

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

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Appendix A

**Review of Economic Analyses of 4-to-3 and Comparable Mergers
in the Wireless Telecommunications Market**

Summary Table

		Price	Investment/Quality
No specific merger			
	Affeldt & Nitsche (2014)	n.s.	
	Houngbonon & Jeanjean (2014)		∩-shaped
	Jeanjean & Houngbonon (2015)		∩-shaped
	Csorba & Pápai (2015)	n.s.	
	Frontier (2015)	n.s.	n.s.
	HSBC (2015)		∩-shaped/Increase
	WIK (2015)		n.s.
	Ofcom (2016)	Increase	
	Jeanjean & Houngbonon (2015)		Increase
Austria			
	T-Mobile/tele.ring		
5-to-4 merger (2006)	Aguzzoni, et al. (2015, 2018)	n.s. / Decrease	
Netherlands			
	T-Mobile/Orange		
4-to-3 merger (2007)	Genakos, et al. (2018)	Increase	Increase
	Aguzzoni, et al. (2015, 2018)	n.s. / Increase	
Austria			
	Hutchison/Orange		
4-to-3 merger (2012)	Genakos, et al. (2018)	Increase	Increase
	Houngbonon (2015)	Decrease	
	HSBC (2015)	Decrease	
	RTR (2016)	n.s. / Increase	
	BWB (2016)	Increase	
	GSMA (2017)		Increase
	BEREC (2018)	n.s. / Increase	
UK			
	T-Mobile/Orange		
5-to-4 merger (2010)	Genakos, et al. (2018)	Increase	Increase
	Lear, et al. (2017)	Decrease	n.s. / Increase
Ireland			
	Hutchison/Telefónica		
4-to-3 merger (2014)	BEREC (2018)	Increase (short-run)	
Germany			
	Telefónica/KPN		
4-to-3 merger (2014)	BEREC (2018)	Increase (short-run)	

"n.s." denotes not statistically significant

Empirical research in wireless telecommunications industry competition is fractured in many ways that may not be helpful in guiding merger reviews by competition and telecom authorities. Many studies focus on short-run price effects and do not evaluate the extent to which post-merger entry, especially by MVNOs, tends to ameliorate or reverse price increases. In economics, the long-run is defined as the time it takes for entry or exit of firms to occur. Thus, any study that does not span a period of time sufficient to include actual or potential entry is, by definition, a study solely of short-term effects.

For example, six of the studies in this literature review analyzed the price effects of the 2012 Hutchison/Orange merger in Austria. Only one, BEREC (2018), spanned a time period that included MVNO entry three years later.

The empirical literature evaluating the effects of competition on investment is sparse: Only six of the studies in this literature review evaluate investment. And most of the studies that evaluate investment review it separately from price—either ignoring price or performing separate regressions for price effects and investment effects.

Frontier (2015) points to an interaction between investment, quality, and price:

In the mobile sector, investment is likely to be the main driver of consumer benefits and social welfare. Investment in the mobile industry will benefit consumers in several ways:

- investment will impact the quality of existing products and services which the consumers receive,
- investment will enable innovation and the delivery of entirely new products and services, and
- investment will lead to improved efficiencies which will lower the unit prices that consumers pay for those products and services.

These are the key factors relevant for consumer welfare and each is highly dependent upon network investment in the mobile industry. Therefore, the impact of mergers on investment should be fundamental to any assessment of mobile mergers.

Frontier (2015) concludes that increased investment would be associated with improved quality and lower prices. However, if improved quality increased consumer

demand (i.e., shifts the demand curve out), consumer welfare can be increased even in the face of higher prices. Thus, a thorough merger review must consider the interaction of prices and investment/quality to evaluate whether a potential merger would enhance or harm consumer welfare. Current research does not answer this question.

I. Studies of price effects

The summary table above shows that among the studies in this literature review, statistical analysis of the effects of market concentration—measured by number of firms, HHI, or merger activity—provides mixed results. BEREC (2018) reports:

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 find significant price increases, there are also studies finding no price effects or even a decrease in prices or positive quality effects. The evidence on 5-to-4 mergers so far does not suggest that the cases investigated had negative effects for consumers. It should be noted that the only mergers that can be studied are those which have been approved by competition authorities (possibly with remedies) because they were considered not likely to impede competition significantly.

The summary table shows that 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 in that the tariffs may be meaningless with respect to a country's consumption bundle. They also caution that researchers should be careful in tracking changes in tariffs over time and cross-country differences in demand, costs, and network quality. Lear et al. (2017), which uses the usage profile approach based on baskets defined by the OECD, concedes that the approach has several drawbacks.

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 importantly 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.¹ 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). However, this simple 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.

¹

- Failure to consider competition from smaller MNOs.

A. Studies of no specific merger

Using data from 23 European countries spanning 2003 through 2012, Affeldt & Nitsche (2014) find “no positive relationship between concentration and prices and some indications that the relationship may be negative.” Number of firms is their measure of competition and they confine their analysis to observations with either three or four MNOs.

In their regression with number of firms as the only independent variable, Affeldt & Nitsche (2014) find that countries with three firms have statistically significantly higher prices than countries with four firms, using effective price per minute (EPPM) as the measure of price. The regression has a relatively poor goodness-of-fit (R-squared of 0.01). The addition of a linear time trend increases the goodness-of-fit (R-squared of 0.66), but causes the number of firms variable to be insignificant and to switch signs.

