

Techno-economic analysis on Mobile Network Sharing contribution to social welfare at 4G-5G area in Hungary

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Abstract—Telecommunication sector faces to parallel investments into both fixed and mobile (5G) networks, however return on investments lag behind profit expectations. Co-investment, like mobile network sharing is a cost efficiency enabler that may accelerate price decrease, may allow earlier, higher coverage and may improve capacity and quality parameters, like download speed, therefore altogether contributes to social welfare increase.

The purpose of this paper to assess the Hungarian mobile network sharing that not cleared by the competition regulator, however has been placed in unchanged form for 8 years.

The research question is to assess what is the connection between mobile network sharing and social welfare improvement at 4G - 5G mobile broadband rollout.

The finding is that, majority of network sharing procompetitive effects allowing benefits, but anticompetitive effects not causing marked distortion. Affordable connectivity prices for information society roots in operators’ cost efficiency, however further research required to assess proper level of efficiency gains pass through to customers and appropriate level of access pricing to shared infrastructure for other rival operators in Hungary. Mobile Network Sharing’s benefits may outweigh potential drawbacks, but due to lack of regulatory clearance, 5G rollout launched without sharing, causing social welfare loss.

The originality of the empirical research is despite network sharing not cleared, procompetitive advantages may outweigh anticompetitive ones.

Index Terms—5G, mobile network sharing, cost efficiency, regulation, social welfare

I. INTRODUCTION

CORPORATE cooperation, like mobile network sharing has received increased attention across a number of disciplines in recent years. The EU aim is the widespread of 5G mobile broadband internet, however the optimal way forward is not clear. Corporates require more cooperation and even consolidation for higher economies of scale, however regulation put a stress on competition and innovation that expectations need to be harmonized.

This paper has been divided into five parts. *The first, introduction part* deals with the Mobile Network Sharing forms and the key driving factors from corporate and regulation sides. In the *second part, the literature review* proceeds the cooperation and co-investment forms, the telco sector as well

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as procompetitive and anticompetitive theories. *The third part* covers the research sub-questions, related measures and quantitative empirical research methodology. In *the fourth, discussion and results part* the Hungarian Network Sharing Agreement is introduced and key measurable procompetitive and anticompetitive effects are assessed. *The fifth, conclusion part* summing up the novelty finding that despite Network Sharing not cleared, the benefits might overweight competition concerns, and benefit loss is foreseen related to 5G rollout due to the absence of extended agreements.

One of the main cost efficiency measurements is the operator-operator collaboration, like horizontal agreements (Network Sharing), covered in this paper and TABLE I. shows the main dimensions of *Network Sharing Agreements (NSA)*.

TABLE I
OVERVIEW ON NSA TYPES

Dimensions of RAN related Network Sharing Agreements		
#	Dimensions	Sub-categories
1.	Technology domains	<ul style="list-style-type: none"> ▪ passive infrastructure elements: towers, masts ▪ additionally active infrastructure elements, like radio –Multiple Operator Radio Access Network (MORAN) ▪ additionally spectrum – Multiple Operator Core Network (MOCN)
2.	Spectrum bands	from a certain spectrum layer, e.g., 800 MHz to full scope
3.	Technology generations	from a certain generation, e.g., 4G to full 2-5G range
4.	Areas	<ul style="list-style-type: none"> ▪ density (rural, urban, exemptions, like capital) ▪ ratio of covered territory (geographic area) ▪ ratio of covered inhabitants ▪ the way of sharing, e.g., geographical split
5.	Market context	<ul style="list-style-type: none"> ▪ number of operators (on the market; participating in NSA) ▪ position of participating operators (market shares) ▪ market concentration (HHI index)

Dimensions of RAN related Network Sharing Agreements		
#	Dimensions	Sub-categories
6.	Operational model	<ul style="list-style-type: none"> cooperative model (e.g., Joint Ventures) contractual model (e.g., reciprocal, one-way sharing) transfer pricing (public, cost based versus any other cases)
7.	Duration	Temporary or mid/long term permanent
8.	Driver	Commercial benefit or regulatory imposed

Source: [1]

Based on regulatory practice, shared technology domains (passive-active) and covered areas (rural-urban) are the most decisive dimensions from the list above. In practice the main cases handled by regulation are *passive sharing* and *active sharing* (MORAN), but additional spectrum sharing (MOCN) many cases ruled-out. The higher the scope, the higher is the financial benefit (saving) and parallel the highest the potential restriction impact on competition and innovation incentives. The higher scope preferred by Mobile Network Operators (MNOs), the smaller scope preferred by regulators. The expected network sharing's cost savings may exceed one third of investment capital expenditure (CAPEX) and operational expenditure (OPEX) based on Arthur D. Little consultancy estimation [2].

II. LITERATURE REVIEW

At first, I take the focus to literature on cooperation forms, review of telecommunication value-chain and market structure. Secondly, I show the NSA relevant legal framework from sector and competition regulation point of view. Thirdly I summarize recent studies related to NSA benefits (procompetitive aspects) and drawbacks (anticompetitive concerns).

