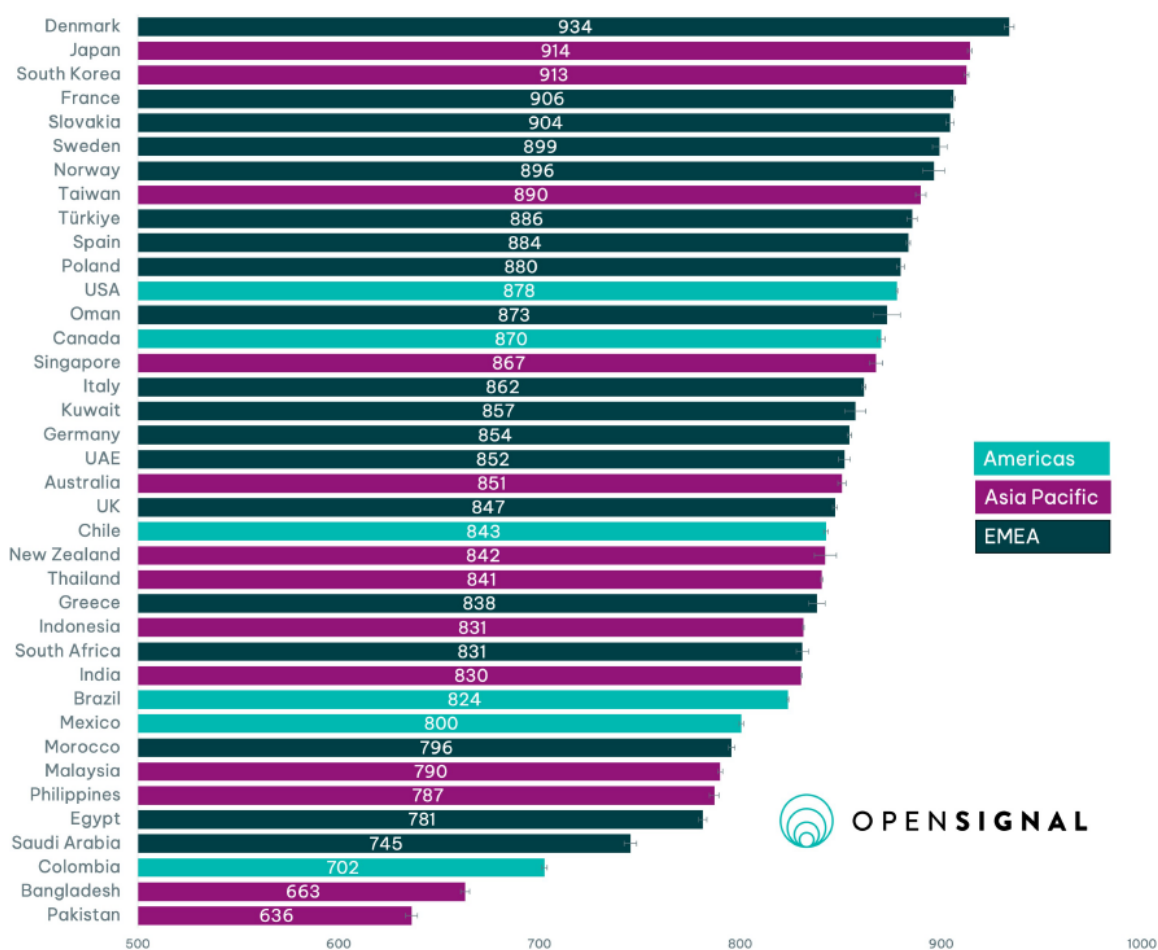
Opensignal’s Reliability Experience metric measures to what extent users stay consistently connected to their mobile network and whether they can continue to do typical tasks like email, watching videos, and using navigation apps while connected. Opensignal’s Reliability Experience metric measures every aspect of the user’s experience of their operators’ mobile data network: when it’s working flawlessly, when it’s working erratically and when you can’t connect at all.

The Reliability Experience score is calculated on a scale of 100-1000, with higher scores indicating better experience. Reliability Experience consists of the following components; Signal Availability (the proportion of time users can successfully connect to a mobile network), Data Connectivity (the proportion of time when the network is available and the device can connect to the internet), Task Completion (whether tasks initiated by the user’s device are completed and Sufficiency (the probability that tasks will be executed sufficiently well for the user).

In its February 2024 Reliability Experience report Opensignal reported the Reliability Experience scores, as seen in the screenshot below for 38 countries. Opensignal collected the Reliability Experience data between the 1st of October 2023 and the 29th of December 2023.

28 out of the 38 countries that were included in Opensignal’s Reliability Experience report where countries were Rewheel is tracking mobile prices. The Reliability Experience scores for these 28 countries are listed in the table in page 6 that depict the input data for this public part of the study.

Reliability Experience (100-1000)

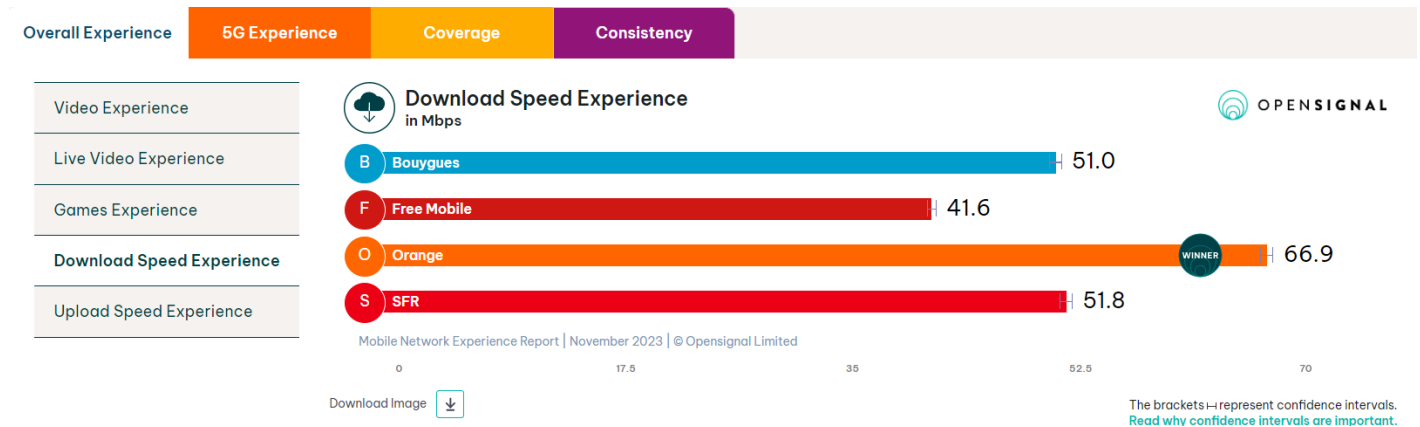


Data collection period: October 1, 2023 – December 29, 2023 | © Opensignal Limited

²¹<https://www.opensignal.com/2024/02/08/the-opensignal-global-reliability-experience-report>

2.2 Mobile network average download speed – Opensignal’s measurements

In its Markets Insights section²² besides Consistent Quality Opensignal reports many more mobile network metrics such as mobile network average download and upload speed, video and games experience, 5G experience, coverage, availability, etc. as seen in the screenshot below that depicts the average download speeds of the French mobile network operators.