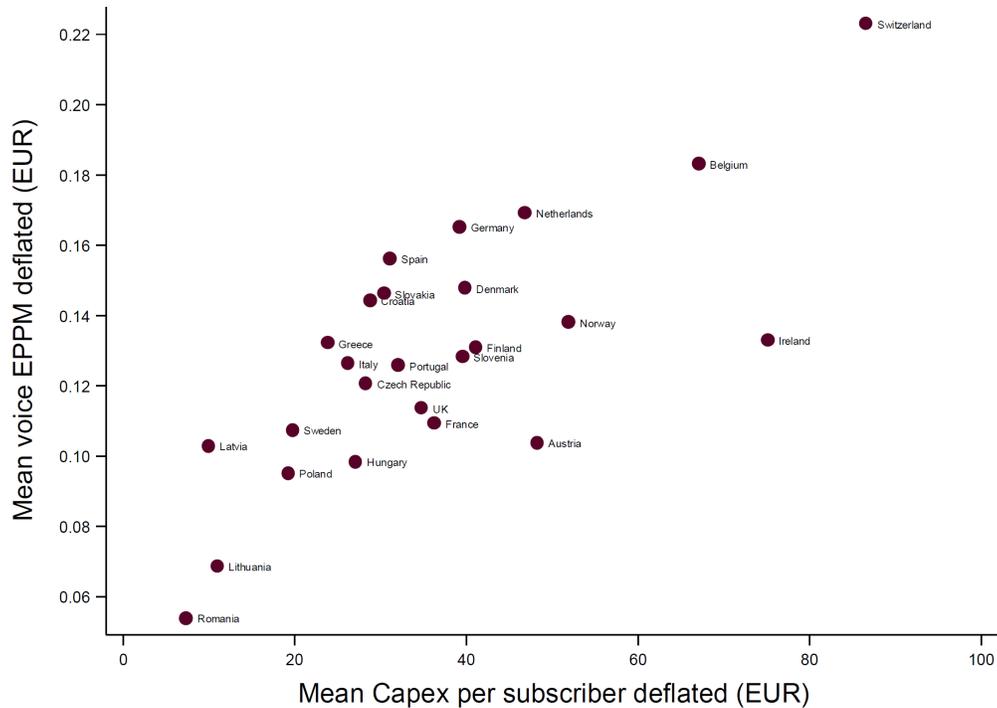
Affeldt & Nitsche (2014) is one of the few studies that includes investment, measured by capex, as an independent variable in its price regressions. In the two specifications that include capex, the paper finds higher capex is associated with higher prices, as shown in Figure 3 from their paper, below. They note that capex “is not purely an indicator of quality but also partly an indicator of differences in costs (at given quality levels).”

Affeldt & Nitsche (2014) criticize the use of tariff data, which is used by most of the research in this area. They argue that hypothetical baskets may be “relatively meaningless” in a particular country, the choice of basket may drive results, and the choice of basket does not allow for changes in consumer usage over time.

Using data from 27 European countries for 2003 through 2010, Csorba & Pápai (2015) find a wide range of effects of the number of firms on prices. These effects vary with how firm activity is measured: e.g., number of MNOs, whether the change in number of firms was associated with entry or a merger, whether an entering firm was a multinational firm or a “disruptive” firm. Csorba & Pápai (2015) conclude there are no price-increasing effects of 5-to-4 mergers. For the only 4-to-3 merger in their data (the 2004 acquisition of Orange by TeliaSonera in Denmark), they find no

significant price effects in the first two years, but a 29 percent increase in prices in the third year after the merger.

Figure 3: Voice EPPM over Capex per subscriber (averaged over the period 2003 to 2012)



Frontier (2015) finds no statistically significant relationship between prices and concentration (measured by HHI) or number of firms (measured by a dummy variable). The report uses data from the EU for the years 2000 through 2014. It measures competition by HHI and a dummy for four firms (versus three firms) as measures of competition. Average revenue per minute of use is the measure of price and capex the measure of investment.

WIK (2015), criticizing Frontier’s (2015) use of ARPM as a measure of prices, notes that the measure may not be appropriate if the mix of call-types or volumes differs between countries. Nevertheless, WIK (2015) concurs with Frontier’s (2015) assessment that competition authorities that focus on short-term price effects overlook longer term “dynamic efficiencies” arising from mergers.

A. Studies of specific mergers

1. Austria: T-Mobile/tele.ring

Using a difference-in-difference approach Aguzzoni et al. (2018) conclude that after the acquisition—for which remedies were imposed—prices in Austria did not increase relative to the considered control countries. Their regression results, presented below, indicate the merger likely led to lower prices in the short- and medium-term across each of the hypothetical consumption baskets.

Table 5 Estimation of merger effect Austria—four cheapest tariffs

Dep. variable basket	(1) Log price Low	(2) Log price Low	(3) Log price Mid	(4) Log price Mid	(5) Log price High	(6) Log price High
Short-term effect	− 0.231*** (0.036)	− 0.019 (0.055)	− 0.134*** (0.042)	− 0.056 (0.058)	− 0.074 (0.045)	− 0.104* (0.058)
Medium-term effect	− 0.340*** (0.052)	0.005 (0.096)	− 0.180** (0.071)	− 0.057 (0.102)	− 0.128 (0.074)	− 0.177* (0.095)
GDP growth	1.562 (1.296)	1.351 (1.107)	0.906 (1.500)	1.282 (1.203)	1.114 (1.482)	1.433 (1.308)
Log MTR	0.007 (0.135)	0.128 (0.118)	0.098 (0.167)	0.120 (0.084)	0.130 (0.172)	0.125 (0.081)
Observations	1727	1727	1727	1727	1727	1727
R ²	0.737	0.754	0.815	0.841	0.832	0.865
Country-spec. trend	No	Yes	No	Yes	No	Yes
Common trend test (<i>p</i> val)	0.014	–	0.261	–	0.674	–

Cluster-robust SE below coefficients (SE clustered at country level)

Time fixed effects and country-MNO fixed-effects

Period: Q2/2004–Q2/2008; 8 quarters pre- and 8 quarters post-merger; Q2/2006 is dropped (merger quarter)

Common trend test—null hypothesis of common trend

Significance level: ***1, **5, *10%

Using a synthetic control group approach Aguzzoni et al. (2015) find a price reduction for Austria following the merger, relative to the selected control countries:

For the Low basket we estimate a strong price reduction of 20% in the short term and 40% in the medium term. For the Mid basket we estimate a price drop of 8% and 15% over the same periods, and for the High basket we find negligible effects.