A. Cooperation forms

Mobile Network Sharing Agreements from competition policy point of view belongs to merger and horizontal agreement categories. From industrial organization aspects the literature refers to it under co-competition definition. The telecommunication sector regulation refers for the cooperation as co-investment.

Mergers and horizontal agreements

A *merger* is an agreement between two existing companies to form a new legal entity under one corporate name. The *horizontal merger* is a merger between competitors. Based on Motta [3], the merger has to be evaluated whether the merged firm can unilaterally (non-coordinated) exercise market power and raise prices, as well as whether can apply pro-collusive (coordinated) actions that might substantially lessen the competition and raise prices. The *horizontal agreement* is a softer form of horizontal merger, the NSA is handled as a *horizontal production agreement*.

Co-competition

From industrial organization approach Brandenburg-Nalebuff [4] name NSA-like cases as a *co-competition*, a parallel cooperation and competition at the same time. It is a cooperation in creating value, and a competition in dividing it up simultaneously. In NSA there is a technology production (mobile network services) cooperation and there is fierce competition at end-user retail mobile telecommunication market.

Co-investment

The new European Electronic Communications Code ("Code" or EECC) introduced in 2018 [5] the *co-investment* for VHCN, that is an exchange for regulatory flexibility compared to standard access remedies. Originally it is used for fixed network investments, but mobile network sharing among competitors is also a typical co-investment.

European MNOs standpoints related to cooperation

European MNOs requesting room for building scale in the telecom industry [6]. Vodafone CEO also added the European mobile market is "*hyper fragmented*", and not only "*cooperation*" (interpreted: network sharing), but also "*consolidation*" (interpreted: merger) needed.

Cooperation levels related to network sharing types

In case of infrastructure owner MNOs, Fig. 1 shows the different sharing status.

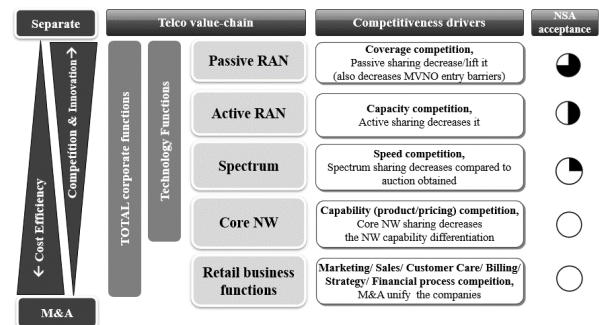


Fig. 1: Overview on NSA related horizontal agreement milestones to M&A Source: [7]

The higher the horizontal agreement scope (covered network domains and corporate functions), the closer the horizontal merger and acquisition (M&A) case that represents the highest cost efficiency but may soften competition. NWS, as a network production agreement is on the mid way, affecting just coverage and/or capacity competitiveness drivers, while product capability in core network and all other business function differentiators are unimpacted. Regulatory acceptance is positive and high for passive sharing, but gradually decreasing involving active elements or even spectrum. Further co-investment covering whole network functions or even other corporate functions, would reach already the status of acquisition, exceeding the network sharing framework.

Telecommunication value-chain and market structure

Papai [8] identified the following three layers, as production layer, wholesale layer and retail layer. Production layer

contains the network technology as a service, which is sold by wholesale either to own retail internal end customers or to Mobile Virtual Network Operators (MVNO). Therefore, the network technology market becomes a functional *upstream market* and the retail market is a *downstream market*. Mobile Network Sharing Agreements impact the production upstream market only.

Network technology production in upstream market consists of Radio Access Network (*RAN* – e.g., base station, towers), Transmission (TRM, mainly has an access part and core part) and *Core Network*, which is the intelligent part of the network. Mobile Network Sharing Agreements impact only the RAN and the access TRM parts. Important note that only RAN production part of network technology upstream market is affected, the Core part remains fully independent that allows MNOs to determine and differentiate their own product, service and pricing capabilities.

The *relevant market* is where from supply aspect the substitution is limited, and from demand side it is without choice if a certain type of service is needed. In this research paper the relevant market is the retail telecommunication service market at HU level.

B. Regulatory framework

The regulation has dual aims: on one side encourages investments and higher coverage, on the other side preserves incentives for competition and innovation.

Sector regulation

The Sector regulation (National Regulatory Authorities – NRAs), represented by Body of European Regulators for Electronic Communication (BEREC) at EU level, has equal focus on meeting Digital Decade 2030 connectivity (100% of EU households covered by Gigabit network and 100% of population covered by 5G) in a cost-efficient way, as well as maintain incentives for preferred infrastructure-based competition and innovation.

The direct regulation elements are the OECD guideline on Wireless Market Structures and Network Sharing [9] and BEREC Common position on infrastructure sharing [10]. The OECD report makes use of competition policy categorizations of potential anticompetitive behavior and distinguishes between potential unilateral and coordinated effects of infrastructure sharing agreements. The BEREC common position from 2019 principally assesses the feasibility of infrastructure-based competition and refers to the population density of the areas.

