The Austrian Market for Mobile Telecommunication Services to Private Customers

An Ex-post Evaluation of the Mergers H3G/Orange and TA/Yesss!

Sectoral Inquiry
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Zusammenfassung

Die Bundeswettbewerbsbehörde (BWB) kann allgemeine Untersuchungen eines Wirtschaftszweiges durchführen, sofern die Umstände vermuten lassen, dass der Wettbewerb in dem betreffenden Wirtschaftszweig eingeschränkt oder verfälscht ist. Im Rahmen einer solchen Branchenuntersuchung hat die BWB die Entwicklung des österreichischen Mobilfunkmarktes untersucht. Im Dezember 2012 wurde die Übernahme von Orange Austria (Orange) durch Hutchinson 3G Austria (H3G) von der Europäischen Kommission unter Auflagen freigegeben. In einer wirtschaftlich verbundenen Transaktion verkaufte H3G die zu Orange gehörende Marke "Yesss!" an den marktführenden Mobilfunkanbieter Telekom Austria (TA). Dieser Zusammenschluss wurde im November 2012 vom österreichischen Kartellgericht ohne Auflagen freigegeben. Die BWB hatte sich in beiden Verfahren, vor dem Kartellgericht und vor der Europäischen Kommission, gegen eine Freigabe ausgesprochen.

Vor den Zusammenschlüssen gab es vier Mobilfunknetzbetreiber am österreichischen Markt. Die Preise für Mobiltelefonie fielen für mehrere Jahre in Folge und waren im europäischen Vergleich eher niedrig. In den zwei Jahren nach den Zusammenschlüssen begannen die Preise wieder zu steigen. In manchen Subsegmenten kam es sogar zu sehr starken Preisanstiegen. Betroffen waren nicht nur Neukunden, sondern auch Bestandskunden. Anfänglich wurden diese Preisanstiege von den Betreibern als Zeichen für die Beendigung eines harten "Preiskrieges" begrüßt.[1] Später wurden die Preisanstiege jedoch mit gestiegenen Kosten begründet.[2]

In der vorliegenden Untersuchung werden die Preiseffekte der Zusammenschlüsse für Bestandskunden analysiert. Dabei greifen wir auf Simulationsverfahren

Preiseffekte der Zusammenschlüsse (Bestandskunden)	
Preis (alle Segmente)	14–20%
Pre-paid Tarife	20–30%
Post-paid Tarife	13–17%
- Sim-only Tarife	10–15%
- Vertragstarife	14–18%

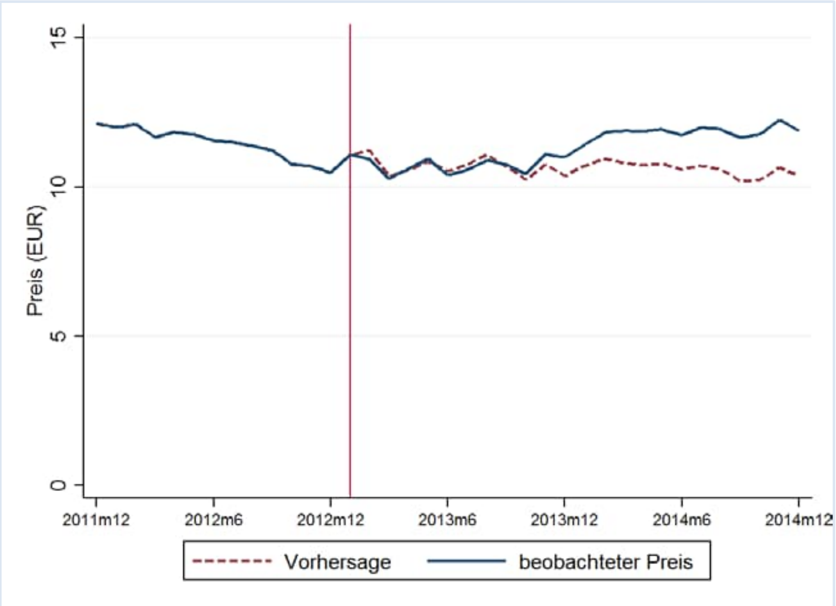
Preisanstiege im Zeitraum Dezember 2012 bis Dezember 2014.

