

A Review of the Empirical Evidence on the Effects of Market Concentration and Mergers in the Wireless Telecommunications Industry

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Executive Summary

This report reviews 18 empirical analyses published in the last five years that study the effects of changes in market concentration (such as by merger) in the wireless telecommunications industry. Of those 18 studies, eight analyzed changes in market concentration across multiple jurisdictions between 2000 and 2015, while ten analyzed specific mergers. We also reviewed a recent study that considered the effects of market concentration in spectrum ownership in the U.S. on measures of quality.

Of the ten studies that looked at specific mergers, about half found that prices decreased following a merger whereas half found that prices increased. Even different studies of the *same* merger found wildly different effects on prices, ranging from significant price decreases to significant price increases. As regards the effect of mergers, including so-called 4-to-3 mergers, on price, the results might best be characterized as conclusively inconclusive.

We identified a number of reasons for these apparently divergent results, including:

- a lack of common measures of prices and price effects across studies;
- differences in the time period chosen; and
- difficulties accounting for variations in geography, demography and regulatory regimes between jurisdictions (the latter also creates a potential for endogeneity bias).

Of those studies that considered the effect on investment in 4-to-3 mergers, all found that capital expenditures, a proxy for investment, increased post-merger.

Several recent studies that looked more broadly at the effects of market concentration in the mobile telecommunications industry indicate that the highest levels of country-wide investment occurred in markets with three facilities-based operators (though total investment was not significantly lower in markets with four facilities-based operators). In addition, a recent analysis found that U.S. markets with higher concentration of ownership of spectrum had faster, more reliable cellular service.

Studies of investment also found that markets with three facilities-based operators had significantly higher levels of investment by individual firms. The implication is that in such markets, individual firms have stronger incentives to invest in the infrastructure that supports the range, quality, and quantity of services provided to

consumers. Studies also suggest this effect may be strengthened when the merger results in a market structure that is more symmetrical (i.e. the various facilities-based providers become more equal in market share).

From an investment perspective, the optimal number of wireless firms in a given market appears, in some studies, to be three; however, in some jurisdictions (such as those that are more densely populated), the optimal number may well be four, while in others (such as those with small populations that are widely dispersed) the optimal number may well be two. Regardless, there is little or no support for categorically claiming that the optimal number of firms in larger jurisdictions, or indeed in any jurisdiction, is four.

When evaluating the merits of a merger, authorities are charged with identifying the effects on the welfare of consumers. On the basis of the studies that we review, 4-to-3 mergers appear to generate net benefits to consumer welfare in the form of increased investment, while the effects on price are inconclusive.

Introduction

This study is prompted by the ongoing federal consideration of, and broader policy discussion about, the proposed merger of T-Mobile and Sprint.⁷ As with previous mobile provider mergers, this merger has occasioned the frequent assertion that further concentration in the wireless telecommunications industry will be harmful to consumers,⁸ and, in particular, that “it’s going to be hard for someone to make a persuasive case that reducing four firms to three is actually going to improve competition for the benefit of American consumers.”⁹

A central question in the review of this merger—as it is in all merger reviews—is the likely effects that the transaction will have on consumers. Some observers have characterized this merger—between the third and fourth largest mobile wireless providers in the United States—as a “4-to-3” merger, as it will reduce the number of large, ostensibly national carriers from four to three (though some have persuasively argued that such a characterization may not be accurate). A number of previous mergers around the world can or have also been characterized as 4-to-3 mergers in the wireless telecommunications industry.

A significant number of economic studies have evaluated the welfare effects of these and similar mergers in other countries, as well as the effects of market concentration in the wireless industry more generally. These studies have been used by both proponents and opponents of the proposed merger of T-Mobile and Sprint to support their respective contentions that the merger will benefit or harm consumer welfare.

⁷ Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, WT Docket No. 18-197.

⁸ See, e.g., Petition to Deny of Free Press at 2, Applications of T-Mobile US, Inc. and Sprint Corporation For Consent to Transfer Control of Licenses and Authorizations (2018), WT Docket No. 18-197. (“[Applicants] have not shown that the deal would not lessen competition, far less that it could enhance competition. In fact, the merger would massively increase concentration in the U.S. wireless market and in critical market segments too.”).

⁹ See, e.g., Sen. Amy Klobuchar, et al., Letter to Assistant Attorney General Makan Delrahim and FCC Chairman Ajit Pai (May 7, 2018) (quoting former Assistant Attorney General Bill Baer), available at <http://bit.ly/2Kr4cVB>.

This literature review comprises a critical appraisal of these economic studies of previous wireless industry mergers in other countries. Its purpose is to better understand what the existing body of empirical literature, taken as a whole, tells us about the likely consumer welfare effects of 4-to-3 mergers between wireless firms and the proposed T-Mobile/Sprint merger.¹⁰

The review begins with a narrative discussion of our findings. Section I briefly describes the studies reviewed and considers some of the methodological challenges. Section II discusses the findings regarding price and quality effects in the studies. Section III considers the relevant factors that affect the outcomes of the studies and their applicability to the assessment of future mergers. Section IV highlights the importance of a careful review of the empirical literature by critically evaluating the Rewheel study,¹¹ a report of wireless pricing which has been cited by opponents of the proposed T-Mobile/Sprint merger. The Rewheel study is not included among the set of empirical studies in this review because, as we demonstrate, it is deeply methodologically flawed. Section V concludes. Throughout this review, we refer to our more detailed, quantitative analysis of the studies, published separately as an Appendix.¹²

I. The Studies Reviewed and Methodological Challenges

We have reviewed 18 empirical analyses, published in the last five years, studying the effects of changes in market concentration (such as by merger) in the wireless telecommunications industry. Of those 18, eight analyzed changes in market concentration across multiple jurisdictions between 2000 and 2015,¹³ while ten ana-

¹⁰ Whether the merger of T-Mobile and Sprint is a true “4-to-3 merger” is beyond the scope of this study. Indeed, there is reason to believe that the merger is better characterized as a “2-to-3” merger by creating a symmetrical market structure of nationwide carriers.

¹¹ *The state of 4G pricing – 2H2018*, Rewheel/research (Oct. 26, 2018) at 6, http://research.rewheel.fi/downloads/The_state_of_4G_pricing_DFMonitor_10th_release_2H2018_PUBLIC.pdf (“Rewheel study”).

¹² The Appendix is here: https://laweconcenter.org/wp-content/uploads/2019/04/ICLE-Telco_Merger_Lit_Review_ApendixFINAL.pdf

¹³ Affeldt & Nitsche (2014); Csorba & Papai (2015); Frontier (2015); Hougbonon & Jeanjean (2014); Jeanjean & Hougbonon (2015); Jeanjean & Hougbonon (2017); Ofcom (2016); WIK (2015).

lyzed specific mergers.¹⁴ These 18 studies represent all the recent empirical studies of which we are aware that report estimated effects associated with the number of firms or changes in the number of firms, along with measures indicating whether the results are statistically significant (in contrast to, for example, the Rewheel study, which we discuss separately, IV, below). The specific mergers considered in these analyses are:

- T-Mobile/tele.ring (2006, Austria, 5-to-4),
- T-Mobile/Orange (2007, Netherlands, 4-to-3),
- T-Mobile/Orange (2010, UK, 5-to-4),
- Hutchinson/Orange (2012, Austria, 4-to-3),
- Hutchison/Telefonica (2014, Ireland, 4-to-3), and
- Telefonica/KPN (2014, Germany, 4-to-3).