2. Netherlands: T-Mobile/Orange

Using a difference-in-difference approach Aguzzoni et al. (2018) conclude that after the acquisition **prices increased in the Netherlands in the analyzed period, relative to the control countries.** They caution that they **could not establish whether price increases were exclusively caused by the T-Mobile/Orange merger or in part by possible price effects brought about by the KPN/Telfort merger completed two years earlier** in the Netherlands. The regression results, presented below, indicate a mix of non-significant and statistically significant estimated coefficients, with the size and significance determined by the inclusion of a country-specific linear time trend in the regression.

Table 6 Estimation of merger effect the Netherlands—four cheapest tariffs

Dep. variable	(1)	(2)	(3)	(4)	(5)	(6)
basket	Log price	Log price				
	Low	Low	Mid	Mid	High	High
Short-term effect	0.062	0.148**	0.093**	0.126**	0.133***	0.050
	(0.049)	(0.052)	(0.035)	(0.053)	(0.021)	(0.036)
Medium-term effect	0.009	0.141*	0.099**	0.149	0.167***	0.030
	(0.050)	(0.070)	(0.042)	(0.084)	(0.036)	(0.063)
GDP growth	2.598**	1.315**	1.964**	0.980*	1.825**	0.806*
	(0.889)	(0.581)	(0.765)	(0.456)	(0.644)	(0.384)
Log MTR	0.015	-0.032	-0.032	-0.036	-0.083	-0.029
	(0.126)	(0.065)	(0.088)	(0.037)	(0.065)	(0.059)
Observations	1318	1318	1318	1318	1318	1318
R ²	0.707	0.727	0.785	0.806	0.825	0.842
Country-spec. trend	No	Yes	No	Yes	No	Yes
Common trend test (<i>p</i> val)	0.039	-	0.410	-	0.005	-

Cluster-robust SE below coefficients (SE clustered at country level)

Time fixed effects and country-MNO fixed-effects

Period: Q2/2005–Q3/2009; 4 quarters pre- and 8 quarters post-merger; Q2-Q3/2007 excluded quarters (merger quarters)

Common trend test—null hypothesis of common trend

Significance level: ***1, **5, *10%

Using a synthetic control group approach Aguzzoni et al. (2015) find **price increases for Austria following the merger, relative to the selected control countries, but “none of the estimated effects appears to be significant.”**

Genakos, et al. (2018) do not directly estimate the effect of the merger on prices in the Netherlands. They use data from 33 European countries for the years 2002-14, with the number of firms, HHI, and entry/exit of firms as independent variables measuring competition, and apply the estimates from the HHI regressions to estimate the effect of mergers in Austria, the Netherlands, and the United Kingdom.

Using the number of firms as independent variable, the estimates of Genakos, et al. (2018) suggest, in separate regressions:

- The addition of a fourth competitor (new entry) would be associated with a price reduction of 8.6 percent;
- The loss of a fourth competitor (e.g., a four to three merger) would be associated a price increase of 15.9 percent; and
- Cumulative net exit of a competitor would be associated with a price increase of 4.3 percent.

Genakos et al. (2018) express HHI as a percent, rather than the standard 0-10,000 scale. Using HHI as independent variable, they suggest a 10 percentage point increase in HHI would be associated with a 20-25 percent increase in price. They estimate that **the T-Mobile/Orange merger increased HHI by 3.6 percentage points, suggesting a 0.6 to 6.8 percent increase in prices.**

Genakos et al. (2018) caution that the T-Mobile/Orange merger may not be the only, or most important, factor explaining the price differences, and identify the earlier KPN/Telfort merger as one additional factor.

3. *Austria: Hutchison/Orange*

BEREC (2018) describes the Hutchison/Orange merger in Austria as “the most investigated mobile merger in terms of ex-post analysis.” Genakos, et al. (2018), Hounghonon (2015), HSBC (2015), RTR (2016), BWB (2016), and BEREC (2018) analyze the effects of the merger on prices, with a **wide range of estimated effects, ranging from a 40 percent decrease in price (Aguzzoni, et al., 2015) to 90 percent increase in price (RTR, 2016).**

BEREC (2018) is the most recent study of the Hutchison/Orange merger in Austria. The authors use data from 13 European countries spanning 2012-16, and covering two years prior to the merger and three years post-merger. The data do not include MVNO prices, handset subsidies, and business plans and data-only plans. The report

concludes there is evidence that the merger led to significant price increases in the first two years. However, after two years—with MVNO entry—the effect became considerably smaller and statistically insignificant in most of BEREC’s specifications, as shown in Table 3 from the report, shown below.