Competition regulation

The competition regulation (National Competition Authorities – NCAs) main focus is to prohibit such cooperation that may prevent, restrict or distort the competition, that may decrease social welfare. However, it handles exemption, where the restriction of competition kept at minimum level and compensated by technical or economic benefits, from which fair share pass through to customers. In other words, cost efficiency benefits considered just on those cases, where it outweighs potential competition drawbacks. [11]

C. Mobile network sharing related procompetitive and anticompetitive effects

In the last part of literature review the Mobile Network Sharing Agreement relevant main benefits, drawbacks and a potential netting are summarized. Recommendations for more likely regulatory approvals will be concluded also.

Procompetitive effects (benefits)

NSA related benefits for social welfare are listed in TABLE II.

TABLE II
OVERVIEW ON NSA PROCOMPETITIVE EFFECTS

#	Benefit	Main elements
1.	Improved Network Efficiency	Sharing leads to faster and wider rollout of high-speed networks coverage and higher quality.
2.	Cost reduction and efficiency gain pass through consumers	Sharing of deployment costs, sharing of operational costs, leading to lower prices.
3.	Enhanced customer choice	Enhanced competition, benefiting customers in terms of lower prices and facilitate entry for third-party operators.
4.	Environmental benefits	Single infrastructure, with less impact on environment.

Source: Author’s summary on [9], [10], [11]

Anticompetitive effects (drawbacks)

The discussion on potential anticompetitive effects of NSA follows the structure of BEREC Common Position and OECD guideline, summarized in TABLE III.

TABLE III
OVERVIEW ON NSA ANTICOMPETITIVE EFFECTS

#	Drawback	Main elements
<i>Unilateral (non-coordinated) effects</i>		
1.	Reduced incentive for investment	Shorten incentives for unilateral investment or hold-up strategies resulting in lower total network investment.
2.	Decreased differentiation	Constrained for differentiation from co-investment partner, unilateral investment, service innovation and other independent strategies;
3.	Excessive access or transfer pricing	Raising internal and/or external access prices to soften competition and raise final prices at the downstream (retail) market

#	Drawback	Main elements
<i>Unilateral (non-coordinated) effects</i>		
4.	Incentive for foreclosure	Raise market entry barriers by excluding third-party potential rivals with deterring access conditions (e.g., prohibitive, excessive access prices, too high commitments). In case of MVNOs, it is vertical impact also.
5.	Cost disadvantages	Outlayer competitor might face to a cost disadvantage, weakening its competitive position, (but any investment in coverage or quality has this effect, is a normal feature of competitive dynamics)
6.	Deter late co-investments	Cherry-pick from third parties, deter late co-investments.
<i>Pro-collusive (coordinated) effects</i>		
7.	Explicit collusion	Potential explicit collusion, depending on the possibilities to exchange information and to coordinate on more than joint investment required.
8.	Tacit collusion	Potential tacit collusion depending on partners' ability to: coordinate on a collusive 'agreement', detect deviations from the agreement and punish deviations.
<i>General effect</i>		
9.	Network supply security	Network resilience: a single rather than multiple infrastructures may imply that in case of network fault, consumers cannot switch to another network.

Source: Author's summary on [8], [9], [10]

Net impact review of pro- and anticompetitive effects

Motta and Tarantino [13] studied the impact of a network sharing agreement between two (mobile) operators on prices and investment in an oligopolistic mobile market. They analyzed the incentives to invest in cost-reducing innovations: coordinate their investment while competing in prices. They found that without merger's investment synergies, a horizontal merger reduces consumer welfare. If synergies are sufficiently large, consumers benefit, as network sharing agreement leads to lower prices and higher investment, and therefore increases consumer surplus.

III. RESEARCH METHODOLOGY

The *research aim* of this paper to quantify, measure and assess mobile network sharing related procompetitive and anticompetitive effects, listed in TABLE IV.

TABLE IV
OVERVIEW ON NSA EFFECTS RELATED MEASURES

#	Benefit/Drawback	Measures
<i>Procompetitive effects assessment</i>		
1.	Improved Network Efficiency	4G and 5G related: Coverage, Penetration, Used Capacity (monthly average data traffic per subscriber), Speed
2.	Cost reduction and efficiency gain pass through consumers	Unit cost decrease and fair share pass through to retail prices (bucket view)
<i>Anticompetitive effects assessment</i>		
3.	Excessive access or transfer pricing, incentive for foreclosure	Cost based and open transfer prices, 3 rd party partnerships
4.	Market context and cost disadvantages	Market context impact: market concentration, market share (voice subscriber, data traffic and service revenue based). Revenue based profitability (EBITDA/Sales)
5.	Decreased incentive for competition (differentiation), incentive for collusion	Different market strategies and offers
6.	Reduced incentive for investment	CAPEX intensity (CAPEX/Sales) – limited accessibility

Source: [14]

In the fourth, discussion and results section these measures are evaluated for Hungary (HU) for 2014-2021 period.