As we stated in the study context, to dispel any doubts – claims by the consolidators that that mobile mergers lead to better and faster networks we also examined herein the direct dependency of mobile network average download speed upon mobile market concentration. The table below depicts the Opensignal reported average download speeds and Consistent Quality scores for the mobile network operators present across the 46 countries included in this comparison. Similarly to the Consistent Quality scores, we derived a country median mobile network average download speed by calculating the median download speed among the country’s operators. For France the country median mobile network average download speed was 51.4 Mbit/s (operator values: Orange 66.9 Mbit/s, SFR 51.8 Mbit/s, Bouygues 51.0 Mbit/s and Free Mobile 41.6 Mbit/s)

²²<https://www.opensignal.com/market-insights>

	MNO name	Download speed (Mbit/s)	Consistent Quality %		MNO name	Download speed (Mbit/s)	Consistent Quality %
AT	A1-AT	54.2	87.9	JP	NTTdocomo-JP	49.0	82.1
AT	T-Mobile-AT	52.2	82.9	JP	KDDI-JP	50.3	82.2
AT	3-AT	48.4	82.1	JP	Softbank-JP	42.3	84.3
AU	Telstra-AU	57.4	76.1	JP	Rakuten-JP	45.9	83.4
AU	Optus-AU	57.9	78.8	KR	SKTelecom-KR	144.9	87.3
AU	Vodafone-AU	68.5	78.0	KR	KT-KR	137.3	75.0
BE	Proximus-BE	55.9	80.4	KR	LGUplus-KR	114.2	81.8
BE	Orange-BE	36.5	82.3	KW	Zain-KW	55.0	64.1
BE	BASE-BE	42.5	80.4	KW	Ooredoo-KW	57.4	66.6
BG	A1-BG	81.7	82.7	KW	STC-KW	48.7	54.9
BG	Yettel-BG	65.4	84.0	LT	Tele2-LT	44.0	79.2
BG	Vivacom-BG	67.0	77.0	LT	Telia-LT	63.8	86.0
BR	Vivo-BR	26.2	58.6	LT	BITE-LT	28.4	80.6
BR	Claro-BR	27.2	59.1	LU	STLuxemburg-LU	N/A	N/A
BR	TIM-BR	26.1	63.4	LU	Tango-LU	N/A	N/A
CA	Rogers-CA	63.6	77.5	LU	Orange-LU	N/A	N/A
CA	Bell-CA	77.0	76.9	LV	Telia-LV	38.1	80.3
CA	Telus-CA	75.7	76.5	LV	Tele2-LV	27.4	77.4
CH	Swisscom-CH	71.4	84.1	LV	BITE-LV	29.7	65.9
CH	Sunrise-CH	44.5	73.5	MT	Epic-MT	N/A	N/A
CH	Salt-CH	57.0	76.2	MT	Go-MT	N/A	N/A
CL	Movistar-CL	22.5	57.5	MT	Melita-MT	N/A	N/A
CL	Entel-CL	26.3	64.0	MX	Telcel-MX	28.4	34.3
CL	Claro-CL	18.6	59.7	MX	ATT-MX	17.9	35.5
CL	WOM-CL	29.8	59.2	MX	Altan-MX	N/A	N/A
CO	Claro-CO	13.2	33.6	MY	Maxis-MY	29.3	56.0
CO	Movistar-CO	10.4	34.3	MY	CelcomDigi-MY	31.1	51.9
CO	Tigo-CO	13.9	34.6	MY	Umobile-MY	39.4	49.0
CO	WOM-CO	11.4	48.2	MY	Yes-MY	24.5	48.1
CY	CYTA-CY	N/A	N/A	MY	Unifi-MY	37.7	67.2
CY	Epic-CY	N/A	N/A	NL	KPN-NL	87.6	86.1
CY	Primetel-CY	N/A	N/A	NL	Vodafone-NL	67.2	85.7
CY	Cablenet-CY	N/A	N/A	NL	Odido-NL	85.2	81.1
CZ	T-Mobile-CZ	49.4	88.4	NO	Telenor-NO	119.9	89.2
CZ	O2-CZ	37.2	74.1	NO	Telia-NO	99.5	84.0
CZ	Vodafone-CZ	30.1	77.5	NO	ice-NO	52.9	85.8
DE	Telekom-DE	58.9	79.6	NZ	One-NZ	38.8	69.2
DE	Vodafone-DE	51.6	72.8	NZ	Spark-NZ	44.9	68.2
DE	Telefonica-DE	37.7	72.9	NZ	2degrees-NZ	39.8	69.6
DK	TDC-DK	90.6	84.4	PE	Movistar-PE	14.8	54.4
DK	Telenor-DK	107.2	89.5	PE	Claro-PE	22.0	57.8
DK	Telia-DK	114.9	87.9	PE	Entel-PE	17.9	59.9
DK	3-DK	89.9	87.7	PE	Bitel-PE	14.2	40.5
EE	Telia-EE	54.9	89.5	PL	Orange-PL	30.3	74.6
EE	Elisa-EE	32.3	78.1	PL	T-Mobile-PL	34.2	76.5
EE	Tele2-EE	34.5	82.1	PL	Plus-PL	28.4	63.1
EL	Cosmote-EL	49.7	78.2	PL	Play-PL	30.6	71.8
EL	Vodafone-EL	35.1	66.9	PT	MEO-PT	49.1	77.1
EL	Nova-EL	33.6	63.4	PT	Vodafone-PT	34.8	76.3
ES	Movistar-ES	46.0	79.6	PT	Nos-PT	55.7	77.9
ES	Vodafone-ES	25.6	73.3	RO	Orange-RO	37.8	73.7
ES	Orange-ES	38.8	76.3	RO	Vodafone-RO	28.3	72.0
ES	Yoigo-ES	31.0	71.8	RO	Telekom-RO	24.0	64.7
FI	Elisa-FI	57.2	84.7	RO	DIGI-RO	33.3	71.5
FI	Telia-FI	58.2	84.4	SA	STC-SA	44.2	60.8
FI	DNA-FI	67.5	85.4	SA	Mobily-SA	43.6	61.9
FR	Orange-FR	66.9	82.3	SA	Zain-SA	30.9	41.9
FR	SFR-FR	51.8	76.7	SE	Telia-SE	63.3	85.3
FR	Bouygues-FR	51.0	78.8	SE	Tele2-SE	56.5	81.4
FR	Free-FR	41.6	72.5	SE	Telenor-SE	60.2	85.5
HR	Telekom-HR	86.4	81.4	SE	3-SE	56.9	86.5
HR	A1-HR	55.8	82.0	SG	SingTel-SG	84.0	79.8
HR	Telemach-HR	74.7	85.7	SG	M1-SG	64.0	74.7
HU	Telekom-HU	38.8	78.3	SG	StarHub-SG	107.7	82.7
HU	Yettel-HU	42.9	75.1	SG	MBATelecom-SG	20.5	70.5
HU	Vodafone-HU	24.4	72.6	SI	TelekomSlovenije-SI	40.1	80.6
IE	Vodafone-IE	28.6	69.8	SI	A1-SI	57.9	78.8
IE	3-IE	40.8	72.1	SI	Telemach-SI	37.2	76.9
IE	eir-IE	34.0	69.7	SI	T2-SI	24.8	76.3
IL	Cellcom-IL	31.6	65.2	SK	Orange-SK	54.2	85.6
IL	Partner-IL	33.0	59.7	SK	Telekom-SK	56.2	85.3
IL	Pelephone-IL	36.1	63.0	SK	O2-SK	31.2	81.9
IL	HotMobile-IL	30.7	38.4	SK	Swanmobile-SK	18.9	68.8
IN	Airtel-IN	26.6	57.7	TR	Turkcell-TR	35.3	72.4
IN	Vodafone-IN	15.5	50.5	TR	Vodafone-TR	17.5	68.5
IN	BSNL-IN	3.4	13.6	TR	TurkTelekom-TR	25.1	73.3
IN	Jio-IN	52.9	60.9	UK	EE-UK	40.0	72.7
IS	Siminn-IS	N/A	N/A	UK	Telefonica-UK	20.9	62.8
IS	dafon Iceland-IS	N/A	N/A	UK	Vodafone-UK	27.9	64.7
IS	Nova-IS	N/A	N/A	UK	3-UK	34.5	66.3
IT	TIM-IT	32.0	58.3	US	Verizon-US	38.1	76.6
IT	Vodafone-IT	37.9	75.8	US	ATT-US	45.5	75.7
IT	WindTre-IT	29.2	68.5	US	T-Mobile-US	113.1	80.3
IT	Iliad-IT	26.9	68.4	ZA	Vodacom-ZA	54.1	62.7
				ZA	MTN-ZA	55.3	57.9
				ZA	Telkom-ZA	53.7	50.6