Table 3: Results for Austria, country-level, 2013 usage

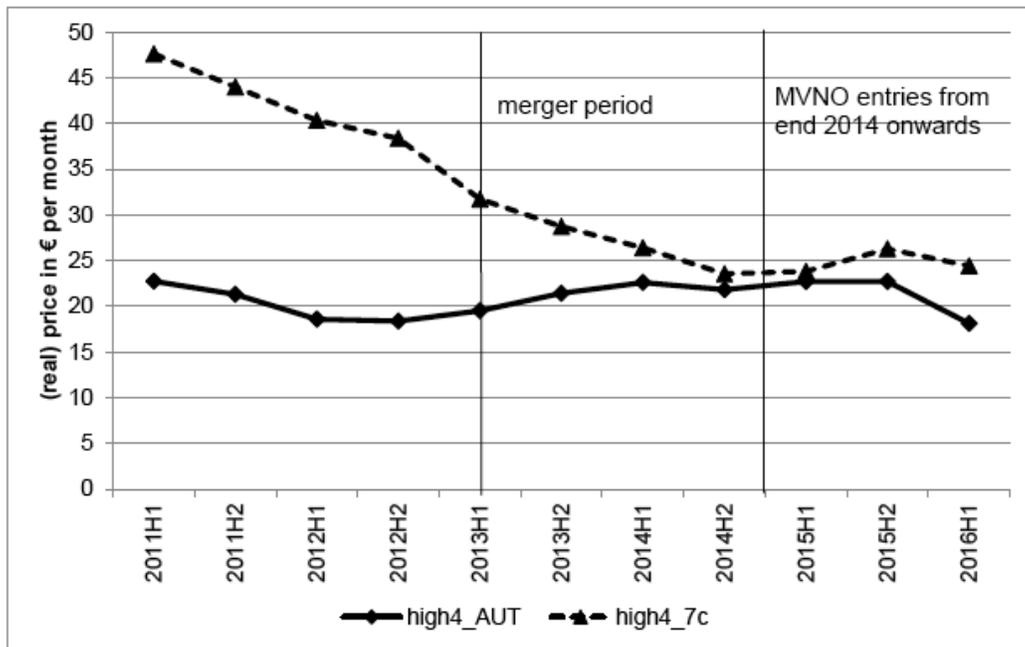
	Low (4 tariffs)			Medium (4 tariffs)			High (4 Tariffs)		
	DiD basic	DiD trend	Synth	DiD basic	DiD trend	Synth	DiD basic	DiD trend	Synth
2013 H2	0.179 (0.182)	0.244** (0.023)	0.098 (0.571)	0.254 (0.132)	0.372*** (0.007)	0.246 (0.143)	0.423*** (0.003)	0.477*** (0.002)	0.187 (0.286)
2014 H1	0.261*** (0.004)	0.223* (0.070)	0.280† (0.000)	0.418*** (0.000)	0.483*** (0.000)	0.449 (0.143)	0.520*** (0.000)	0.532*** (0.000)	0.298 (0.429)
2014 H2	0.328*** (0.000)	0.258** (0.024)	0.247† (0.000)	0.518*** (0.000)	0.545*** (0.000)	0.456† (0.000)	0.661*** (0.000)	0.664*** (0.000)	0.452 (0.286)
2015 H1	0.248*** (0.002)	0.178 (0.186)	0.153† (0.000)	0.493*** (0.000)	0.561*** (0.000)	0.617† (0.000)	0.662*** (0.000)	0.671*** (0.000)	0.474 (0.286)
2015 H2	0.277*** (0.007)	0.168 (0.300)	0.138† (0.000)	0.549*** (0.000)	0.564*** (0.001)	0.533† (0.000)	0.666*** (0.000)	0.663*** (0.000)	0.463 (0.143)
2016 H1	0.100 (0.379)	-0.004 (0.982)	-0.038 (0.714)	0.230* (0.067)	0.301* (0.076)	0.117 (0.429)	0.381*** (0.000)	0.387* (0.063)	0.142 (0.429)
GDP growth	0.621 (0.830)	-0.321 (0.848)		4.614 (0.132)	2.114 (0.411)		4.141 (0.107)	3.690 (0.219)	
MTRs	-0.114 (0.287)	-0.232* (0.088)		0.097 (0.444)	-0.020 (0.898)		0.034 (0.763)	-0.022 (0.901)	
constant	2.443*** (0.000)	7.596*** (0.000)		2.660*** (0.000)	10.813*** (0.000)		2.497*** (0.000)	5.910** (0.012)	
Obs.	80	80		80	80		80	80	
R ²	0.845	0.927		0.813	0.922		0.906	0.943	
Trend test passed?	Yes			Yes			Yes		

Country and time fixed effects included in the regressions (but not shown in the table)

DiD: Robust p-values in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Synth: Standardised p-values (Galiani and Quistorff, 2016): † treated county has highest RMSP-ratio

Figure 6 from BEREC (2018), shown below, 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. After MVNO entry, the figure shows that prices in Austria declined, while prices in comparison countries increased.



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

BEREC (2018) cautions that they may overestimate the impacts of the merger on price because of “significant competitive pressure” from the entry of additional MVNOs in 2015. The study points out that, in addition to the merger, another transaction Hutchison spun off the Orange sub-brand Yesss! to A1 Telekom Austria, creating a “more symmetrical market structure.”

Genakos, et al. (2018) do not directly estimate effects of the merger on prices in Austria. They use data from 33 European countries for the years 2002-14, with the number of firms, HHI, and entry/exit of firms as independent variables measuring competition. They apply the estimates from the HHI regressions to estimate the effect of mergers in Austria, the Netherlands, and the United Kingdom.

Using the number of firms as independent variable, the estimates of Genakos, et al. (2018) suggest, in separate regressions:

- The addition of a fourth competitor (new entry) would be associated with a price reduction of 8.6 percent;

- The loss of a fourth competitor (e.g., a four to three merger) would be associated a price increase of 15.9 percent; and
- Cumulative net exit of a competitor would be associated with a price increase of 4.3 percent.