In addition, we reviewed a recent study that considered the effects of market concentration in spectrum ownership in the U.S. on measures of quality.¹⁵

The complete results of our review are presented in the attached Appendix A;¹⁶ a narrative summary of the results is presented below.

In general, our review raises significant questions about the utility of individual empirical studies, both in understanding the effects of past transactions and, especially, in predicting the likely effects of future transactions. The reviewed studies find divergent price effects possibly arising from similar-seeming mergers, and sometimes even from the *same* merger, ranging from significant price decreases to significant price increases. They also show a range of effects of mergers on quality of service and/or investment (although in all cases these effects are positive or neutral), both of which are, of course, essential to properly assessing a merger's consumer welfare effects.

Perhaps most important, our review demonstrates that any individual study is, in fact, *likely* to offer only a partial picture of the effects of a given merger, which may

¹⁴ Aguzzoni, et al. (2015); Aguzzoni, et al. (2018); BEREC (2018); BWB (2016); Genakos, et al. (2018); GSMA (2017); Hougbonon (2015); HSBC (2015); Lear, et al. (2017); RTR (2016).

¹⁵ Woroch (2019)

¹⁶ https://laweconcenter.org/wp-content/uploads/2019/04/ICLE-Telco_Merger_Lit_Review_ApendixFINAL.pdf

be misleading. This is best seen in the empirical analyses of the 2012 Hutchison/Orange merger, a 4-to-3 merger in Austria. The Hutchison/Orange merger was specifically considered in seven of the analyses that we reviewed.¹⁷ Of these, four found that the merger resulted in price *increases*, two found that it resulted in price *decreases*, and one did not study price effects at all. Collectively, the studies estimated the merger's price effects to range from between a 40 percent decrease and a 90 percent increase.¹⁸ On the investment and/or quality front, three of the studies also found that the merger *increased* network investment and/or quality, while four analyses did not consider these effects.

Even taken collectively (and without reference to the objectivity of the individual studies), the studies of the Hutchison/Orange merger that we review present an incomplete picture of the likely effects of a given merger. In the advocacy context, for instance, one might expect such results to be portrayed by merger opponents as supporting the assertion that “4-to-3 mergers are twice as likely to cause price increases as decreases.” While naively defensible (since four studies showed price increases, while only two showed decreases), such a statement does not fairly represent the actual effects either of the specific merger or 4-to-3 mergers in general. One reason is that only one of the studies spanned a long enough period-of-time to include the entry by mobile virtual network operators (MVNOs) that occurred in the studied market. As a result, it would be appropriate to characterize only this study as even *potentially* capturing long-run price effects.

By contrast, with respect to the effects on investment it would be rather more defensible to observe that “of those studies that found an effect on investment in 4-to-3 mergers, all found that investment increased post-merger.”

In addition to the merger studies, we also reviewed two large-scale studies that investigated the relationship between market concentration and capital expenditures in the wireless telecommunications industry.¹⁹ These studies—one of which looks at capital spending by firms in 199 countries between 2000 and 2014, and the other

¹⁷ Aguzzoni, et al., (2015); Hougbonon (2015), HSBC (2015), RTR (2016), BWB (2016), and BEREC (2018); Genakos, et al. (2018). See Appendix Section 3.

¹⁸ Appendix Section 3.

¹⁹ Hougbonon and Jeanjean (2014) and HSBC (2015)

of which looks at capital spending by firms in 66 countries between 2003 and 2013—produce similar results, finding that firms’ capital expenditures (a measure of investment in networks and a proxy for network quality) are maximized around a Lerner index of 37 to 38 percent (a rough proxy for market power). Based upon these findings, it appears that network investment is generally maximized in a market with three providers. Indeed, HSBC (2015) recommends the European approval of 4-to-3 mergers as a way to facilitate higher network investment with better outcomes for users.

We also reviewed two studies that looked at the relationship between market concentration and investment in a range of countries over 10-year periods. The first considered 38 countries between 2004 and 2013. The authors found that, broadly, investment followed an inverted-U curve, with the highest levels of investment occurring in markets with three operators, though markets with four operators had only slightly lower levels of total investment and the difference was not statistically significant. But, importantly, the study found that at the firm level investment was considerably lower in markets with four than in markets with three operators. Given the importance of firm level investment for improving quality and lowering prices over time, the authors conclude that “the unit price paid by consumer is larger with four firms than with three if the dynamic efficiency effect is significant.”²⁰

The second study considered 17 Western European markets between 2006 and 2015. It found that where the market is fully covered (i.e. where all consumers who might realistically have access to mobile telephony already have service of some kind), an increase in the number of firms tends to reduce overall investment.²¹ Moreover, it found that where markets are asymmetric (i.e. some firms are significantly larger than others), the effect of an increase in the number of firms tends to have a more significant negative effect on investment by smaller firms. Thus, a merger that both reduces the number of firms and makes the market structure more symmetric, as is likely to be the case with the T-Mobile/Sprint merger, could potentially have significantly positive effects on both firm level and industry investment.

²⁰ Jeanjean and Hounghonon (2015)

²¹ Jeanjean and Hounghonon (2017)

Finally, we reviewed a recently-published study that considered the relationship between measures of quality and carrier-level holdings of spectrum as a share of total holdings in 697 Cellular Market Areas (CMA) in the United States.²² This study found that quality and coverage measures are positively related to carrier-level holdings of spectrum as a share of total holdings in the CMA. In particular higher carrier-level holdings of spectrum are associated with statistically significant broader 4G coverage, as well as generally faster and more reliable networks (with mixed statistical significance). In addition, Woroch (2018) concludes carriers with faster and more reliable networks and with a broader deployment of 4G technology are associated with more subscribers.

The purpose of our review is not to make predictions about any particular transaction, nor is it to express support for or concern about policy decisions that may have been undertaken in reliance on the empirical analysis of any past transaction. Rather, because analyses of past mergers are being used to support or critique a particular transaction (the proposed T-Mobile/Sprint merger), the purpose of this study is to assess and identify the utility of these past analyses in prospectively evaluating any particular transaction.

The results of our review suggest that the use of these empirical analyses for predictive purposes, either alone or collectively, is a fraught and ultimately unreliable endeavor, especially regarding the effects on price. But this does not mean that the studies do not offer valuable insights helpful for the review of any given merger. The value, however, is not for the most part in the “headline results” that the studies report; rather, the value is in the factors that the studies identify—or that can be identified from the studies—as affecting the outcomes of past (and, thus, presumably, future) mergers. Especially when taken as-a-whole, our review reveals a number of factors that should be considered when seeking to understand the likely welfare effects of a given merger. These include:

- whether the effects to be evaluated are limited to price or also include qualitative measures such as capital expenditures and other investment in quality of service;

²² Woroch (2019)

- the effects on different tiers of service measured by hypothetical consumption profiles or “baskets”;
- the presence or entry of MVNOs;
- the effects of different geographic circumstances or regulatory regimes on a given firm (including divestitures or other commitments imposed as part of the merger review process);
- the extent to which the effects of previous mergers may confound projected effects of the merger at-hand; and
- whether a transaction occurs during, or even as part of, a transition between different generations of technology (e.g., during an upgrade from 3G to 4G networks).