This study employs quantitative empirical data based approach both for primary and secondary data analysis. The research design contains conclusive researches, in both descriptive and causal approaches. Descriptive research with cross-sectional design and in some cases also with longitudinal design applied for all measures related to network quality and market context description. Causal research is limited to representative sample analysis, as not enough reliable data (observations) are available for correlation analysis of profitability and investment intensity neither for cross-sectional, nor for longitudinal design.

IV. DISCUSSION AND RESULTS OF HUNGARIAN MOBILE NETWORK SHARING ASSESSMENT

Although competition regulation raised potential serious concerns already in 2015, the case have not yet been concluded, therefore NSA has been in place in unchanged form for 8 years.

TABLE V. shows the main characteristics of HU mobile market.

TABLE V
OVERVIEW ON HU MOBILE MARKET

Dimensions (data for 2021 YE)	Hungary
Territory	93,030 sq KM
Population	9.73 Million
GDP per capita (PPP based, in USD), 2020 YE (EU27 avg: 44,791 USD – Worldbank)	33,076 USD
Total subscribers (active SIM cards) (HU: 2021 H1)	11.23 Million
TOP 3 MNOs and Market share (subscriber based, active SIM) (HU: 2021 H1)	1. Magyar Telekom (DT): 43.9% 2. Vodafone: 27.4% 3. Telenor/Yettel (PPF): 26.8%
Avg. Voice minutes (per active SIM, monthly) (EU27 avg: 186 min – Statista.com)	200 min
Avg. Data traffic (per data using active SIM, monthly) (HU: 2021 H1) (CEE: 9.9 GB; Western EU: 15.5 GB – Ericsson)	7.2 GB

Source: Author’s summary based on [15], [16]

HU market is a typical 3 MNO player market, MVNO presence become insignificant, the market is matured, however slight changes took place, in HU Vodafone has grabbed the 2nd position based on more measures in recent years.

Mobile network sharing agreement in HU

In the Hungarian case the integrated incumbent market leader (both fixed and mobile) Magyar Telekom (subsidiary of Deutsche Telekom) entered into an MOCN (passive + active asset and spectrum sharing) NSA with second market player Telenor Hungary (at that time owned by Telenor Group, later sold to PPF Group) on 4G LTE 800MHz rollout in the whole country with geo split operation, except capital Budapest. The highest cost saving potential, but from regulatory aspects most opposed MOCN NSA concept might come from Telenor side related to Danish market, where Telenor Denmark and Telia Denmark had an approved MOCN NSA from 2012. Third market player Vodafone appealed the NSA at NCA. Local NRA approved the agreement driven by technology spectrum efficiency aspects, however local NCA raised concerns in 2015, but final decision not made till nowadays. This resulted, that no further NSA made in the market, however 5G non-standalone rollout started with 2-4G lifecycle network swap in separated 3 networks, apart from the only shared 4G L800 MHz layer.

TABLE VI. summarize the main characteristics of the HU NSA.

TABLE VI
OVERVIEW ON HU NSA

#	Dimensions	Hungary
1.	Technology domains	MOCN (passive + active asset + spectrum sharing)
2.	Spectrum bands	4G 800 MHz – rural coverage spectrum (temporary 3G 900MHz - rural coverage spectrum)
3.	Technology generations	4G (temporary 3G), no 5G extension
4.	Areas	Population coverage: 80% Geo split: Magyar Telekom (East), Telenor (West), exemption Budapest
5.	Market impact	Started: from 2014 (4G 800MHz), 2016-2019 temporary for 3G (900MHz) rural 3 MNO market, HHI is: 3517 Parties: Magyar Telekom (No.1 player) and Telenor (No.2 player)
6.	Operational model	contractual (4G reciprocal; temporary 3G one-way sharing)
7.	Duration	from 2014, end 2029 (expires the 800MHz license) (temporary only 3 years till 2019) transfer price: no public information disclosed
8.	Driver	commercial driven

Source: [1]

Regulatory assessment

In 2015 NMHH, the Hungarian NRA was notified by Magyar Telekom and Telenor Hungary about the NSA to mutually and partially share the spectrum with each other in the 4G LTE 800 MHz band nationwide with exception of capital Budapest. NMHH approved the lease, as a secondary trading. NMHH declared, the agreement enabled both operators to offer a larger capacity and better technology characteristics. NMHH examined that the individual obligations linked to the individual licenses are fulfilled. As NMHH had no competence to examine the competition law aspects of the lease agreement, NMHH sent its decision to the NCA for information. [17]

In 2015 GVH, the Hungarian NCA launched the investigation process with respect to the NSA.

In 2018 GVH held unannounced inspections at both parties of the cooperation in order to examine whether there was collusion during the spectrum tender in 2014. Therefore, NSA related investigation was extended for last spectrum tender, contained 800 MHz. The aim of the investigation was to assess whether the agreement may have been aimed at sharing the relevant market in advance and at coordinating the bids of the undertakings with the purpose of fulfilling the tender’s

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conditions. These practices may have violated provisions of the Hungarian Competition Act and TFEU, which prohibit agreements restricting competition. [18]

In 2019 GVH communicated that investigation still ongoing. Probably the Hungarian NRA also wait for the EC final decision related the Czech NSA case. Despite Czech case already reached an agreement in July 2022, HU case still unclear.