Genakos et al. (2018) express HHI as a percent, rather than the standard 0-10,000 scale. Using HHI as independent variable, they suggest a 10 percentage point increase in HHI would be associated with a 20-25 percent increase in price. They **estimate that the Hutchison/Orange merger increased HHI by 6.4 percentage points, suggesting a 1.0 to 12.2 percent increase in prices.**

The time period covered by Genakos et al. (2018) does not include MVNO entry. BEREC (2018) notes that two years after the merger, with MVNO entry, their effect became considerably smaller and statistically insignificant in most specifications.

The Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR, 2016) **estimates price increases of 24 percent in the short run and 90 percent in the long run in the smartphone segment.** The study **estimates no significant change in the short run and 31 percent increase in the long run in the traditional segment.** RTR (2016) uses data from 11 European countries spanning 2011-14 and a merger dummy as measure of competition.

Figure 2 from RTR (2016), shown below, indicates **much of the price difference between Austria and comparison countries in the smartphone segment results from a decline in comparison country prices, rather than increases in prices in Austria**—a finding similar to that shown in BEREC (2018). The time period covered by RTR (2016) does not include MVNO entry, which occurred in 2015. BEREC (2018) notes that two years after the merger, with MVNO entry, their effect became considerably smaller and statistically insignificant in most specifications.

The Austrian Federal Competition Authority (BWB) 2016 uses a merger simulation to **estimate price increases of 14-20 percent after merger.** BWB (2016) makes clear that it consider the Hutchison/Orange merger together with sale of the Orange Yesss! segment to Telecom Austria. Thus, BWB (2016) does not evaluate the Hutchison/Orange merger by itself.

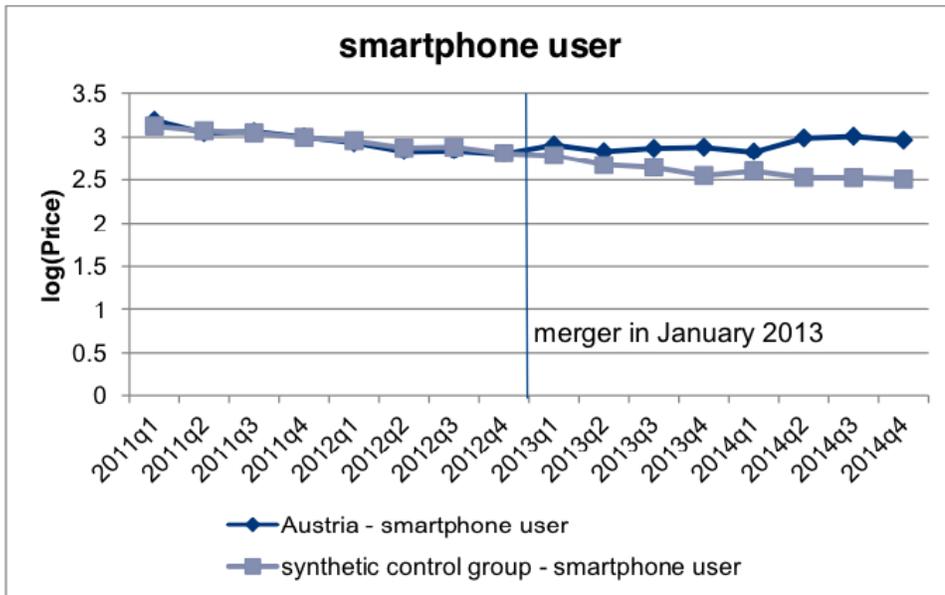


Figure 2: Price development in Austria compared to the synthetic control group

BWB (2016) notes its analysis does not include MVNO entry, which occurred in 2015, and was associated with a decrease in price.

Houngbonon (2015) examines the Hutchison/Orange four to three merger in Austria and a three to four entry in France. **He estimates the effect of the Austria merger as a price decrease. The paper reports no effect of the merger on standalone data and a decrease of \$6 per GB in price for bundled data.** Results indicate a price-increasing effect associated with the entry of a fourth MNO in France.

The study uses data from 40 countries for seven quarters spanning 2013-14 to identify countries with the most similar pre-merger price series to Austria and identifies Italy as the most similar country. Estimates are based the comparison of Austria and Italy’s price series pre- and post-merger, using a merger dummy. HSBC’s (2015) price analysis follows Houngbonon’s (2015) approach and supports the latter’s results.

HSBC (2015) estimates the effects of competition on prices and investment. For the price analysis, the research examines the Hutchison/Orange four to three merger in Austria and a three to four entry in France. As with Houngbonon (2015), **the paper finds no price effect of the merger on standalone data and a decrease of \$8.00 to**

\$8.60 per GB in price for bundled data. Results indicate a price-increasing effect associated with the entry of a fourth MNO in France.

For the price analysis, HSBC (2015) focuses on the same issue as Hounghonon (2015), and applies the same econometric approach to a slightly different database.

4. UK: T-Mobile/Orange

Genakos, et al. (2018) do not directly estimate effects of the merger on prices in the U.K.. They use data from 33 European countries for the years 2002-14, with the number of firms, HHI, and entry/exit of firms as independent variables measuring competition. They apply the estimates from the HHI regressions to estimate the effect of mergers in Austria, the Netherlands, and the United Kingdom.

Using the number of firms as independent variable, the estimates of Genakos, et al. (2018) suggest, in separate regressions:

- The addition of a fourth competitor (new entry) would be associated with a price reduction of 8.6 percent;
- The loss of a fourth competitor (e.g., a four to three merger) would be associated a price increase of 15.9 percent; and
- Cumulative net exit of a competitor would be associated with a price increase of 4.3 percent.