A. The relevance of empirical studies of past mergers to merger enforcement

The question at the heart of the regulatory review of, and enforcement decision regarding, a merger is whether the transaction’s potential benefits to consumers outweigh its potential costs. Our review thus focuses on the evidence presented in the studies of past mergers that reliably pertains to the identifiable benefits and/or costs those mergers yielded for consumers.

Crucially, this requires consideration of merger effects *other* than merely price effects. Merger welfare effects are multi-dimensional. Evaluation of a merger with reference to only a single outcome—e.g., “prices went up” or “investment went down”—are invariably insufficiently nuanced and misleading.

The most obvious merger effects are price effects: increases or decreases in prices charged to consumers for a given quantity and quality of service. The traditional concern of competition law is that reduced competition allows firms greater ability to increase their profits by raising prices charged to consumers. But prices do not exist in a vacuum, and many mergers are undertaken specifically on the expectation that the combined firm will be able to improve quality or lower costs in ways that *also* affect consumer welfare. Of course, the converse may be true, as well: again, facing less competition, one concern of competition law is that firms will increase their profits by reducing product or service quality (thereby reducing the costs of providing those products or services) to the detriment of consumers.

At the same time, it is important to understand what is meant by reduced or increased “competition.” A transaction that reduces the number of competitors within a market need not necessarily reduce *competition*. Rather, a merger might result in the creation of a more effective competitor to other incumbents, thereby potentially increasing competition, even while reducing the number of *competitors*. And a smaller number of larger firms facing more intense competition may be far better for consumers than a larger number of smaller, less-effective firms. For example, in examining the Hutchison/Orange merger in Austria, BEREK (2018) points out that in addition to the merger itself, in another transaction Hutchison spun off the Orange sub-brand Yesss! to A1 Telekom Austria, creating a “more symmetrical market structure.”

Precisely because competition is multi-dimensional, and because a transaction may increase consumer welfare along one dimension (by increasing R&D investment, for example) while simultaneously reducing it along another (by raising short-term prices, for example), assessments and predictions of merger effects that focus solely on price are unlikely to offer an accurate picture of the overall effects of a merger on competition and consumer welfare. As the commentary on one recent study notes:

[A] merger can be justified if there are large efficiency gains from the merger (e.g., because investments in the broadband networks increase). Hence, it is important to assess empirically the existence of this potential trade-off between efficiency gains and increases in prices charged to consumers.²³

Contrary to the laments of some advocates for more aggressive antitrust enforcement,²⁴ American antitrust law has long recognized the importance of both price-

²³ Francesco Drago, Discussion of Christos Genakos, Tommaso Valletti & Frank Verboven, *Evaluating market consolidation in mobile communications*, 33 (93) ECON. POL’Y 86, 87 (2018).

²⁴ Kevin Caves and Hal Singer, *When the Econometrician Shrugged: Identifying and Plugging Gaps in the Consumer Welfare Standard*, GEORGE MASON L. R. (forthcoming), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3205518; Marshall Steinbaum, *The Consumer Welfare Standard Is an Outdated Holdover from a Discredited Economic Theory*, ROOSEVELT INSTITUTE (Dec. 11, 2017) available at <http://rooseveltinstitute.org/consumer-welfare-standard-outdated-holdover-discredited-economic-theory/>.

and non-price effects in evaluating the competitive effects of conduct.²⁵ The importance of both types of effects is expressly recognized in the Horizontal Merger Guidelines,²⁶ and has been consistently affirmed by the courts.²⁷ Thus our review assesses the studies' results along both of these dimensions.

II. Top-line Results

A. Effects on Price and Quality

A detailed, critical review of the studies' findings on price and quality, including summary tables, are provided in Appendix A. Our key findings from this review are:

- Of those analyses that looked at specific mergers, about half found that prices decreased following a merger whereas half found that prices increased.
- But there was no common measure of price effects across these studies. Some, for instance, considered low, medium, and high hypothetical consumption

²⁵ See Makan Delrahim, *All Roads Lead to Rome: Enforcing the Consumer Welfare Standard in Digital Media Markets*, Remarks as Prepared for Delivery at The Jevons Colloquium (2018) (noting that the consumer welfare standard is flexible, and the Court has long recognized the importance of factors such as innovation, consumer choice, and quality), available at <https://www.justice.gov/opa/speech/file/1065096/download>; See also Joshua D. Wright, *Antitrust Provides a More Reasonable Framework for Net Neutrality Regulation*, FREE STATE FOUNDATION (Aug. 16, 2017) at 6 ("The rule of reason, and antitrust jurisprudence generally, has evolved to reach all forms of competitive harms—including innovation and quality.") available at http://www.freestatefoundation.org/images/Antitrust_Provides_a_More_Reasonable_Framework_for_Net_Neutrality_Regulation_081617.pdf.

²⁶ U.S. Dep't of Justice & Fed. Trade Comm'n, Horizontal Merger Guidelines § 6.4 (rev. 2010), available at <https://www.justice.gov/atr/horizontal-merger-guidelines-08192010#6d>.

²⁷ As recently noted by the Supreme Court, "[d]irect evidence of anticompetitive effects would be 'proof of actual detrimental effects on competition,' such as reduced output, increased prices, or decreased quality in the relevant market," *Ohio v. American Express*, 585 U.S. ____ (2018) (holding that American Express's anti-steering practices did not violate antitrust law because, *inter alia*, "business model has spurred robust inter-brand competition and has increased the quality and quantity of credit-card transactions.") (quoting *FTC v. Indiana Federation of Dentists*, 476 U. S. 447, 460 (1986) (alterations omitted)). For examples of recent merger litigation alleging non-price effects, see, e.g., *FTC v. Sysco Corp.*, 113 F.Supp. 3d 1 (D.D.C. 2015); *FTC v. Sanford Health* (D.D.C. 2017); *United States et al. v. Anthem, Inc.*, and *Cigna Corp* (D.D.C. 2016); *United States v. H&R Block, Inc.*, 833 F.Supp. 2d 36 (D.C. Cir. 2011).

baskets,²⁸ while another considered smartphone and “traditional” device users.²⁹ Most, if not all, of the studies do not consider business or data-only plans.

- The study time periods varied such that some allowed for subsequent entry³⁰ while others were more narrowly short-run studies in which the measurement period was too short to allow for entry.³¹
- Only about half of the studies considered investment effects. **Of those that found a statistically significant relationship, all found that network investment increased with a 4-to-3 merger.**³²
- One study found both increased investment and decreased prices (the best of all possible consumer outcomes, at least in terms of the direction of each effect)³³
- Another study found increased investment effects as well as increased prices (at least in the short term). This result, while common, is perhaps the most difficult to parse in consumer welfare terms: Identifying the net welfare effect of divergent price and investment effects is difficult in absolute terms, but made even more complicated by generally requiring a comparison of short-run price effects with anticipated, long-run benefits from short-run investment.³⁴

The results of our review are similar to those of other surveys of the empirical literature. BEREC (2018) (which offers both its own empirical analysis, so is included in our review, as well as its own survey of prior literature) notes that:

It is clear that the evidence from the literature on the effects of 4-to-3 mergers is mixed (which is not surprising given the heterogeneity of the approaches and the events investigated). While there are studies which

²⁸ See, for example, Csorba & Pápai (2015), Aguzzoni, et al. (2018), Lear, et al. (2017), and BEREC (2018).