2.3 Mobile market concentration metrics – Herfindahl-Hirschman Index (HHI) and HHI adjusted (HHIa)

According to the United States Department of Justice (USDOJ) the Herfindahl–Hirschman Index²³ (HHI) is a commonly accepted measure of market concentration. HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. For example, for a market consisting of four firms with shares of 30, 30, 20, and 20 percent, the HHI is 2,600 ($30^2 + 30^2 + 20^2 + 20^2 = 2,600$).

The United States Department of Justice generally consider markets in which the HHI is between 1,500 and 2,500 points to be moderately concentrated, and markets in which the HHI is in excess of 2,500 points to be highly concentrated. The 4-MNO Polish market is the market with the lowest HHI of 2,522 among the 50 EU & OECD mobile markets including in the study.

The HHI values used in this analysis and depicted in the table below are calculated by squaring the market shares of the mobile network operator present in each of the 50 countries. The market shares of the mobile network operators are based on the reported mobile subscriber numbers that each operator had by year-end 2023 and can be found in Rewheel's 'Wireless market and operator competitiveness – 2023' study²⁴. The mobile subscriber market shares for the four mobile network operators present in Singapore are not part of our 2023 study. Singapore was added in the list of 50 countries during the 1H2024. Hence, for Singapore we separately calculated an HHI of 3,118. Singtel had 4.3 million subscribers, M1 2.29 million, StarHub 2.17 million and SIMBA 0.938 million in 2023.

The Herfindahl-Hirschman Index adjusted for the factors that are shown to effect competition in mobile markets (HHI adjusted or HHIa) score has been calculated using the following formula:

$$HHIa = HHI + (No. of MNOs present - No. of effective MNOs) \times \frac{HHI}{No. of effective MNOs}$$

In effect the adjustment modulates the original HHI score in markets where there are more or less effective mobile network operators than the number of nominal mobile network operators present and as well in markets where a maverick mobile network operator is present. The modulation decreases the HHI score in markets where more effective mobile network operators are present compared to the number of nominal mobile network operators and similarly increases the HHI score in markets where less effective mobile network operators are present compared to the number of nominal mobile network operators. The increase or decrease is the product of the difference between the nominal and effective number of mobile network operators and of the ratio of the original HHI score to the number of effective mobile network operators.

For example, in a 5 to 4 consolidated market where currently 4 mobile network operators are present each having a 25% mobile subscriber share the HHI score is 2500 points (4×25^2). If the number of effective mobile network operators assigned to this market was 5 ($4 + 0.5$ for transitional 5 to 4 consolidation effects + 0.5 for a maverick MNO present) then the HHIa score for this market will be:

$$\left[2500 + (4 - 5) \times \frac{2500}{5} \right] = [2500 - 500] = 2000$$

For more information on the HHI adjusted calculations please see section 2.12 of our January 2022 study²⁵.

²³<https://www.justice.gov/atr/herfindahl-hirschman-index>

²⁴https://research.rewheel.fi/downloads/Wireless_market_operator_competitiveness_2023_PUBLIC.pdf

²⁵https://research.rewheel.fi/downloads/Mobile_prices__2_to_5_times_lower_in_markets_with_4_MNOs_PUBLIC_VERSION.pdf

Country name	Herfindahl-Hirschman Index (HHI)	Herfindahl-Hirschman Index adjusted (HHIa)
Austria	3,526	2,645
Australia	3,954	3,954
Belgium	3,582	3,582
Bulgaria	3,386	3,386
Brazil	3,398	3,398
Canada	3,341	4,009
Switzerland	4,154	3,560
Chile	2,606	2,316
Colombia	3,406	3,028
Cyprus	4,436	3,802
Czechia	3,457	4,149
Germany	3,444	2,952
Denmark	2,737	2,433
Estonia	3,478	3,478
Greece	3,594	4,313
Spain	2,524	2,524
Finland	3,382	3,382
France	2,618	2,327
Croatia	3,621	3,621
Hungary	3,672	3,672
Ireland	3,539	2,654
Israel	2,686	2,149
India	3,021	2,417
Iceland	3,387	2,903
Italy	2,603	2,083
Japan	3,305	3,777
Korea	3,418	3,418
Kuwait	3,354	3,354
Lithuania	3,516	3,014
Luxemburg	3,957	3,957
Latvia	3,558	3,050
Malta	3,493	3,493
Mexico	4,610	3,951
Malaysia	3,165	3,797
Netherlands	3,492	2,993
Norway	3,856	4,628
New Zealand	3,587	3,587
Peru	2,583	2,583
Poland	2,522	2,242
Portugal	3,399	3,399
Romania	2,784	2,475
Saudi Arabia	3,658	3,658
Sweden	2,631	2,339
Singapore	3,118	3,118
Slovenia	2,953	2,953
Slovakia	2,884	3,296
Turkey	3,462	3,462
United Kingdom	2,719	2,417
United States	3,334	2,858
South Africa	3,791	4,549

3 Mobile market concentration vs. mobile network performance – NO correlation

In this section we examine the dependency of mobile network performance upon mobile network concentration. As detailed in the methodology section, we use two mobile network performance metrics; the country median Consistent Quality score and the country median Reliability Experience score and two mobile concentration metrics; the country's mobile market Herfindahl-Hirschman Index (calculated using mobile network operator's subscriber shares) and the country's mobile market Herfindahl-Hirschman Index adjusted for the factors that are shown to effect competition in mobile markets.

We examine the dependency of mobile network Consistent Quality upon mobile network concentration in two groups of countries; a group of all EU & OECD countries where Opensignal measures mobile network performance (46 countries out of the total 50 countries where Rewheel tracks mobile prices) and in a group of 20 EU countries that share a common regulatory framework and where mobile prices are in Euro.