In this chapter at the research methodology listed potential procompetitive and anticompetitive measures will be analyzed for concrete HU market figures in order to assess the NSA impact.

A. Network Efficiency Improvement

Coverage

The cost driver of telecommunication investments moved from voice to data traffic, therefore the expected NSA benefit can be measured related to 4G LTE mobile broadband internet, shown in TABLE VII.

TABLE VII
OVERVIEW ON HU 4G COVERAGE SURPLUS

4G coverage (% of households [average of operators])	2018	2019
EU	94%	96%
Hungary	96%	97%

Source: Author’s summary based on [19], [20]

TABLE VII. displays that HU had higher coverage in the early matured period of 4G, compared to EU average. It means that the NSA boosted 4G rollout was faster, than in other EU countries.

Capacity (Speed and Quality)

Capacity drives the download and upload speeds of the network, from which the ranking positions out of 87 countries displayed in Fig. 3.

Country (Ranking #)	4G availability	Video experience	Download speed	Upload speed	Latency
Hungary	8.	2.	11.	8.	2.

Fig. 3. Overview on 4G download speed experience in Q1 2019

Source: [21]

The download speeds are in the high segment for Hungary, to which 4G NSA may contributed also. The Hungarian MOCN NSA (network sharing includes spectrum sharing) also enabled the good results. NSA participant Magyar Telekom and Telenor in the 800 MHz spectrum tender in 2014 successfully acquired 10-10 MHz blocks unilaterally that could combine to double (20 MHz) bandwidth.

Mobile Data usage (GB traffic)

Data usage trends are summarized in Fig. 4 and 5.

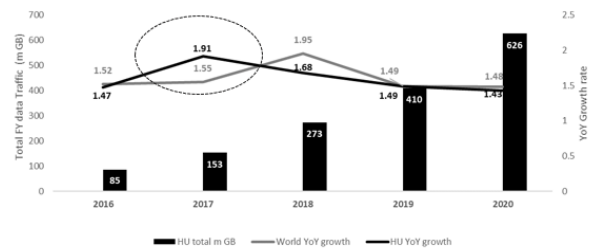


Fig. 4. Overview on Total Data traffic growth in HU

Source: Author’s summary based on [15], [16]

In HU after major part of the 4G LTE network on 800 MHz shared rolled out (2016-2017), there was a tremendous year-on-year total data traffic increase (almost doubled the traffic) in 2017, which peak was 1 year ahead of data blow-up at worldwide. In case of HU, the NSA led faster rollout was the definite driver of data growth and it enabled Telenor to launch a differentiating unlimited data offer.

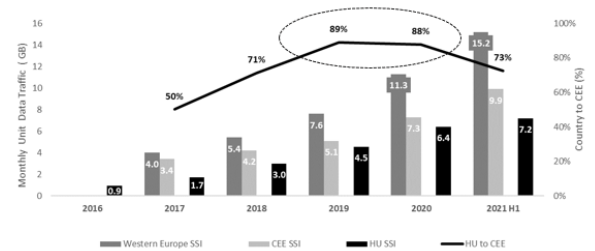


Fig. 5. Overview on Monthly Unit Data traffic in HU

Source: Author’s summary based on [15], [16]

After major part of shared 4G LTE network rolled out, the GAP between CEE and HU SIM card level unit data traffic began to narrowing and NSA enabled to reach 89% of the CEE average traffic in 2018 due to the mentioned Telenor offer. However later the lack of shared 5G rollout also contributed to the data growth slowdown and the GAP started widening again. The findings clearly indicate that NSA contributed to network efficiency improvement and increased social welfare in HU.

B. Cost reduction and efficiency gain fair sharing

Network OPEX (site rental, energy cost, operational & maintenance cost, personnel cost, transmission cost, spectrum yearly fees) were responsible for 48% of telco Total OPEX in 2021 based on Analysys Mason [22] and the dominant part related to RAN. The 30-40% NSA related efficiency gain results some 10% cost savings at company level.

GB costs, therefore the GB prices also decreasing without Network sharing, as data traffic growth exceed the cost increase. Price decrease coming from a mixture of new technology generation and additional cost efficiency actions, like network sharing.

Retail price benchmarking

In the EU one of the most accepted telco price benchmarks is the *Empirica report* that key findings on HU usage pattern fitting baskets summarized in TABLE VIII.

TABLE VIII
OVERVIEW ON HU USAGE PATTERNS AND EMPIRICA BASKETS

HU Baskets Data in 2020	Voice (call unit)	Voice (minutes)	Data (GB)
HU SSI	70	243,9	6,4
HU LSI (w FWA)	0	0	28,3
Empirica I6 basket (voice and data - SSI)	30	80	5
Empirica I4 basket (voice and data - SSI)	300	600	5
Empirica MBB5 basket (data only - LSI)	0	0	20

Source: Author's summary based on [15], [24]

Fig. 6. shows the I6 and MBB5 basket relevant overall detailed ranking.