²⁹ RTR (2016).

³⁰ See, for example, BEREC (2018).

³¹ See, for example, Genakos, et al. (2018), Hounghonon (2015), HSBC (2015), RTR (2016), and BWB (2016).³² Hounghonon & Jeanjean (2014), Jeanjean & Hounghonon (2015), HSBC (2015), Genakos, et al. (2018), GSMA (2017).

³² Hounghonon & Jeanjean (2014), Jeanjean & Hounghonon (2015), HSBC (2015), Genakos, et al. (2018), GSMA (2017).

³³ Lear, et al. (2017)

³⁴ Genakos, et al. (2018)

find significant price increases, there are also studies finding no price effects or even a decrease in prices or positive quality effects.

B. What the results tell us about prospective merger enforcement

Some of this inconclusiveness, especially with regard to the effects on prices, is a function of the difficulty, endemic to most empirical work of this kind, of reliably measuring even seemingly simple things like price changes. Moreover, comparing results across countries, years, and mergers is complicated, at best; like-kind comparisons are inevitably imperfect and the interpretation of results invariably defies simple slogans. Consider, for example, that (among other things):

- Different carriers offer different tiers of service with different qualitative characteristics (e.g., speed and data allowances);
- Carriers offer different promotions, payment terms, combinations of service, and the like such that there is rarely a single “price” at any given time;
- The prices for these services also change over time in response to exogenous factors (e.g., pricing pressures from competitors or changes in consumer preferences);
- A merger may yield short-run price effects on specific offerings that give way to different longer-run price effects, and it may change its service offerings over time to reflect changes in demand, cost, and the like; and
- All of this is compounded by the varying effects of different, merger-specific regulatory commitments or pricing constraints that may result from each merger.

All these factors make it difficult to measure how or even whether a given merger affects prices, and even more difficult to compare those effects across mergers.

These measurement difficulties are compounded in the case of non-price effects. All of the same factors may apply to non-price effects (e.g., changes in the quality of service), but because non-price effects are generally not readily reduced to directly measurable or standardized units (as opposed to price which is, arguably, measurable and consistent), assessing and comparing non-price effects is that much more difficult. Many studies thus simply ignore non-price effects and focus on seemingly measurable characteristics. Those studies that do attempt to measure quality effects typically rely on proxies such as capital expenditures: In the wireless telecommunications industry, increased capex

suggests that a firm is investing to improve its network either to accommodate higher quantities of usage (indicating lower costs of service per unit) or to accommodate higher qualities of service.

Given these considerations, the results of our review are unsurprising—and perhaps “unsexy.” They are, however—and precisely because of this—policy-relevant. Our review of the 18 empirical studies of previous changes in concentration in the wireless industry are conclusively inconclusive as to the price effects of 4-to-3 or similar mergers.

III. Factors that Commonly Affect Study Results

Although the studies we reviewed do not produce consistent results with any predictive value for understanding the effects of a prospective merger, our evaluation of the studies nonetheless identifies a number of factors that should be considered when reviewing the likely competitive effects of comparable, prospective mergers. This result, as well, is not unique to our review. As Genakos, et al (2018) conclude:

[T]he main pay-off from an understanding of the expected efficiencies arising from a horizontal merger is likely to be the insights this gives about the nature of competitive rivalry in an industry, which in turn will assist in gathering evidence on market dynamics and likely supply-side responses. Such evidence should not be an after-thought. It deserves a central role in a unilateral effects assessment that justifies a departure from the constraints imposed by simple theoretical static models.

In particular, our review suggests that the following four elements should be included in any review of a wireless telecommunications industry merger:

1. Evaluation of both price and non-price factors;
2. Evaluation of the full range of product and service offerings, including an accounting of the relevant differences in the cost inputs to each;
3. Assessment of the timing and effects of MVNO entry and ongoing competition on the marketplace; and
4. Accounting for the effects on conduct and merger outcomes of transaction-specific regulatory, technological, geographic, and other characteristics of the merging parties and their competitive environment.

Some of these factors are particularly important to consider when evaluating a transaction on its own merits; others are more relevant to the comparison of a prospective transaction with potentially analogous, prior ones.

A. Challenges measuring price effects

Most research evaluating the relationship between the number of firms or firm concentration and wireless carrier prices relies on published tariffs as a measure of price. Many of these studies, such as Aguzzoni et al. (2018), Lear et al. (2017), and Genakos et al. (2015) use a price-basket approach. They define “high,” “medium,” and “low” usage profiles (or “baskets”) based on the consumption of voices, minutes, and data, and then identify the lowest-cost tariff or set of tariffs for each user profile and for each period and compute the average mobile expenditure. In most studies, information for only the two largest carriers is available.

The reliance of information from only the largest carriers in a country may produce biased results inasmuch as smaller carriers and MVNOs may engage in competitive pricing strategies that benefit consumers and discipline larger firms. Thus it is possible, if not likely, that nearly all studies suffer from an upward bias in their measures of price.

Affeldt & Nitsche (2014) criticize the use of tariff data:

Such approaches are taken by Rewheel (2013) and also the Austrian regulator rtr (when tracking prices over time, see rtr (2014)). Such studies face the following problems: They may pick tariffs that are relatively meaningless in the country. They will have to assume one or more consumption baskets (voice minutes, data volume etc) in order to compare tariffs. This may drive results. Apart from these difficulties such comparisons require very careful tracking of tariffs and their changes. Even if one assumes studying a sample of tariffs is potentially meaningful, a comparison across countries (or over time) would still require taking into account key differences across countries (or over time) like differences in demand, costs, network quality etc. We are not aware of any study which does this carefully.

Lear et al. (2017), which uses the usage profile approach based on baskets defined by the OECD, concedes that the approach has several drawbacks in that “it re-

quires making several assumptions on the ‘representative’ usage profile and may be based on tariffs that are irrelevant for the country.”

None of the studies reviewed report the share of consumers represented by each of the hypothetical baskets used. Thus, even if a study reports a large, sustained price increase for a “high” basket, and small decreases for “medium” and “low” baskets, for example, it is still impossible to infer a net consumer welfare loss from the relative magnitudes of the effects because there is no way to know what fraction of the market is subject to each of them.

Perhaps more important for antitrust review is the implicit presumption that each usage profile represents a distinct product market. There is widespread agreement that there is considerable churn of consumers between wireless providers with often differing service offerings, and that usage patterns vary across countries and time. These dynamics suggest that there is no bright line separating the wireless market into distinct product markets distinguished by usage.