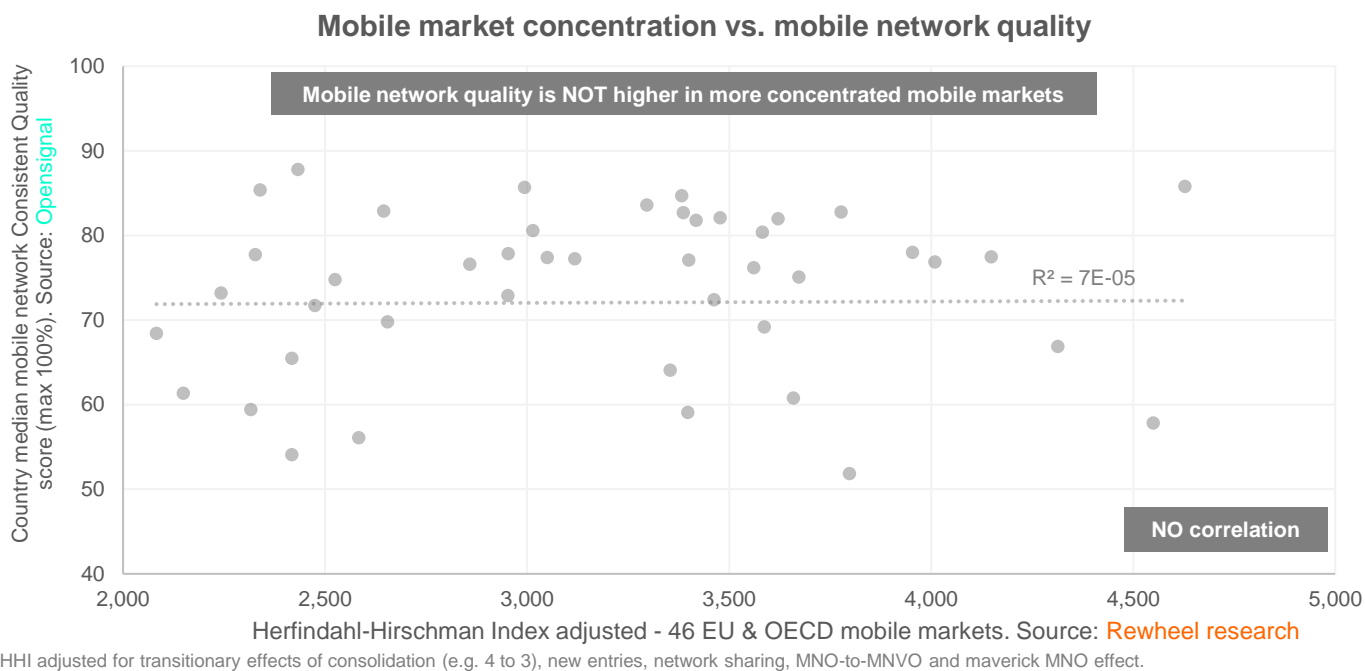
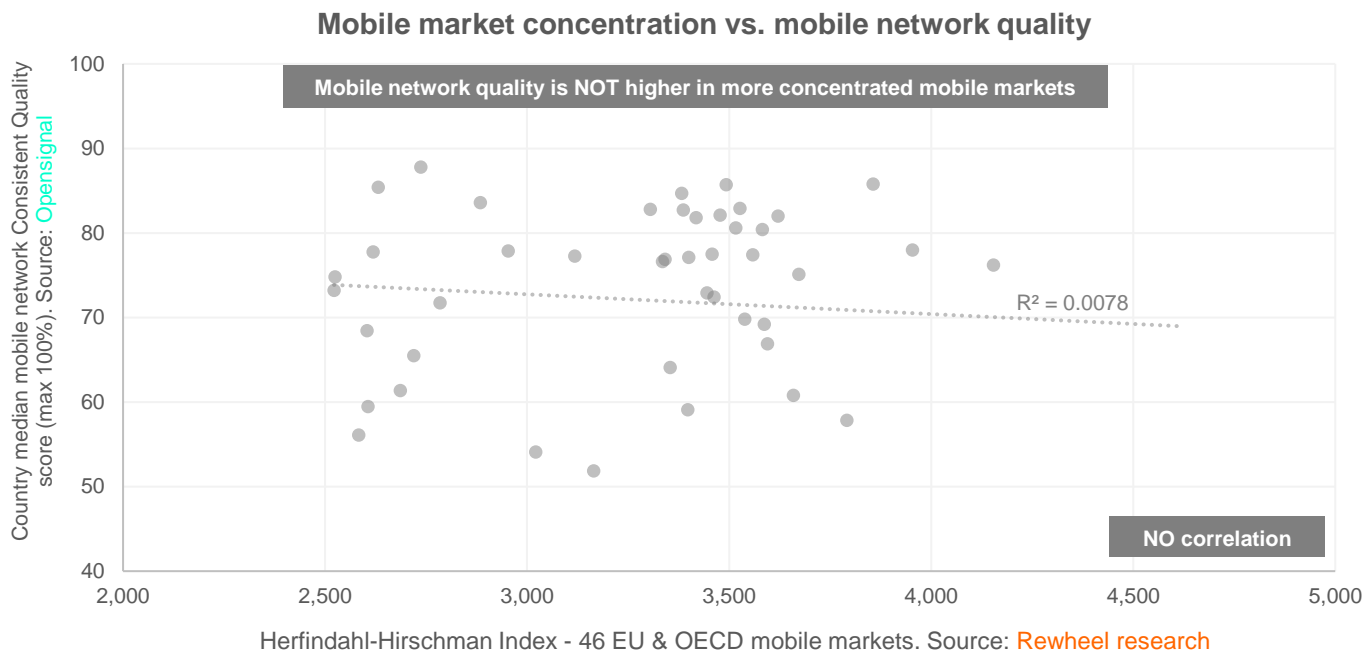
The dependency of mobile network Reliability Experience upon mobile network concentration is examined on a single group of 28 EU & OECD of countries. The group of EU countries with Euro prices whereas Opensignal measures Reliability Experience is too small (7 countries) to perform statistical analysis and draw robust conclusions.

We examine the dependency between the country median mobile network Consistent Quality and Reliability Experience scores and mobile market concentration by performing statistical and linear regression analysis. We present scatter plots that depict the linear relationship between the variables and include information regarding the r (Pearson), r^2 value, the confidence interval and the statistical significance of the correlation, if any. We consider a correlation between two variables to be statistically significant if the r value is equal or higher than the critical value α (confidence interval of 95% or $\alpha = 0.05$).

If we observe statistically significant (95% confidence interval and higher) uniformly positive linear correlations between the country median mobile network Consistent Quality and Reliability Experience scores and mobile market concentration (across both HHI and HHI adjusted) across all groups of countries (across the 46 EU & OECD countries and as well across the 20 EU Euro countries for the Consistent Quality score and across the 28 EU & OECD countries for the Reliability experience score) we conclude that mobile network performance is higher in more concentrated mobile markets. If not, we conclude that mobile network performance is not higher in more concentrated markets and hence an increase in mobile market concentration due to consolidation (e.g., 4 to 3 mobile merger) will most likely not lead to higher (better) network performance.