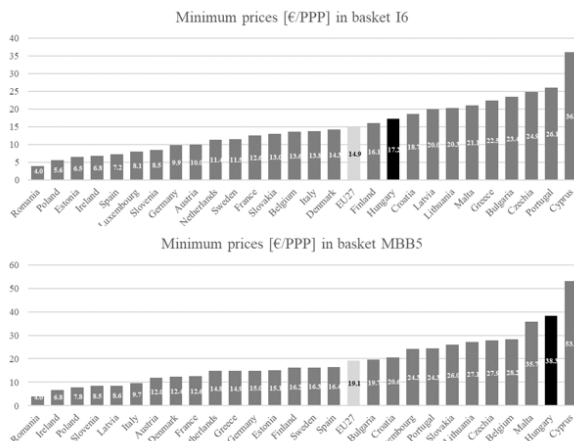


Fig. 6. Detailed country price ranking in I6 and MBB5 baskets

Source: [24]

Based on Fig. 6. HU market belongs to the (most) expensive markets in voice and data bundle (SSI - Small Screen Internet via smartphone) and data only (LSI - Large Screen Internet via stick) most relevant baskets, covering average usage habits. HU position is better in bundled I6 package, but almost at the high-end in data only segment.

Other standard reports show quite similar picture also based on *OECD Mobile voice and Data as well as the Mobile Broadband reports* made by Teligen Strategy analytics or *Rewheel researcher*.

There is a difficulty in reaching a final conclusion on whether fair share from NSA related efficiency gains passed through to customers, despite realized cost reduction.

C. Excessive access or transfer pricing

Limited information published on charging mechanism between NSA parties to judge excessive access or transfer pricing, as it belongs to confidential information on commercial contract terms. It is known that HU NSA not built on cooperative agreements (special joint venture), but on contractual agreement (reciprocal access sharing).

Excessive access prices may incentivize foreclosure of other MNOs or MVNOs. Vodafone was the biggest outlayer telco in HU. When Vodafone realized financial disadvantages of outlayer position, it would have been difficult go for nationwide asset company model to serve three MNOs both from corporate and regulation perspective.

Regarding other players in the HU market MVNOs continuously loosed ground as second brands were retired (Tesco, Lidl Mobile) or acquired (UPC mobile by Vodafone-Liberty transaction). There is one half MNO, half MVNO player, the ex-subsiary of Romanian Digi, bought by 4iG in 2021. Digi managed to buy only very limited spectrum at 1800 MHz and 3600 MHz in the mobile segment, therefore it was unable to launch a fully-fledged MNO service. Digi made a lot of local deals for passive sharing even with the NSA parties, however such a big deal that was disclosed as in Germany between 1&1 Drillisch and Vantage TowerCO, was not announced. 4iG resolved the lack of spectrum in mobile services by buying the Vodafone HU in 2023.

D. Market context and cost disadvantages

Market concentration

Bourreau in [23] provided a market concentration overview for the European market per country. Calculations based on GSMA and company data, applying the cumulative criteria of number of network operators (3 or 4) and the industry concentration (measured by Herfindahl-Hirschman Index, HHI). Out of EU 27 markets only 9 markets are 4-player and 18 markets are 3-player. Out of 3 player markets, HU located in the mid-low segment in HHI ranking with value of 3517, that means there are 13 Member States with a higher industry concentration among 3-MNO market. So, there is no extraordinary market context that would restrict market competition in HU market.

Market shares

Development of market shares may reveal unfair market behavior and anticompetitive trends, if NSA outlayer companies loosing continuously ground. HU relevant market share (MSH) trends are displayed on the followings: Fig. 7. shows the active (voice) SIM and service revenue based, Fig. 8. the data generating SIM based and data traffic, GB based.

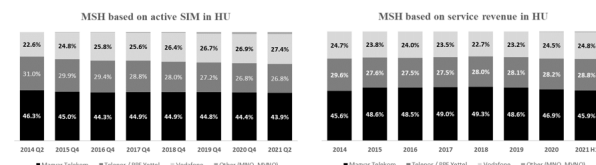


Fig. 7. Market shares based on active SIM cards and service revenue in HU

Source: Author's own summary based on [15]

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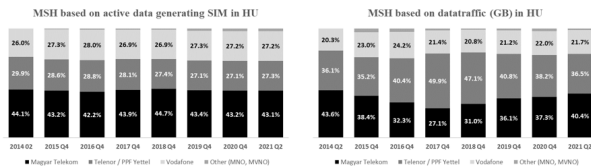


Fig. 8. Market shares based on data generating SIM cards and data traffic in HU

Source: Author’s own summary based on [15]

It is visible that NSA outlayer Vodafone’s MSH in all of the 4 cases has increased in HU that is significant finding refers to NSA not distorted the market position of Vodafone, therefore the competition. The share of other MNVOs, MNOs, also show some slight increase in the majority of the categories. The highest increase in Vodafone’s market share took place in active SIM based comparison in HU, where almost 5% increase was enough to overtake NSA participant Telenor in the ranking and grab the 2nd position (Fig. 8.).