Another approach uses the average revenue per user (ARPU) as a measure of prices. On the one hand ARPU has the advantage that it captures, to some degree, the actual (average) cost to consumers. On the other hand, however, this straightforward measure does not distinguish between price and usage level: An increase in revenues may be attributed to indeterminate combinations of either or both increased prices and/or increased usage per user. Studies such as Affeldt & Nitsche (2014) use ARPU while accounting for usage, a measure they call “effective price per minute” (EPPM), but this measure is related only to voice services.

Finally, and as discussed in more detail below, every study suffers from one of more of the following complications:

- Failure to account for differences in pre- and post-paid plans,
- Exclusion of business plans,
- Exclusion of data-only plans,
- Computation of prices without handset subsidies,
- Failure to account for MVNO entry and/or MVNO pricing, and/or
- Failure to consider competition from smaller mobile network operators (MNOs).

In addition to data considerations, it is also important to consider the analytical approaches taking in the research. Most pricing studies employ a difference-in-difference approach, a synthetic control group approach, or both approaches.

With a difference-in-differences approach, price effects are estimated by comparing the differences between the price trends in the country being examined (the country affected by the merger, or the “treatment” country) and prices in several unaffected countries (the “control” countries.) The approach is intended to statistically estimate the difference between the pre-merger differences and the post-merger differences, giving the procedure the name difference-in-differences.

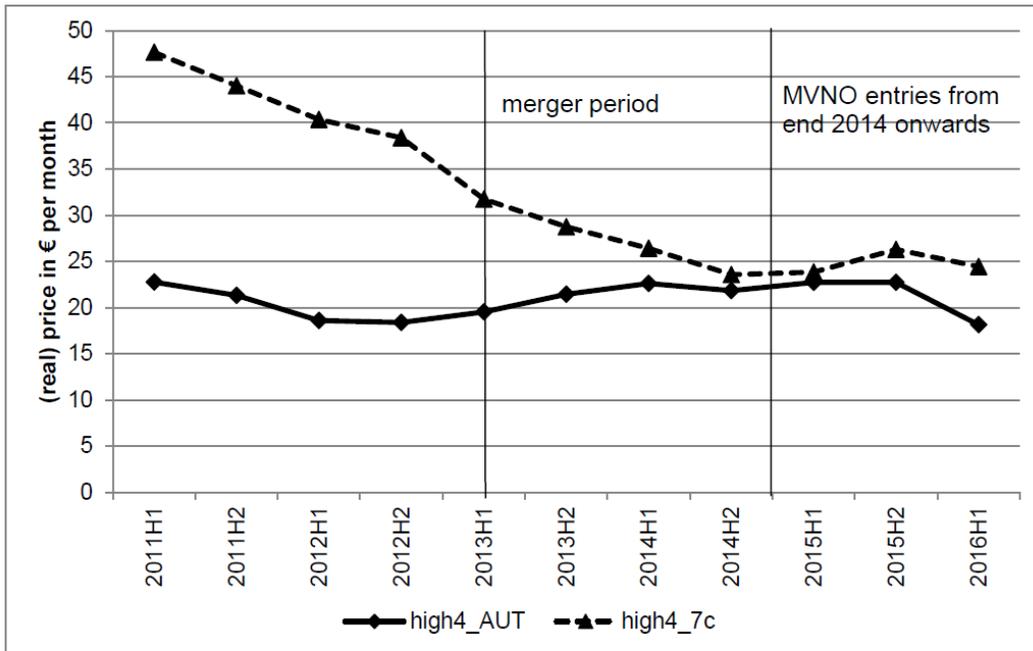
The synthetic control approach combines elements from matching and difference-in-differences approaches. Rather than using a large set of different control countries, the synthetic control approach identifies a smaller subset of control countries that have statistically similar pre-merger price trends. The difference-in-differences approach is then applied to treatment country and the smaller subset.

Both approaches have gained acceptance *in other contexts*. However, in evaluating the results of such studies in the context of mergers, caution should be exercised. In particular, the results of the approaches may find a statistically significant positive increase in the differences. However, this result does not indicate that a merger led to higher absolute prices for consumers. A difference-in-differences approach in each of the following hypotheticals would lead to a conclusion the merger led to higher prices.

1. **Pre-merger:** Treatment and control have same prices.
Post-merger: Treatment prices increase 10 percent, and control countries prices are unchanged.
2. **Pre-merger:** Treatment and control have same prices.
Post-merger: Treatment prices are unchanged, and control countries prices decrease 10 percent.
3. **Pre-merger:** Treatment and control have same prices.
Post-merger: Treatment prices decrease 5 percent, and control countries prices are decrease 10 percent.

In only one of the hypothetical examples does the country in which the merger takes place experience an increase in absolute prices. In the other example, the country with the merger simply did not experience the same decrease as the control

countries. Thus, one cannot infer high absolute post-merger prices from examining difference-in-differences results alone.



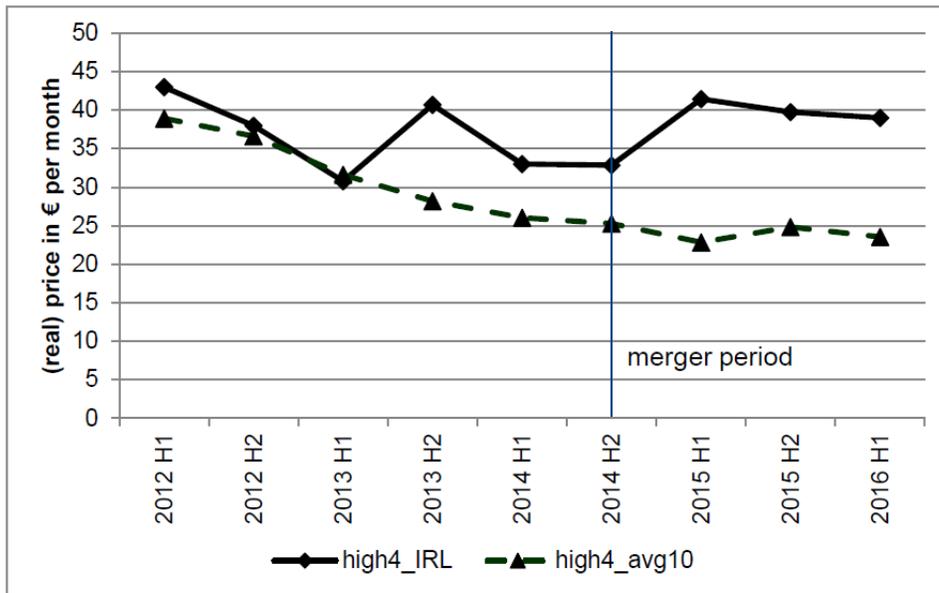
7c refers to an average of the seven control group countries BE, DK, ES, EL, IT, PT, SE

Figure 6: Price trends for users with a high usage profile in Austria

Source: BEREC (2018)

For example, BEREC’s (2018) study of the Hutchison/Orange merger in Austria finds a statistically significant positive increase in the differences between Austria (the treatment country) and the control countries, especially for the “high” bundle of hypothetical usage. However, Figure 6 from the study, shown above, indicates much of the price difference between Austria and comparison countries results from a decline in comparison country prices, rather than increases in prices in Austria.