Genakos et al. (2018) express HHI as a percent, rather than the standard 0-10,000 scale. Using HHI as independent variable, they suggest a 10 percentage point increase in HHI would be associated with a 20-25 percent increase in price. **They estimate that the T-Mobile/Orange merger increased HHI by 6.7 percentage points, suggesting a 1.1 to 12.7 percent increase in prices.**

Lear, et al. (2017) examine a five to four merger in 2010 in the U.K. between T-Mobile and Orange. The econometric analysis, using a difference-in-difference approach similar to Aguzzoni et al. (2018) **indicates that the prices of mobile services fell 8.5-18.6 percent because of the merger, in particular for medium-consumption and high-consumption profiles, with no significant effect on low-consumption profiles.** The study uses data from 13 European countries spanning 2009-14.

Lear, et al. (2017) report T-Mobile and Orange, whose aggregate market share by subscribers was 35.6 percent before the merger, dropped to 29.2 percent four years

after the merger. Over the same period, the aggregate market shares of MVNOs increased from 11.3 percent to 13.6 percent.

5. Ireland: Hutchison/Telefónica

BEREC (2018) uses data from 13 European countries spanning 2012-16, and covering two years prior to the merger and 18 months post-merger. The data do not include MVNO prices, handset subsidies, and business plans and data-only plans. BEREC (2018) estimates some evidence of price increases for all three baskets in the difference-in-difference specification. However, the results are not robust across the difference-in-difference specifications and the synthetic control group specifications.

Table 5: Results for Ireland, country-level, 2013 usage

	Low (4 tariffs)			Medium (4 tariffs)			High (4 tariffs)		
	DiD basic	DiD trend	Synth	DiD basic	DiD trend	Synth	DiD basic	DiD trend	Synth
2015 H1	0.163** (0.042)	0.351*** (0.000)	0.244 (0.400)	0.398*** (0.000)	0.402** (0.011)	0.444 (0.300)	0.436*** (0.000)	0.279* (0.063)	0.829 (0.300)
2015 H2	0.121 (0.167)	0.414*** (0.002)	0.229 (0.400)	0.156 (0.136)	0.235 (0.312)	0.239 (0.400)	0.360*** (0.002)	0.154 (0.439)	0.682 (0.500)
2016 H1	0.052 (0.664)	0.329*** (0.009)	0.197 (0.400)	0.370*** (0.004)	0.346 (0.107)	0.167 (0.900)	0.305** (0.027)	0.063 (0.774)	0.644 (0.500)
GDP growth	0.256 (0.798)	-0.358 (0.731)		1.078 (0.312)	0.198 (0.866)		-0.420 (0.752)	-0.353 (0.766)	
MTRs	-0.118 (0.131)	-0.063 (0.440)		-0.058 (0.484)	-0.065 (0.440)		0.041 (0.623)	0.005 (0.956)	
constant	2.394*** (0.000)	6.723*** (0.000)		2.675*** (0.000)	9.131*** (0.002)		3.036*** (0.000)	6.112*** (0.000)	
Obs.	88	88		88	88		88	88	
R ²	0.873	0.926		0.877	0.915		0.903	0.931	
Trend test passed?	Yes			Yes			Yes		

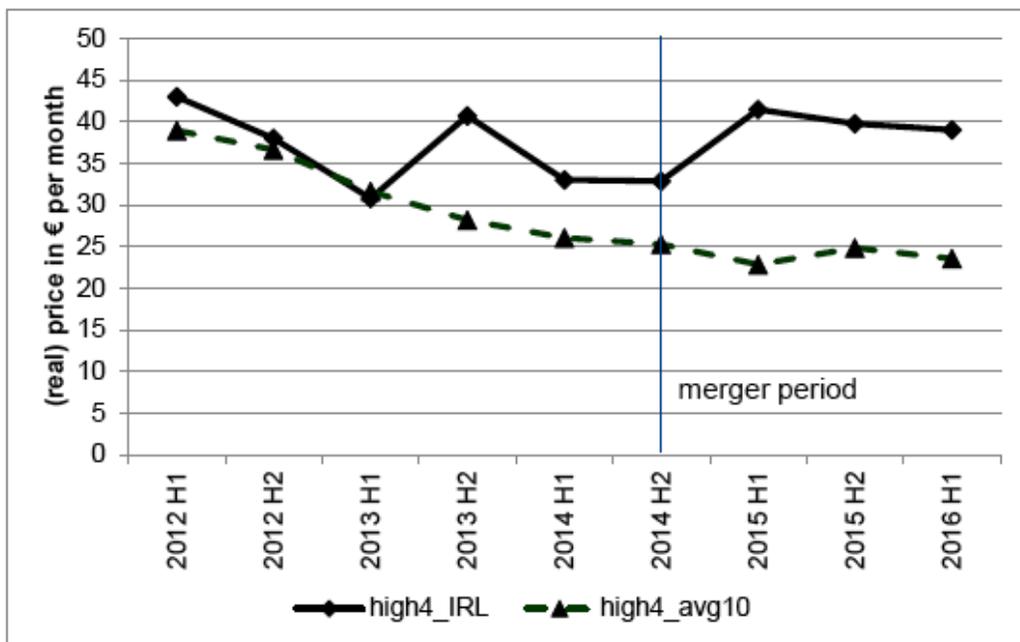
Country and time fixed effects included in the regressions (but not shown in the table)

DiD: Robust p-values in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Synth: Standardised p-values (Galiani and Quistorff, 2016): † treated county has highest RMSP-ratio

For example, as shown below in Table 5 from BEREC (2018), while the difference-in-difference approach finds statistically significant short term price increase in each basket, the synthetic control group approach finds no statistically significant price increase for any basket over any period of time.