Summing up, the NSAs in HU not restricted the competition in terms of outlayer operator losing market share. This is an important evidence that the opposed NSAs did not restrict the competition and not cause a harm to social welfare.

Cost disadvantages

Cost disadvantage as an unilateral effect may restrict competition via weakening competitive position of NSA outlayer companies. The relevant indicator is the *EBITDA/Sales* revenue based profitability margin, presented in TABLE IX.

TABLE IX
OVERVIEW ON EBITDA MARGINS IN 2019 IN HU

EBITDA /Sales margin (2019FY, After Lease - IFRS16 corrected back)	HU
Telekom (Magyar Telekom – converged)	29.4%
PPF (Telenor HU – pure mobile)	36.7%
Vodafone (Vodafone HU both pure mobile)	22.3%

Source: Author’s summary based on operators’ Financial reports for 2019

In Hungary the NSA outlayer Vodafone’s EBITDA margin lagged behind significantly and stood only at 22.3%. Vodafone’s market share after more than 15 years entering into the HU market just slightly exceeded 22% on active SIM cards. On one hand Vodafone’s cost structure and amount is similar to competitors, who own 30% - 40% of the market revenues, therefore gaining higher profitability. On the other hand, the analyzed 2014-2021 period was the time, when Vodafone managed to overtake Telenor and grab 2nd position in the market gradually. Based on Vodafone’s strategy the first priority was to increase SIM volume and revenue market shares, therefore overspent the market, thus EBITDA margin stuck in under 25%. So potential cost disadvantage of outlayer NSA position was not the driver of lowest profitability.

The other financial indicator of potential cost disadvantage is *CAPEX intensity (CAPEX/Sales margin)*. In 4G investments’ peak 2-3 years period, it may have resulted marked extra investment for outlayer Vodafone, but not such a tremendous that could weaken its competitive position, shorten market competition and harming social welfare.

E. Decreasing incentive for competition (differentiation) and investment

At theoretical level in section II.A Cooperation forms, it was presented that although passive NSA in coverage and active NSA in capacity may decrease differentiation in RAN segment, for whole network capability in the Core NW segment is responsible for product and service differentiation. Core segment is unshared and all of the other business (marketing, sales, customer care) and overhead (strategy, communication) functions of the participants are separately managed.

In spite of NSA, preserved differentiation in Network can be demonstrated at the Hungarian market by one case study. In 2016, after majority of the 4G LTE 800MHz network was rolled-out, the pure mobile operator Telenor Hungary launched an out-of-box reverse (data first) unlimited data offer [25]. The enabler was the NSA with more and faster rollout, and as a pure mobile operator wanted to immediately take and advantage of 4G countrywide (coverage and capacity). As Fig. 8. showed, Telenor’s data traffic blowup at that. It is highly demonstrative example, that NSA participants on the same network how different business strategy can build.

Reduced differentiation might rooted in *wider information exchange*. Considering differentiation examples above, there are no sign of *tacit collusion*. However, all current full-fledged MNOs in HU market are highly incentivized to preserve the total market profitability and therefore in competition they do not introduce such disruptive and status quo changing offers that might generate a negative spillover effect for total market profitability.

CAPEX/Sales margin is the industrywide measure of investments, however there is limitation on availability. Based on financial reports Magyar Telekom converged operator has stable CAPEX/Sales ratio, exceeding 15% without spectrum license acquisition cost and After Lease (IFRS 16 correction back) effect, which is in line with industry investments. PPF Telecom Group, including converged and pure mobile operators as well as asset company, for the CEE region reported an overall CAPEX/Sales margin under 15%, exceeding 12%, as blended figure of higher converged and lower pure mobile investments. For Vodafone no local data reported. Based on available information there is no sign of reduced investments due to NSA.

V. CONCLUSION FOR 4G, 5G AND SOCIAL WELFARE

The main goal of this study was to assess the Hungarian mobile network sharing agreement impact for social welfare. MNOs strive for more cooperation (horizontal agreement) and even consolidation (merger) in the “hyper fragmented”

European market to reach better economies of scale, productivity and cost efficiency. Mobile Network sharing, as a horizontal agreement may restrict much less the competition, than a full-scale merger, however both sector and competition regulation has condition lists for approvals.

The more stricter competition policy lays on TFEU, that on one hand prohibits competition distorting or preventing agreements, however also allows an exemption where the restriction is kept to the minimum level and compensated by technical or economic progress, and a fair share of the efficiency gains passed to customers. Effects summarized in TABLE X.