3.1 Mobile market concentration vs. mobile network Consistent Quality – NO correlation

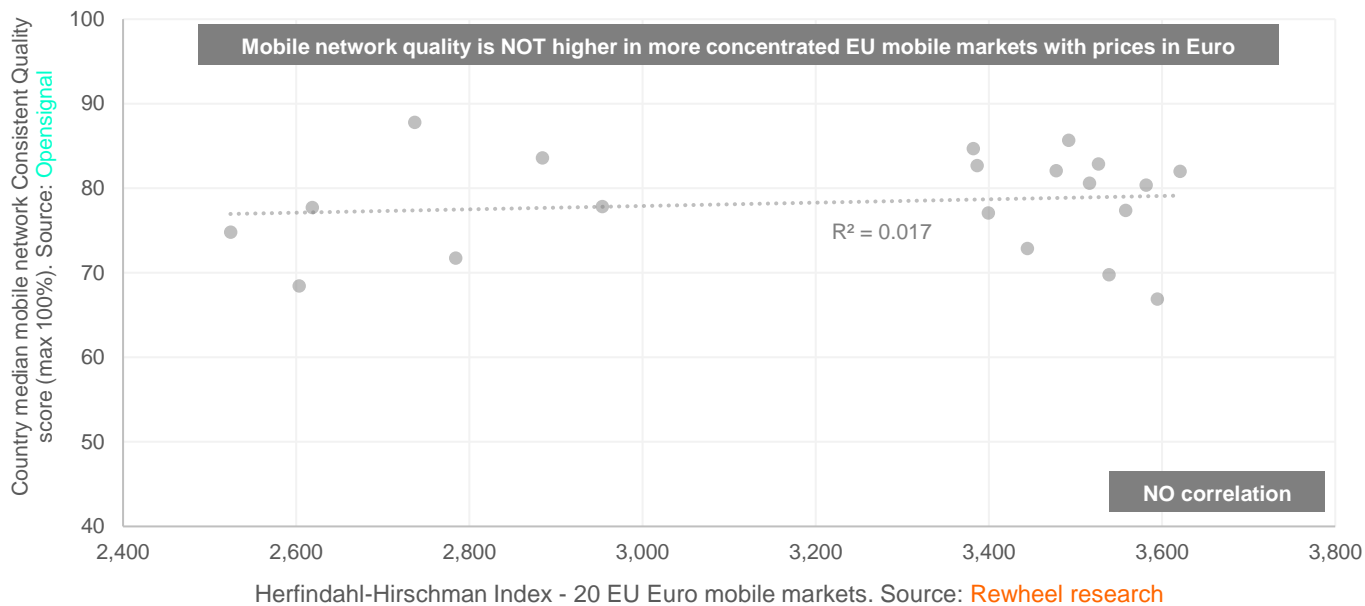
In the scatter plots below, we present the relationship between the country median mobile network Consistent Quality score and mobile market concentration (Herfindahl-Hirschman Index and Herfindahl-Hirschman Index adjusted) in the group of 46 EU & OECD mobile markets.



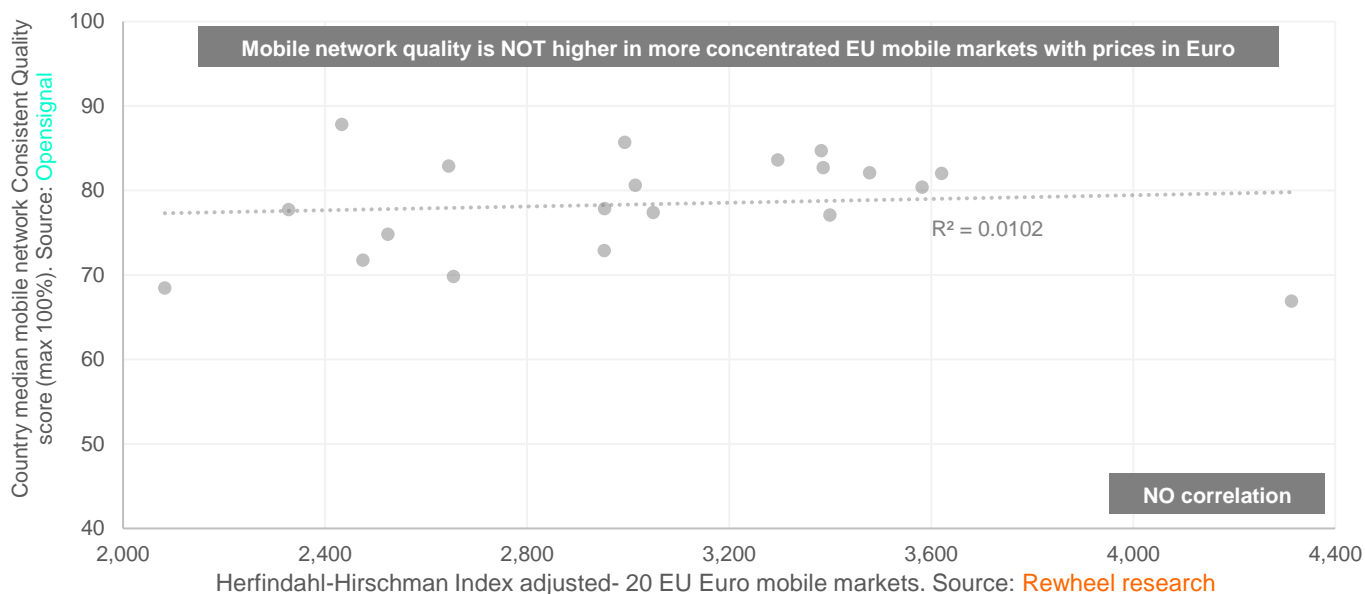
As seen in the scatter plots above, there is NO relationship whatsoever between the country median mobile network Consistent Quality score and mobile market concentration.

In the scatter plots below, we present the relationship between the country median mobile network Consistent Quality score and mobile market concentration (Herfindahl-Hirschman Index and Herfindahl-Hirschman Index adjusted) in the group of 20 EU mobile markets with prices in Euro.