Figure 9 from BEREC (2018), 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

6. Germany: Telefónica/KPN

BEREC (2018) uses data from 13 European countries spanning 2012-16, and covering two years prior to the merger and 18 months post-merger. The data do not include MVNO prices, handset subsidies, and business plans and data-only plans. BEREC (2018) estimates statistically significant price increases for all three baskets in the difference-in-difference specification. However, the results are not robust across the difference-in-difference specifications and the synthetic control group specifications.

For example, as shown below in Table 8 from BEREC (2018), while the difference-in-difference approach finds statistically significant price increases in each basket, with the exception of the low basket in the first half of 2016, the synthetic control group approach only finds no statistically significant price increase for any basket over any period of time.

Table 8: Results for Germany, 4 cheapest tariffs, country-level, 2013 usage

	Low (4 tariffs)			Medium (4 tariffs)			High (4 tariffs)		
	DiD basic	DiD trend	Synth	DiD basic	DiD trend	Synth	DiD basic	DiD trend	Synth
2015 H1	0.434*** (0.000)	0.458*** (0.000)	0.461 0.100	0.202*** (0.004)	0.270* (0.083)	0.088 0.200	0.136** (0.039)	0.180 (0.304)	0.154 0.400
2015 H2	0.248*** (0.000)	0.277** (0.034)	0.212 0.300	0.139* (0.050)	0.219 (0.249)	0.043 0.200	0.131* (0.071)	0.181 (0.402)	0.181 0.100
2016 H1	0.454*** (0.000)	0.506*** (0.002)	0.431† 0.000	0.348*** (0.000)	0.470** (0.048)	0.126 0.200	0.250*** (0.001)	0.327 (0.219)	0.124 0.400
GDP growth	1.017 (0.483)	-0.000 (1.000)		2.484* (0.097)	0.480 (0.800)		2.762** (0.047)	1.362 (0.461)	
MTRs	-0.094 (0.274)	-0.002 (0.975)		-0.064 (0.472)	-0.022 (0.820)		0.041 (0.662)	0.062 (0.576)	
constant	2.375*** (0.000)	4.555*** (0.006)		2.647*** (0.000)	6.071* (0.086)		3.022*** (0.000)	4.686* (0.055)	
Obs.	77	77		77	77		77	77	
R ²	0.863	0.922		0.877	0.913		0.899	0.919	
Trend test passed?	Yes			Yes			Yes		

Country and time fixed effects included in the regressions (but not shown in the table)

DiD: Robust p-values in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Synth: Standardised p-values (Galiani and Quistorff, 2016): † treated county has highest RMSP-ratio

In the case of the low basket, it should also be noted that no data is available for the MVNO and service provider segment or for sub-brands of MNOs. The paper points out this may be especially relevant in Germany as the MVNO and service provider segment of the German market is relatively large at approximately 20 percent of the market.

II. Investment and quality effects

B. Studies of no specific merger

Using data from 199 countries around the world for 2000 through 2014, Hounghonon & Jeanjean (2014) find an inverted-U relationship between the intensity of competition (measured by a Lerner index) and investment (measured by capex). **The capex maximizing Lerner index is at 63 percent plus or minus 6 percentage points at the 5 percent confidence level, which corresponds to an EBITDA of 37 percent of total revenue.**

Using an approach similar to Hounghonon & Jeanjean (2014), HSBC (2015) uses capex data from 66 countries for 2003-13 to evaluate the four to three Hutchison/Orange merger in Austria, using a Lerner index as a measure of competition, where $L = 1 - (\text{EBITDA}/\text{Revenue})$. The report estimates the **maximum level of investment, as measured by capex, occurs at an EBITDA of 38 percent.** HSBC (2015) reports the average EBITDA of the mobile sector in Europe is significantly below this—on average 31-32 percent. Thus, **the report concludes a four to three merger in Europe would result in EBITDA closer to the optimal amount of 38 percent and would, therefore, lead to higher investment with better outcomes for users.**

Both Frontier (2015) and WIK (2015) find no statistically significant relationships of competition measured by HHI or a four firm (versus three firm) dummy.

Jeanjean & Hounghonon (2015) construct a dataset 38 countries worldwide, spanning the years 2004 to 2013. The data do not include Canada, the U.S., India, and China. They estimate capex at both the firm level (818 observations) and the market level (378 observations). Rather than use the number of firms in a country as a measure of competition, the study uses a dummy variable for each number of firms, with three firms as the baseline. Thus, the regression results are relative to a country with three firms. In addition, the study uses a measure of relative market share as a measure of what the authors call “relative efficiency.” **They conclude a merger would be associated with an increase in each firm’s investment and firms with a larger market share would make larger investments. They also conclude that aggregate investment is maximized at three or four MNOs.**

Jeanjean and Hounghonon (2017) use a dataset of 50 mobile operators from 17 European countries, spanning the years 2006 through 2015. The data includes operator-level information regarding capex, market share by subscribers (both pre- and post-paid), average revenue per subscriber, EBITDA, and mobile termination rates. Country-level data include the number of mobile operators, the total number of subscribers, the penetration rate of fixed lines, population, gross domestic product (GDP) per capita, and a political variable that aims to capture the position of the government towards the welfare state. Investment is measured by the natural logarithm of capex. Competition is proxied by the number of mobile operators in each country and each firm's market share asymmetry. Market share asymmetry is measured as the difference between each firm's market share and the average market share for the country. **Jeanjean and Hounghonon (2017) find that in markets that are asymmetric (i.e., where firms are of different sizes), an increase in the number of firms tends to have a more significantly negative effect on investment by smaller firms. This suggests that a merger that results in a more symmetric market structure would be associated with a stronger positive effect on investment.**

Woroch (2019) uses a data set of 697 U.S. Cellular Market Areas, spanning the years 2012–2013. Using carrier-level data, he concludes 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.