TABLE X
OVERVIEW ON NSA EFFECTS AND FINDINGS IN HU

#	Benefit/Drawback	Measures	HU
Procompetitive effects assessment			
1.	Improved Network Efficiency	Coverage, penetration, capacity, speed	✓ ●
2.	Cost reduction and efficiency gain pass through consumers	Unit cost, retail prices	? ●
Anticompetitive effects assessment			
3.	Excessive access or transfer pricing, incentive for foreclosure	Cost, 3 rd player partnership	? ●
4.	Market context and cost disadvantages	Market concentration, market share, EBITDA/Sales	✓ ●
5.	Decreased incentive for competition (differentiation), incentive for collusion	Different market strategies	✓ ●
6.	Reduced incentive for investment	CAPEX/Sales	✓ ●

Source: Author's own summary

Conclusion for 4G

The conclusion is that there is no doubt on network quality related benefits of NSA and there is no visible investment decrease. The assessment is still positive on market context with the only exemption that 1st and 2nd players of the market made the NSA. Market concentration, market share trends do not justify shortening competition and the profitability trends do not display a serious cost disadvantage for outlayer players. There is no absence of differentiation in retail perceived strategies (rooted also in RAN segment), so there is no reduced incentives for competition. There is no sign of tacit collusion, however there are also no market status quo changing disruptive offers that may jeopardies market profitability. The assessment is unclear related to efficiency gain pass through customers, as based on standard benchmarks there is no clear evidence on relative improvement of retail prices compared to other EU countries, however it is doubtless that unit GB prices are falling. There is no transparency on access or transfer prices and

despite no direct connection can be detected, MVNOs' presence is low and no countrywide access deal has been published.

The conclusion for net impact is that there is no critical restriction for competition and harm for social welfare, therefore anticompetitive impacts kept at quite low level that are overweighted by technical and economic progress by efficiency gain partial sharing.

The main finding and the originality of this study, that despite active asset (MORAN) and spectrum (MOCN) sharing NSAs are highly opposed, the benefits outweigh potential drawbacks, the net contribution for social welfare is positive.

Consequences for 5G

Although 4G shared rollout not cleared by the regulator, but allowed to remain in operation in unchanged form, the concrete harm of uncertain regulation realized in 5G with more costly separate rollouts. Unfortunately, in HU market the NSA has not evolved further, as MNOs might evaluated at high risk to expand the agreement for 5G until existing NSAs are not cleared. This caused two critical problems from cost efficiency point of view: (1) 5G spectrum tendering (700MHz, 3500MHz) and 5G rollout was the current window of opportunity to extend NSAs for 5G; (2) around 2020 MNOs met the need of parallel 5G rollout and 2-3-4G RAN lifecycle swap that could have enlarged the savings potential for 2-3-4-5G scope in RAN consolidation. The missed savings opportunity not only a loss for MNOs, but has a cost for society as may slow down data unit price decrease, impacting 5G rollout and penetration development.

GSMA disclosed a study in 2019 on expected 5G cost evolution, that stated the TCO of 5G rollout is higher, than for 4G. GSMA said that the 5G baseline cost at TCO level is by 46% higher than the 4G reference cost, that could be optimized by network sharing and virtualization opportunities to reduce increase to 24% [26].

In Hungary the eNET consultancy prepared the National 5G strategy update, in which the bottom-up modelled assumption was, that the operation (OPEX) of 2-3-4-5G network in 2027 could be 1.7 times higher, than the 2-3-4G was in 2019, and the investment (CAPEX) for 2020-27 could be 2.5 times higher, than was in 2013-2019 without virtualization and further network sharing. The assumption for TCO level savings potential was almost 20% with passive sharing and top on came more than 10% additional for active sharing. [27]

Conclusion for 5G

There is trade-off between cost efficiency as well as competition and innovation. Due to lack of extended NSAs, substantial cost savings are missed, therefore cost efficiency was ranked into second position, after competition and innovation. Final conclusion extended for 5G in HU is that, on one hand there is a clear missed cost savings opportunity from 5G shared rollout, that may slowdown unit prices decrease and 5G widespread, on the other hand there is an unclosed evaluation of potential competition restrictions of 4G sharing, that's potential net negative impact based on the findings of this study could not be justified.

Techno-economic analysis on Mobile Network Sharing contribution to social welfare at 4G-5G area in Hungary

Due to data monetization challenges and missing savings incentives from extended NSAs the 5G rollout currently had a slower pace based on DESI report: 5G population coverage was 7% in HU, compared to EU average 14% in 2020. [28]

Future scope

The 5G is a technology shift, corresponding with *network function virtualization (NFV)*, *software defined networks (SDN)* enabling *open RAN* multivendor concept. At the second part of 5G lifetime the rollout will move *from macro cells to micro cells* in high density urban areas that requires extra investments and need of cooperation. However NSAs under current regime, especially active sharing, in particularly in the high-density populated urban areas are considered potentially competition restrictive, therefore harmful for social welfare, compared to infrastructure-based competition. The virtualization (NFV, SDN) and open RAN may move the competition into software based segment and increase the competition landscape in upstream vendor market that may contribute to more differentiation in RAN segment and more intensive competition in downstream market. Therefore *the current competition approach may require a full reassessment related to mobile network sharing in high density 5G macro and micro cell areas* that might be the future scope of next research.

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