Mobile market concentration vs. mobile network quality



Mobile market concentration vs. mobile network quality

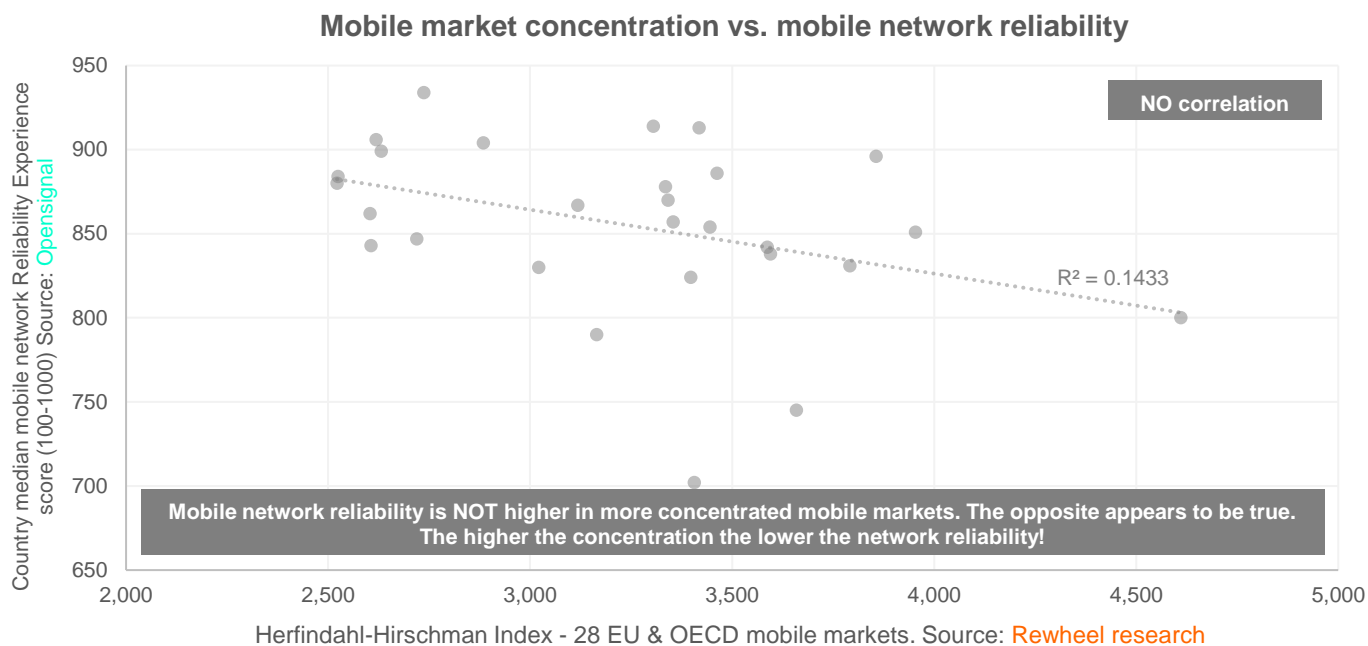


HHI adjusted for transitional effects of consolidation (e.g. 4 to 3), new entries, network sharing, MNO-to-MNVO and maverick MNO effect.

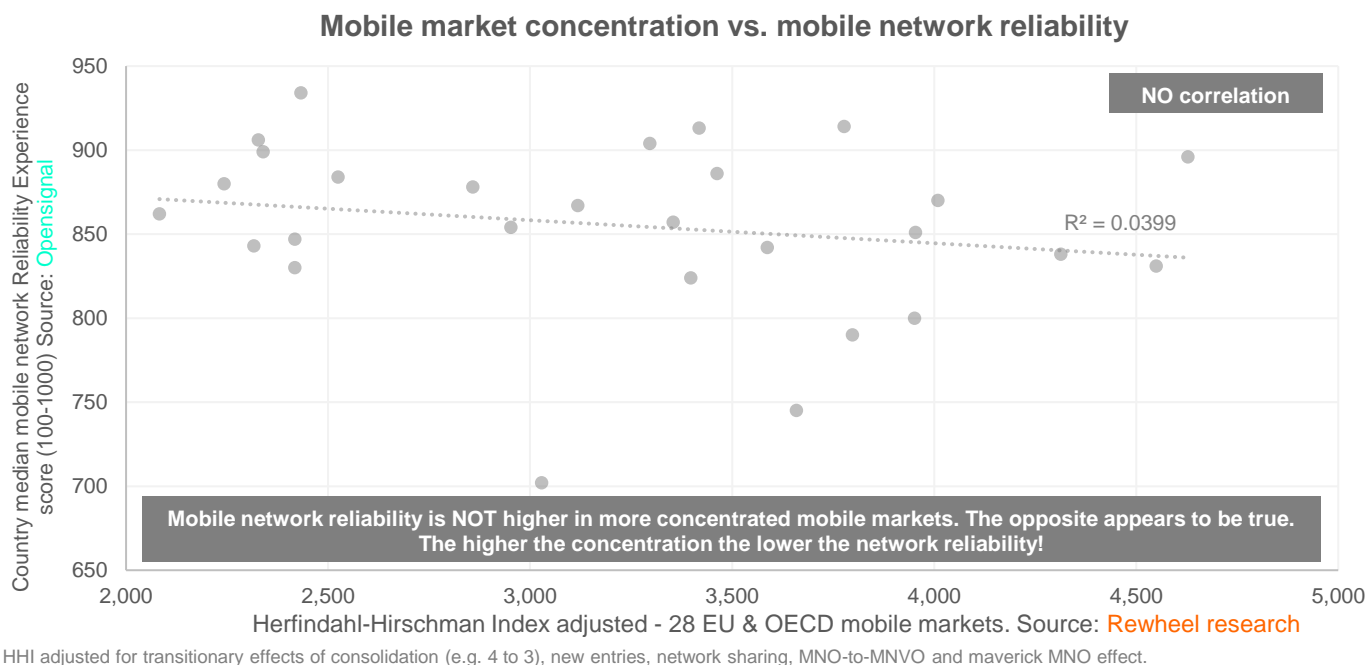
As seen in the scatter plots above, there is NO relationship whatsoever between the country median mobile network Consistent Quality score and mobile market concentration.

3.2 Mobile market concentration vs. mobile network Reliability Experience – NO correlation

In the scatter plots below, we present the relationship between the country median mobile network Reliability Experience score and mobile market concentration (Herfindahl-Hirschman Index and Herfindahl-Hirschman Index adjusted) in the group of 28 EU & OECD mobile markets.



Mobile network reliability is NOT higher in more concentrated mobile markets. The opposite appears to be true. The higher the mobile market concentration the lower the network reliability is.



Considering the outcome of the regression analysis presented in the six scatter plots above we conclude that mobile network performance (Consistent Quality and Reliability Experience) is NOT higher in more concentrated mobile markets. If anything, mobile markets with lower concentration (e.g. mobile markets with 4 vs. 3 MNOs) appear to have better Reliability experience scores.

Mobile network performance is not higher in more concentrated markets and hence an increase in mobile market concentration due to consolidation (e.g., 4 to 3 mobile merger) will most likely not lead to higher (better) network performance.

4 Mobile market concentration vs. mobile network average download speed – NO correlation

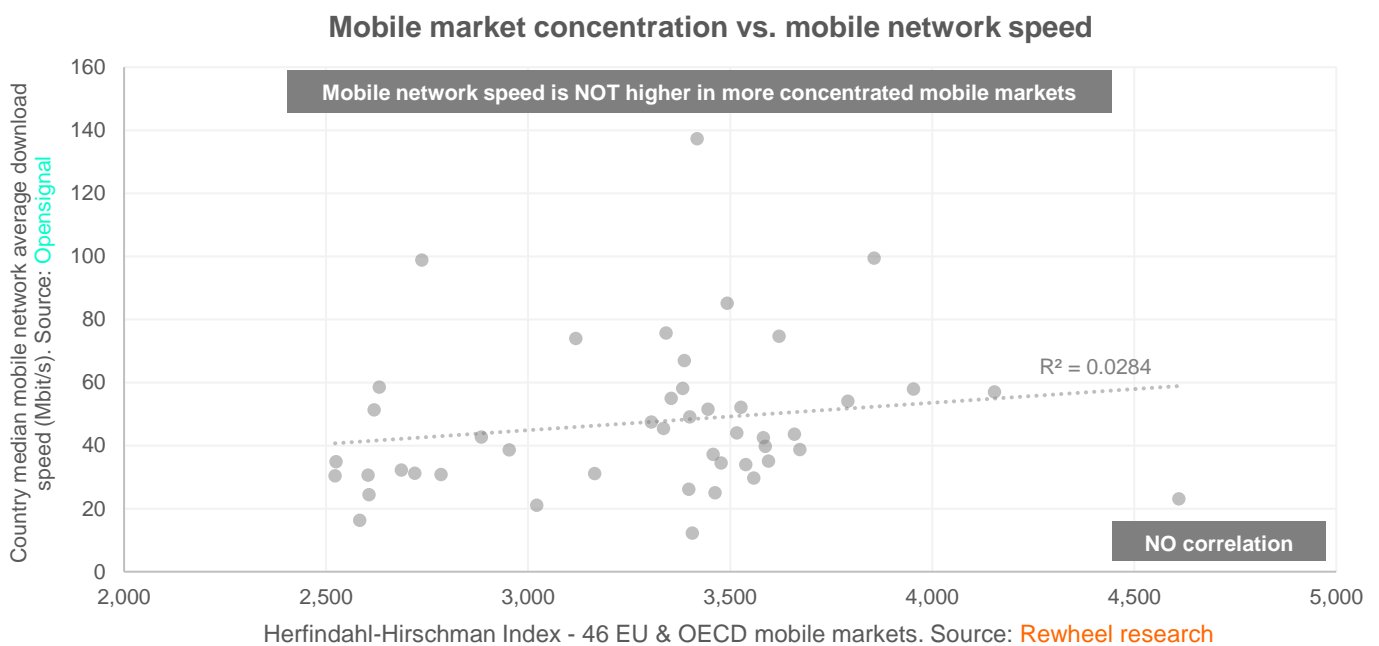
In this section we examine the dependency of mobile network average download speed upon mobile network concentration. We use the country median mobile network average download speed and two mobile concentration metrics; the country’s mobile market Herfindahl-Hirschman Index (calculated using mobile network operator’s subscriber shares) and the country’s mobile market Herfindahl-Hirschman Index adjusted for the factors that are shown to effect competition in mobile markets.