Similarly Figure 9 from BEREC’s (2018) analysis of the Hutchison/Telefónica merger in Ireland, shown below, indicates much of the price difference between Ireland and comparison countries for the high basket results from a decline in comparison country prices, rather than increases in prices in Ireland.



avg10 refers to a simple average of the ten control group countries

Figure 9: Price trends for users with a high usage profile in Ireland

Source: BEREC (2018)

B. Evaluation of both price and non-price factors

A first and, frankly, obvious observation from our review of these studies is that it is essential to consider both the price and non-price effects of a transaction in order to assess its likely net effect on consumer welfare. This is well-trod merger law in the United States, yet advocates frequently focus on price-effects to the exclusion of non-price effects, and regulators often allow price-effects to overdetermine their evaluations of proposed transactions.

The empirical analyses we survey demonstrate both the extent to which merger policy can be myopically focused on price effects and the reasons that this is problematic. Roughly half of the empirical studies of 5-to-4 and 4-to-3 mergers do not look at non-price effects at all. Of those that do, *all* find likely positive (i.e. beneficial) non-price effects.³⁵ This suggests that pro-consumer non-price effects are prevalent

³⁵ Genakos, et al. (2018), GSMA (2017), Hougbonon & Jeanjean (2014), Jeanjean & Hongbonon (2015), HSBC (2015).

in these transactions. Studies that do not consider these effects are incomplete for purposes of evaluating the mergers' consumer welfare effects, and all-too-easily used by advocates to misleadingly predict negative consumer outcomes. This is not necessarily a criticism of the studies themselves, which generally do not make comprehensive policy conclusions. The reality is that it is exceptionally difficult to comprehensively study even price effects, such that a well-conducted study of price effects alone is a valuable contribution to the literature. Nevertheless, in the context of evaluating prospective transactions, the results of such studies must be discounted to account for their exclusion of non-price effects.

Quality improvements attributable to network investment are especially crucial to evaluating the welfare effects of telecommunications industry mergers occurring in large and/or sparsely populated countries or regions or areas with a large rural population (see Section III.D below), and during periods of technological transition—such as from 3G to 4G, or 4G to 5G networks. This is true both as it reflects the deployment of more technologically advanced services, but also as a determinant of future price competition.

Firms “race” to deploy new technologies both so that they can offer customers a higher-quality product (and correspondingly charge more for that product) and also so that, if they “win” that race compared to their peers, they will benefit from a period of reduced competition while other firms continue to upgrade their own networks.³⁶ Mergers that occur during periods of technological dynamism may tend to increase the short-term, negative price effects of monopolistic competition, allowing firms to raise their prices further above marginal cost than in periods of static technologies, during which firms instead compete on price alone. But that effect may also increase the pace of deployment of a next-generation technology, during a period that the firm's competitors are also deploying their own next-generation technologies, thus benefitting consumers in the short-run (by allowing them access to

³⁶ See generally: Schumpeter, Joseph A. (1950) *Capitalism, Socialism, and Democracy*. 3d ed. New York: Harper and Brothers.

more advanced technology sooner) and also in the long-run (as completion of these improved networks facilitates price competition).³⁷

C. Evaluation of the full range of product and service offerings and an accounting of their cost differences

One of the primary reasons that empirical studies of price effects show different results when analyzing the same transactions is that each study may consider prices for a different set of services, or different aspects of multi-part prices within a transaction. Ironically, this typically presents a greater challenge for price-effects than for non-price effects. This is because markets such as wireless telecommunications often involve a wide range of pricing options for different users and services, with the result that there are so many possible prices to consider that meaningful comparison is often impossible. By contrast, when it comes to non-price effects, researchers more often face the challenge of finding *any* relevant measurements.

In the case of the studies we reviewed, we find studies measuring a range of different price effects: prices associated with varying combinations of high, medium, and low hypothetical consumption profiles; short-run and long-run prices; prices for service plans that both do and do not include subsidized features such as handsets; and prices for both pre- and post-paid service. Additionally, the studies generally exclude certain types of plans that may provide important information about the competitive effects of a transaction, such as business-tier and data-only plans.

D. Assessment of the effects of MVNO entry and competition on the marketplace

One of the most significant factors affecting competition in the wireless marketplace is the entry, ongoing presence (or absence), and consumer usage of mobile virtual network operators (MVNOs). Yet most studies, including those that found negative (consumer) price-effects, did not explicitly account for the possibility that MVNO competition could exert downward pricing pressure on merged firms. The absence of an assessment of the possibility or actuality of MVNO competition is particularly likely to lead to misleading conclusions because MVNOs, given their

³⁷ See e.g. Declaration of David S. Evans in the Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, WT Docket No. 18-197, Appendix G, at 112 ff.

structure as resellers of facilities-based providers' (also known as mobile network operators, or MNOs) services, benefit from certain advantages as a means of disciplining prices relative to mobile network operators, such as: the ability to leverage existing brands and retail marketing infrastructure (and in some cases relevant physical infrastructure, such as a fiber-optic network), while avoiding the need for investment in network-wide cellular infrastructure and spectrum licenses.³⁸ Meanwhile, as Michelle Connolly (2018) notes:

With multiple MNOs competing for MVNOs that have access to unique consumer segments, MVNOs are able to obtain competitive wholesale rates. This leads to lower overall prices, due to greater economies of scale in the upstream market, and increased price/quality discipline in the downstream retail market.

These effects are seen, for instance, in the studies evaluating the 2012 Hutchison/Orange merger in Austria. Five of the six studies of this merger that we review look at merger effects occurring in a timeframe that does not include the entry of MVNOs into the marketplace in 2015. The only study that did consider the market's competitiveness following *both* the merger and the subsequent entry of MVNOs was BEREK (2018), which notes that:

In 2016 H1 (first half of 2016), the [price-effects] became considerably smaller and statistically insignificant in most specifications (although, for the medium usage basket, some effect in 2016 H1 cannot be ruled out completely). This is likely caused by competitive pressure from MVNOs, which gained significant market share since entry at the beginning of 2015.

Similarly, Lear, et al.'s (2017) study of the 2010 T-Mobile/Orange merger notes that the firms' combined market share decreased by 6.4 percent in the four years following the merger and suggests that this may have been due in part to competition from MVNOs (which grew in market share by 2.3 percent in the same period).

Meanwhile, it is likely just as important to consider the effect of smaller carriers on the overall mix of services and prices available in the market following a merger. Because of limitations in available data, many studies focus on only the largest car-

³⁸ Banerjee and Dippon (2009)

riers in a country or region, to the exclusion of smaller carriers that may not be seen as a substitute for the services offered by larger carriers because their offerings are more limited in geographic scope. No studies that we reviewed expressly considered the role of smaller carriers, but it is reasonable to expect that they could have a price-disciplining effect comparable to that of MVNOs, especially in markets in which regional carriers are more common (such as in parts of the United States).³⁹ While Csorba & Pápai (2015) and Ofcom (2016), consider the effects of “disruptive” carriers, such carriers can, in principle, be large or small.