C. Studies of specific mergers

Genakos, et al. (2018) do not separately estimate effects of individual mergers on investment in specific countries. They use data from 33 European countries for the years 2002-14, with the number of firms, HHI, and entry/exit of firms as independent variables measuring competition. They apply the estimates from the HHI regressions to estimate the effect of mergers in Austria, the Netherlands, and the United Kingdom.

Using the number of firms as independent variable, the estimates of Genakos, et al. (2018) suggest, in separate regressions:

- The addition of a fourth competitor (new entry) would be associated with a price reduction of 8.6 percent;
- The loss of a fourth competitor (e.g., a four to three merger) would be associated a price increase of 15.9 percent; and
- Cumulative net exit of a competitor would be associated with a price increase of 4.3 percent.

Genakos et al. (2018) express HHI as a percent, rather than the standard 0-10,000 scale. Using HHI as independent variable, **they suggest a 10 percentage point increase in HHI would be associated with a 24-28 percent increase in price.** For their three mergers evaluated in their report, they estimate:

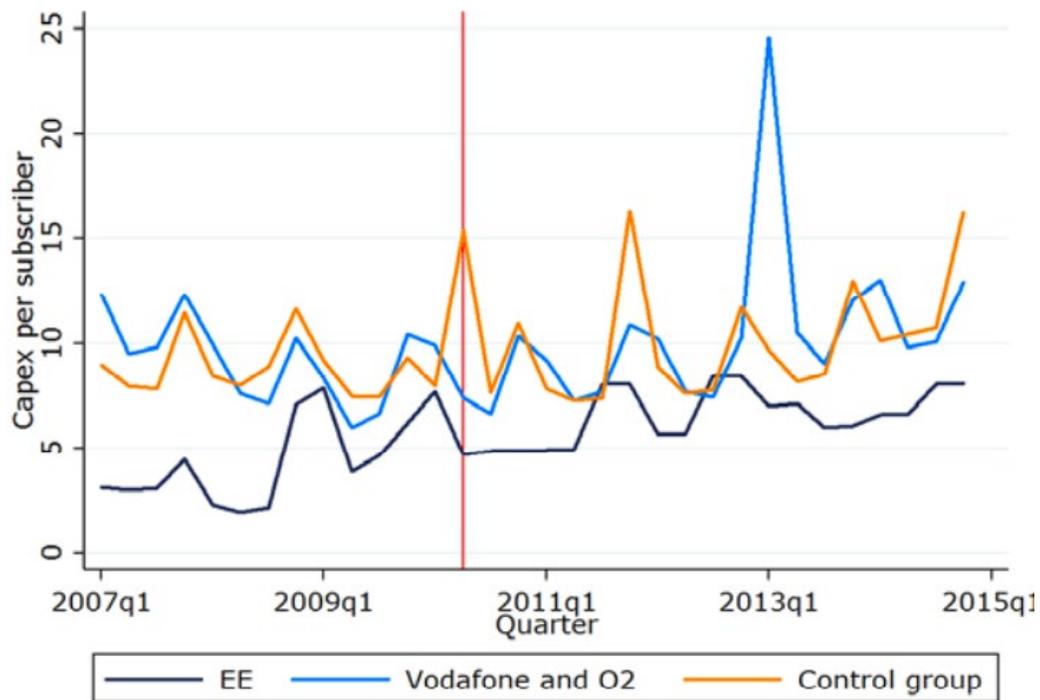
- **The Hutchison/Orange merger in Austria increased HHI by 6.4 percentage points and was estimated to result in 1.2 to 25.5 percent increase investment;**
- **The T-Mobile/Orange merger in the Netherlands increased HHI by 3.6 percentage points and was estimated to result in 0.7 to 14.3 percent increase investment; and**
- **The T-Mobile/Orange merger in the UK increased HHI by 6.7 percentage points and was estimated to result in 1.2 to 26.5 percent increase investment.**

Lear, et al. (2017) reviewed the five to four merger in 2010 in the U.K. between T-Mobile and Orange. The study uses data from 13 European countries spanning 2009-14. The study uses a merger dummy as measure of competition and uses capex and capex per subscriber as measures of investment. The econometric analysis suggests that **the merger was associated with increased investment, as measured by capex. However, estimates calculated using the ratio of capex to the number of subscribers are not significant.**

Figure 6.4 from Lear, et al. (2017) indicates relatively high seasonal variation in capex per subscriber, which could affect the estimates of statistical significance (where “EE” denotes combined T-Mobile and Orange). The authors, however, use several specification to control for seasonality and, “rule out the possibility that the volatility of the results is driven by seasonality in capex data.”

GSMA (2017) analyzes the four to three Hutchison/Orange merger in Austria on innovation and quality in mobile services, using data from 17 European countries spanning 2011-16, and using a merger dummy as measure of competition. The study uses 4G coverage data in order to measure the level of innovation and download/upload speeds of 4G and 3G networks as indicators of quality of service. **The estimates suggest that the merger accelerated the rollout of Hutchison’s 4G network and that all measures of network quality also increased.**

Figure 6.4 – Capex over number of subscribers, EE against other UK operators and control countries (weighted average)



BEREC (2018) criticizes the approach and data in GSMA (2017):

- No pre-merger 4G download speed data available for Hutchison.
- Limited pre-merger 4G download speed for other Austria operators. Most of the increase in speeds occurred in the two quarters immediately after the merger. BEREC concludes the timing suggests that the increases were not because of the merger.

- Pre-merger, Austria had no 800 MHz spectrum available (and 1,800 MHz spectrum was not allowed for 4G), calling into question HSBC's implication that the merger itself led to increased 4G coverage.

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