We examine the dependency of mobile network average download speed upon mobile network concentration in two groups of countries; a group of all EU & OECD countries where Opensignal measures mobile network average download speeds (46 countries out of the total 50 countries where Rewheel tracks mobile prices) and in a group of 20 EU countries that share a common regulatory framework and where mobile prices are in Euro.

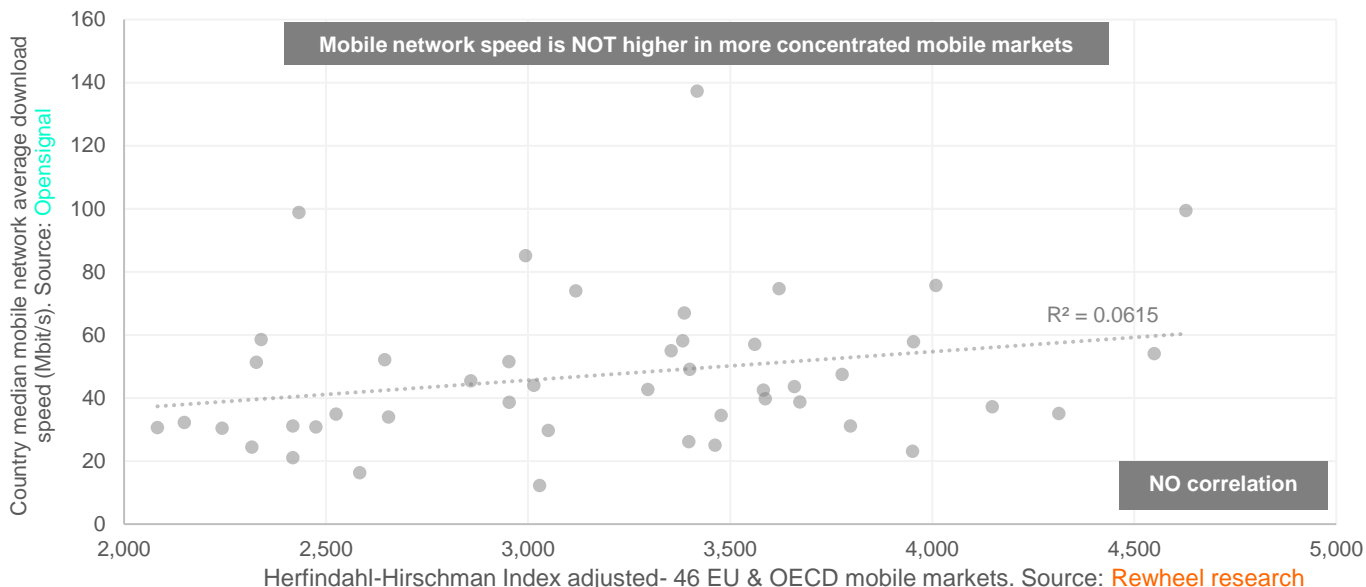
We examine the dependency between the country median mobile network average download speed and mobile market concentration by performing statistical and linear regression analysis. We present scatter plots that depict the linear relationship between the variables and include information regarding the r (Pearson), r^2 value, the confidence interval and the statistical significance of the correlation, if any. We consider a correlation between two variables to be statistically significant if the r value is equal or higher than the critical value α (confidence interval of 95% or $\alpha = 0.05$).

If we observe statistically significant (95% confidence interval and higher) uniformly positive linear correlations between the country median mobile network average download speed and mobile market concentration (across both HHI and HHI adjusted) across both groups of countries – the 46 EU & OECD countries and as well across the 20 EU Euro countries – we conclude that mobile network average download speed is higher in more concentrated mobile markets. If not, we conclude that mobile network average download speed is not higher in more concentrated markets and hence an increase in mobile market concentration due to consolidation (e.g., 4 to 3 mobile merger) will most likely not lead to higher (faster) mobile network average download speed.

In the scatter plots below, we present the relationship between the country median mobile network average download speed and mobile market concentration (Herfindahl-Hirschman Index and Herfindahl-Hirschman Index adjusted) in the group of 46 EU & OECD mobile markets.