E. Accounting for transaction-specific characteristics of the merging parties and their competitive environment

A final factor that bears consideration relates to how (or whether) to use the results of a prior transaction to understand the likely effects of a future transaction. It is entirely possible that exogenous factors affecting a given transaction will predominate over any likely consistencies attributable to structural similarities with past transactions. The key selection factor for the empirical studies that we reviewed was that they focused on four versus three firm, or similarly concentrated, markets in the wireless telecommunications industry. But the fact that a future proposed transaction is also a 4-to-3 wireless merger does not automatically mean that these studies meaningfully bear upon it.

It is as important to consider the regulatory, geographic, and technological setting of a merger as it is to consider the transaction’s market structure. A transaction undertaken in a regulatory regime with strong *ex post* enforcement of competition law, or with substantial experience designing and implementing effective *ex ante* remedies in its transaction reviews, for example, is likely to lead to very different effects than a transaction undertaken in a different regulatory environment.⁴⁰

Perhaps even more important to understanding the implications for US mergers of the merger studies included in this review is that all of the mergers evaluated in those studies were European. The dramatically different geography of the United

³⁹ For example, Jeanjean & Hounghonon (2015) exclude the U.S. and Canada from their study because the presence of regional carriers “makes it difficult to assess the impact of the number of firms.”

⁴⁰ See e.g. Jeanjean and Hounghonon (2017) at 13-16.

States imposes vastly different constraints upon telecommunications providers than do the geographies of the countries in which these mergers took place. Austria, the Netherlands, Ireland, the UK, and even Germany are much smaller countries, with far fewer people, and much simpler geographies, than the United States. At the margin, smaller countries—especially those with greater population densities—are likely to see a greater portion of consumer benefit from a transaction arising from lower prices than from infrastructure investment. Larger countries—especially those, like the United States, with huge swaths of land with minimal population density and a larger rural population—require significant capital expenditures to provide comprehensive coverage. For example, GSMA (2015) finds that higher population density in a country has a statistically significant positive relationship with 4G coverage levels. The consumer welfare benefits of mergers in larger countries are much more likely to arise from network investment.

IV. A Cautionary Example: The Rewheel Study

As problematic as it is to apply otherwise methodologically sound studies to subsequent mergers, it is even more problematic to apply methodologically *unsound* studies to any purpose at all. Whatever the problems of making inferences from the studies discussed in our review, there is no basis at all for accepting any predictions or assessments based on fundamentally flawed studies. Our review of the relatively high-quality studies included here also provides a useful point of reference for distinguishing and disregarding studies that fail to offer any intrinsically reliable findings.

In his testimony before the House Committee on Energy & Commerce, Subcommittee on Communications & Technology, Phillip Berenbroick of Public Knowledge referred to “[a]n October 2018 report from Finnish research firm Rewheel[, which] found that consumers in markets with three facilities-based providers paid twice as much per gigabyte as consumers in four firm markets.”⁴¹ The Rewheel Study that Mr. Berenbroick relied upon, however, is marred by a number of significant flaws, which undermine its usefulness.

⁴¹ Testimony of Phillip Berenbroick, Senior Policy Counsel, Public Knowledge, Before the U.S. House of Representatives Committee on Energy & Commerce Subcommittee on Communications & Technology, *Protecting consumers and competition: An examination of the T-Mobile and Sprint merger* (Feb. 13, 2019), citing Rewheel study, *supra* note 11, at 6.

Rewheel's report purports to analyze the state of 4G pricing across 41 countries that are either members of the EU or the OECD or both. The report's conclusions are based mainly on two measures:

1. Estimates of the *maximum* number of gigabytes available under each plan for a specific hypothetical monthly price, ranging from €5 to €80 a month. In other words, for each plan, Rewheel asks, "How many 4G gigabytes would X euros buy?" Rewheel then ranks countries by the median amount of gigabytes available at each hypothetical price for all the plans surveyed in each country.
2. Estimates of what Rewheel describes as "fully allocated gigabyte prices." This is the monthly retail price (including VAT) divided by the number of gigabytes included in each plan. Rewheel then ranks countries by the median price per gigabyte across all the plans surveyed in each country.

A. Rewheel's convoluted calculations

Rewheel's use of the country median across all plans is problematic. In particular it gives all plans equal weight, regardless of consumers' use of each plan. For example, a plan targeted for a consumer with a "high" level of usage is included with a plan targeted for a consumer with a "low" level of usage. Even though a "high" user would not purchase a "low" plan (which would be relatively expensive for a "high" user), all plans are included, thereby skewing upward the median estimates.

But even if that approach made sense as a way of measuring consumers' willingness to pay, in execution Rewheel's analysis contains the following key defects:

- The Rewheel report is essentially limited to quantity effects alone (i.e., how many gigabytes available under each plan for a given hypothetical price) or price effects alone (i.e., price per included gigabyte for each plan). These measures can mislead the analysis by missing, among other things, innovation and quality effects.
- Rewheel's analysis is not based on an impartial assessment of relevant price data. Rather, it is based on hypothetical measures. Such comparisons say nothing about the plans actually chosen by consumers or the actual prices paid by consumers in those countries, rendering Rewheel's comparisons virtually meaningless, as noted by Affeldt & Nitsche (2014).

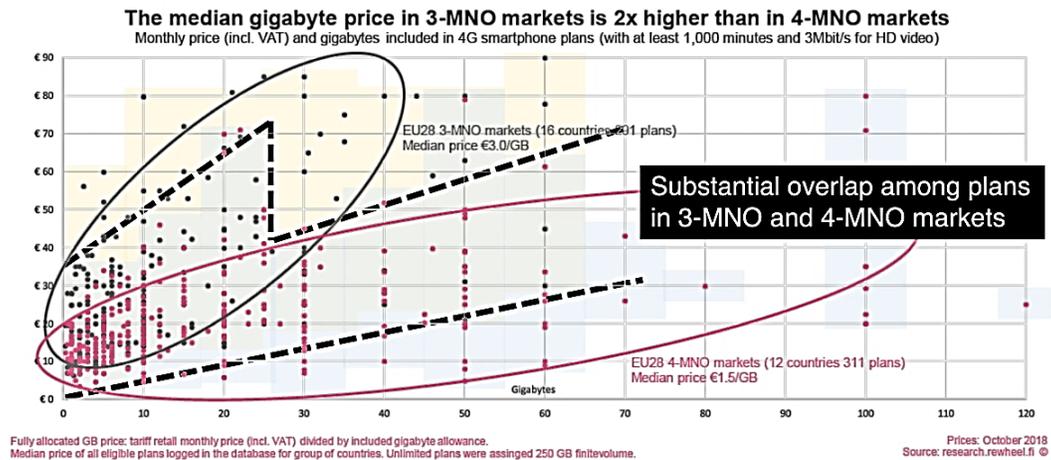
- The Rewheel report bases its comparison on dissimilar service levels by not taking into account, for instance, relevant features like comparable network capacity, service security, and, perhaps most important, overall quality of service.

B. Rewheel’s unsupported conclusions

Rewheel uses its analysis to come to some strong conclusions, such as the conclusion on the first page of its report declaring the median gigabyte price in countries with three carriers is twice as high as in countries with four carriers.