Mobile market concentration vs. mobile network speed

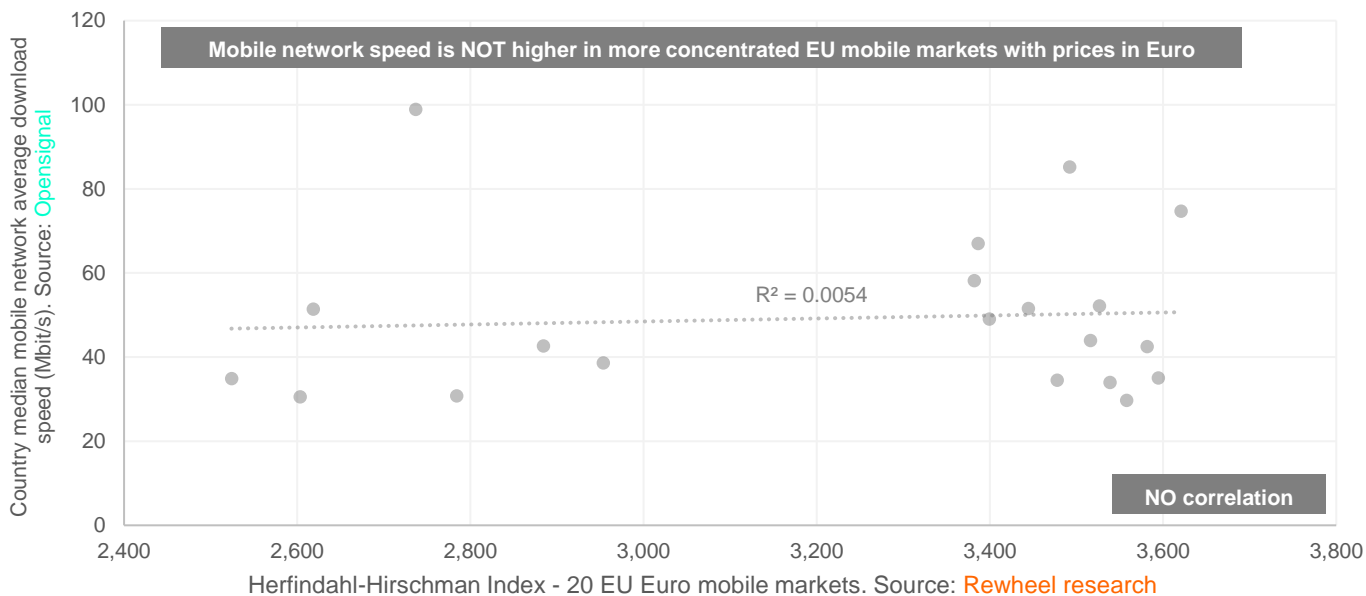


HHI adjusted for transitional effects of consolidation (e.g. 4 to 3), new entries, network sharing, MNO-to-MNVO and maverick MNO effect.

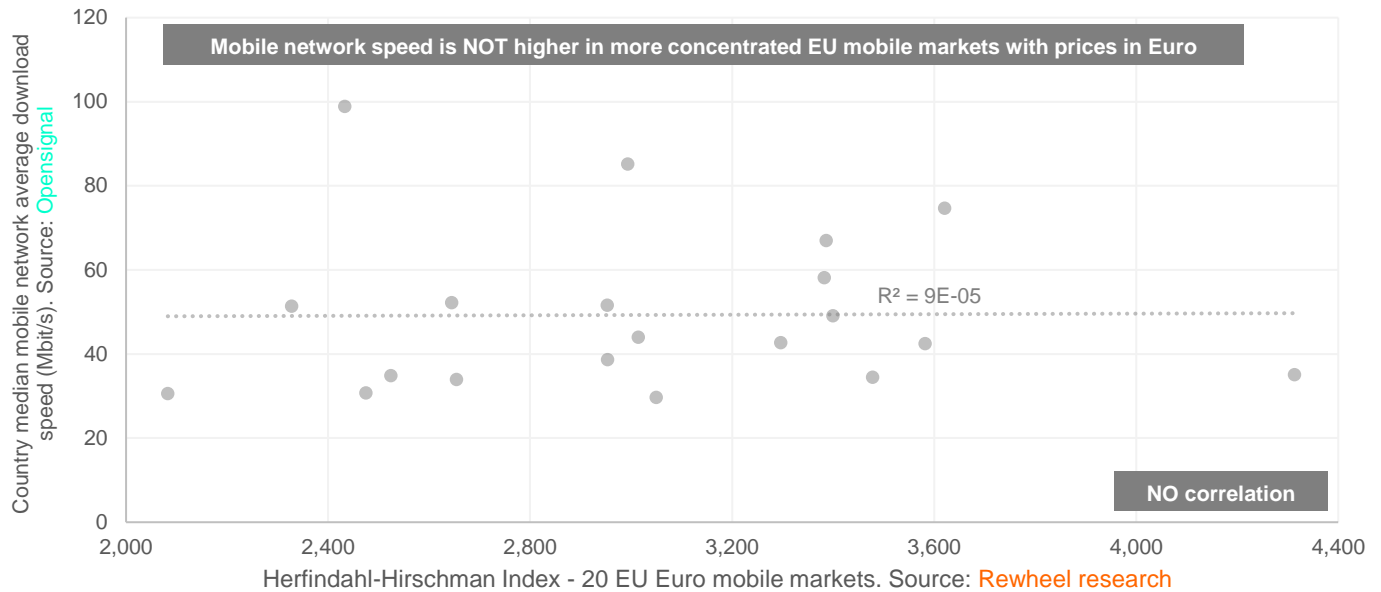
As seen in the scatter plots above, while there are weak positive correlations between the country median mobile network average download speed and mobile market concentration as measured by HHI and HHI adjusted, the correlations are NOT statistically significant. The critical value for a 95% confidence interval with 44 degrees of freedom in a two-tailed test is $\alpha=0.2907$ and the r (Pearson) value of the correlation is 0.1686 ($R^2=0.0284$) for HHI and 0.2480 ($R^2=0.0615$) for HHIa respectively.

In the scatter plots below, we present the relationship between the country median mobile network average download speed and mobile market concentration (Herfindahl-Hirschman Index and Herfindahl-Hirschman Index adjusted) in the group of 20 EU mobile markets with prices in Euro.

Mobile market concentration vs. mobile network speed



Mobile market concentration vs. mobile network speed



As seen in the scatter plots above the weak positive statistically NOT significant relationship between the country median average download speed and mobile market concentration seen among the group of 46 EU & OECD mobile markets is no longer present in the group of 20 EU Euro mobile markets. In the group of 20 EU Euro mobile markets mobile network average download speed and mobile market concentration have NO relationship whatsoever.

This expected finding highlights the main flaw of average download speed as a measured of mobile network performance from the end-user perspective. As we explained in the study context and in many of our previous studies the average mobile network speed is affected by countless technical and commercial factors and/or limitations such as operator spectrum holdings, deployed sites, deployed carriers, carrier configuration, EMF limits, mobile network traffic data load (how congested or empty is the radio network) and end-user speed restrictions (speed tiers/caps etc).

The group of 46 EU & OECD mobile markets includes many markets from developing countries (e.g., Colombia, Chile, India, Malaysia, Peru) with relatively low mobile market concentrations and relatively low mobile network average download speeds. For more information in this topic see Rewheel's 'Wireless market and operator competitiveness – 2023' study²⁶. In those markets mobile network operators hold substantially less spectrum, have deployed substantially fewer mobile sites, have deployed fewer 5G sites and in some cases have not deployed 5G yet. As a direct consequence, mobile network average download speed is substantially lower in those markets. The more sites and spectrum per site and operator deploys and the more of those sites and operator equips with 5G the faster the average download speed of the operator.

On the other hand, there is lower variation in spectrum holdings, deployed sites and 5G deployment among the 20 EU Euro markets and hence if higher mobile market concentration was in fact leading to higher mobile network average download speed, then we would expect the relationship between mobile market concentration and mobile network average download speed to strengthen among the group of 20 EU Euro mobile markets.

But rather than strengthening the analysis in the group of 20 EU Euro mobile markets shows that there is NO relationship whatsoever between the mobile network average download speed and mobile market concentration.

Moreover, when considering what end-users value the most i.e., consistent quality and reliability rather than mobile network average download speed the fact is that a mobile network that has higher average download speed does not mean that that network will automatically have as well better consistency and/or reliability. For example, as seen in the table in page 12, Softbank is the mobile network operator with the lowest average download speed among the 4 Japanese MNOs, and despite that, Softbank is the operator with the highest Consistent Quality score in Japan.

²⁶https://research.rewheel.fi/downloads/Wireless_market_operator_competitiveness_2023_PUBLIC.pdf

5 Mobile market concentration vs. network performance and speed – NO correlation

The scatter plots below summarize the main findings of this study: NO relationship whatsoever exists between mobile network performance (Consistent Quality and Reliability Experience) and mobile market concentration (HHI and HHIa) or between mobile network average download speed and mobile market concentration (HHI and HHIa).