The figure below is a revised version of the figure on the first page of Rewheel’s report. The yellow blocks (gray dots) show the range of prices in countries with three carriers the blue blocks (pink dots) shows the range of prices in countries with four carriers. The darker blocks show the overlap of the two. The figure makes clear that there is substantial overlap in pricing among three and four carrier countries. Thus, it is not obvious that three carrier countries have significantly higher prices (as measured by Rewheel) than four carrier countries.

A simple “eyeballing” of the data can lead to incorrect conclusions, in which case statistical analysis can provide some more certainty (or, at least, some measure of uncertainty). Yet, Rewheel provides no statistical analysis of its calculations, such as measures of statistical significance. However, information on page 5 of the Rewheel report can be used to perform some rudimentary statistical analysis.



The information from the columns for hypothetical monthly prices of €30 a month and €50 a month can be converted into a hypothetical price per gigabyte to generate the dependent variable. Following Rewheel's assumption, "unlimited" is converted to 250 gigabytes per month. Greece is dropped from the analysis because Rewheel indicates that no data is available at either hypothetical price level.

This rudimentary statistical analysis includes the following independent variables:

- Number of carriers (or mobile network operators, MNOs) reported by Rewheel in each country, ranging from three to five. Israel is the only country with five MNOs.
- A dummy variable for EU28 countries. Rewheel performs separate analysis for EU28 countries, suggesting they think this is an important distinction.
- GDP per capita for each country, adjusted for purchasing power parity. Several articles in the literature suggest higher GDP countries would be expected to have higher wireless prices.
- Population density, measured by persons per square kilometer. Several articles in the literature argue that countries with lower population density would have higher costs of providing wireless service which would, in turn, be reflected in higher prices.

The tables below confirm what an eyeballing of the figure suggest: Rewheel's data show the number of MNOs in a country have no statistically significant relationship with price per gigabyte, at either the €30 a month level or the €50 a month level.

Dependent variable: Price per GB at €30 per month

	Coeff.	Std. Err.	t-stat	p-value
Intercept	9.536	6.676	1.43	0.162
Number of MNOs	-1.854	1.692	-1.10	0.281
EU28 country dummy	-0.332	1.955	-0.17	0.866
GDP per capita (PPP)	-1.6E-05	5.5E-05	-0.29	0.771
Population density	0.003	0.004	0.76	0.455
R-squared	0.05			
Observations	40			

Dependent variable: Price per GB at €50 per month

	Coeff.	Std. Err.	t-stat	p-value
Intercept	3.067	2.006	1.53	0.135
Number of MNOs	-0.597	0.509	-1.17	0.249
EU28 country dummy	0.023	0.587	0.04	0.968
GDP per capita (PPP)	1.5E-06	1.7E-05	0.09	0.928
Population density	0.001	0.001	0.56	0.577
R-squared	0.05			
Observations	40			

While the signs on the MNO coefficient are negative (i.e., more carriers in a country is associated with lower prices), they are not statistically significantly different from zero at any of the traditional levels of statistical significance.

Also, the regressions suffer from relatively low measures of goodness-of-fit. The independent variables in the regression explain approximately five percent of the variation in the price per gigabyte. This is likely because of the convoluted way Rewheel measures price, but is also due to the known problems with performing cross-sectional analysis of wireless pricing, as noted by Csorba & Pápai (2015):

Many regulatory policies are based on a comparison of prices between European countries, but **these simple cross-sectional analyses can lead to misleading conclusions because of at least two reasons. First, the price difference between countries of n and $(n + 1)$ active mobile operators can be due to other factors, and the analyst can never be sure of having solved the omitted variable bias problem.** Second and more importantly, the effect of an additional operator estimated from a cross-sectional comparison cannot be equated with the effect of an actual entry that might have a long-lasting effect on a single market.

C. The Rewheel report cannot be relied upon in assessing consumer benefits or harm associated with the T-Mobile/Sprint merger, or any other merger

Rewheel apparently has a rich dataset of wireless pricing plans. Nevertheless, the analyses presented in its report are fundamentally flawed. Moreover, Rewheel's conclusions regarding three vs. four carrier countries are not only baseless, but clearly unsupported by closer inspection of the information presented in its report. The Rewheel report cannot be relied upon to inform regulatory oversight of the T-Mobile/Sprint merger or any other.

The Rewheel study is, in effect, the epitome of a flawed study and the opposite of the approach that we have attempted to take in our analysis. It focuses on an artificially constructed measure that does not represent real-world characteristics of competition; that measure focuses only on price effects to the exclusion of other effects, and even then it considers only two (non-realistic) consumption baskets to the exclusion of the fuller range of services consumers actually have available. While every study we have reviewed necessarily makes certain limiting assumptions, either as a reflection of data limitations inherent in these sorts of empirical studies or of the necessity of limiting the scope of analysis in order to yield a manageable undertaking, the extent of the Rewheel study's assumptions and limitations is breathtaking. If anything, the Rewheel study demonstrates the importance of rigorous critical literature reviews such as this one, which endeavor to systematically synthesize results across a wide range of empirical analyses in order to discern the legitimate generalized understandings that may be gleaned from such a complex data set. The Rewheel study, by contrast, is a careless mish-mash of data points from which no reliable conclusions can be drawn.

Conclusion

This review of studies looking at the effects of changes in market concentration in the mobile telecommunications industry has highlighted numerous challenges facing researchers undertaking such studies—as well as the resulting challenges for the regulators and others trying to use studies such as these to predict the future effects of any given merger.

These challenges appear to be most acute when trying to analyze the effects of mergers on prices of mobile offerings. As we noted above, studies of these effects yield

conclusively inconclusive results. The authors of most of these studies acknowledge these challenges and do not pretend that their results are in any way definitive. Unfortunately, others have used the findings in these studies selectively and without reference to the challenges in order to claim, erroneously, to have found more conclusive evidence of price effects.

Some studies, most notably the Rewheel analysis described in section IV, take a more cavalier approach, drawing conclusions that are simply not grounded in a sound analysis of the evidence.

Studies that look at the effect of market concentration on investment consistently find a positive correlation between concentration and investment at both the industry and firm level. From an investment perspective, the optimal number of wireless firms in a given market appears, in some studies, to be three; however, in some jurisdictions (such as those that are more densely populated), the optimal number may well be four, while in others (such as those with small populations that are widely dispersed) the optimal number may well be two. There is little or no support for categorically claiming that the optimal number of firms in larger jurisdictions is four.

The finding, in the only study that specifically investigated the issue, that increases in the number of competitors in asymmetric markets leads to disproportionately lower levels of investment by smaller firms, suggests that a merger between two smaller firms that results in greater market symmetry is likely to result in higher levels of investment by the merged firms relative to the unmerged entities.

These findings have implications for dynamic efficiency, since higher levels of investment are plausibly correlated with more rapid roll-out of new technologies, improved service for customers and, over time, reduced costs. This is likely to be particularly true during periods when new generations of mobile communications are being rolled out.

From a consumer welfare perspective, it seems plausible that in a large, geographically dispersed market such as the U.S., facing the prospective introduction of 5G, the optimal number of national facilities-based mobile telecommunications firms may well even be fewer than four.

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