(Merger Simulation) zurück, die auch in Zusammenschlussverfahren verwendet werden, um Preiseffekte vorherzusagen.[3]

[1] Vgl. http://www.reuters.com/article/us-telekomaustria-profit-idUSBRE9AJ0ZD20131120 (20.11.2013, in Englisch), abgefragt am 18.2.2016.
[2] Vgl. http://futurezone.at/digital-life/preisanstieg-wegen-netzausbau-und-teurer-frequenzen/56.709.623 (19.3.2014), abgefragt am 18.2.2016.
[3] Vgl. Davis, P. und Garcés, E. (2009). Quantitative techniques for competition and antitrust analysis, Princeton University Press. Die "Upward pricing pressure" (UPP) Analysen, die in den Zusammenschlussverfahren H3G/Orange und TA/Yesss! durchgeführt wurden um Preiseffekte vorherzusagen, stellen vereinfachte Varianten dieser Simulationsverfahren dar.

Die Zusammenschlüsse erhöhten die inflationsbereinigten Preise für Bestandskunden im Durchschnitt um 14–20%. Für Pre-Paid Kunden waren die Preisanstiege am größten (20–30%). Die Preisanstiege für Post-Paid Kunden (Vertragskunden) waren etwas geringer (13–17%). Innerhalb des Post-Paid Segmentes kam es bei Sim-Only Tarifen (Tarife ohne Bindungsfrist) zu sehr hohen Preisanstiegen. Diese Preisanstiege konnten zu einem guten Teil durch eine stark erhöhte Datennutzung erklärt werden. Die Zusammenschlüsse erklären einen Preisanstieg von 10–15%. Bei Vertragstarifen mit Bindungsfrist führten die Zusammenschlüsse zu einem Preisanstieg von 14–18%.

Abbildung: Gewichtete Bestandskundenpreise.[4]



Wie aus der Abbildung hervorgeht, stieg der tatsächlich beobachtete Preis erst Ende 2013 über das Preisniveau an, das ohne die Zusammenschlüsse zu erwarten gewesen wäre ("Vorhersage"). Zu dieser Zeit wurde in den Medien das "Ende des Preiskrieges" begrüßt. Im Jahr 2015 (nicht abgebildet) traten mehrere neue virtuelle Mobilfunknetzbetreiber (MVNOs) in den Markt ein. Dem Neukundenpreisindex der RTR zufolge begannen die Preise dadurch wieder zu sinken.[5]

Die Mobilfunknetzbetreiber konnten also nicht sehr lange von einem höheren Preisniveau profitieren. Andererseits kann festgehalten werden, dass die Auflagen im Zusammenschlussfall H3G/Orange auf neue Markteintritte abgezielt hatten. Im Endeffekt kam es jedoch zwei Jahre lang zu keinen Markteintritten.

Zusammenfassend kann festgehalten werden, dass effektiver Wettbewerb auch in regulierten Märkten entscheidend ist, um niedrige Preise, attraktive Produkte und hohen Konsumentennutzen sicherzustellen. Wenn problematische Zusammenschlüsse ohne Auflagen freigegeben werden oder die Auflagen unzureichend sind,

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[4] Abbildung für das Modell 2/I im Bericht.
[5] https://www.rtr.at/de/pr/PI15022016TK, (15.02.2016)

kann das zu einer großen Belastung für Konsumentinnen und Konsumenten und für die gesamte Volkswirtschaft führen. Auf Grundlage der umfassenden Kenntnisse, die die BWB über den untersuchten Markt gewonnen hat, wird die BWB den Mobilfunkmarkt weiter genau beobachten und gegebenenfalls weitere Schritte setzen.

Executive Summary

The Austrian Competition Authority (BWB) can conduct sector inquiries if there are indications that competition is restricted or distorted. In an investigation of the Austrian mobile telecommunications market, BWB evaluated the impact of two recent mergers in the mobile telecommunications sector. In December 2012, the acquisition of Orange Austria (Orange) by Hutchinson 3G Austria (H3G) was cleared subject to remedies by the European Commission. In a related transaction, H3G sold on Orange's second brand "Yesss!" to the incumbent operator Telecom Austria (TA). This merger was cleared by the Austrian Cartel Court without remedies in November 2012. BWB objected the clearance of both mergers.

Prior to the mergers, there were four mobile network operators (MNO) on the Austrian market. Prices for mobile telecommunication services had been falling for several consecutive years and were relatively low compared to other European countries. However, in the two years following the mergers, prices started to increase again and they increased considerably in some sub-segments of the market. These price increases did not only concern new subscribers, but regular subscribers (existing customers) as well. While Austrian operators initially welcomed the end of a "price war"[6] in the international trade press, they later explained price increases by rising costs.[7]

In our ex-post assessment, we isolate the price effects that can be attributed to the mergers. Thereby we consider not only new subscribers, but also regular subscribers. This is achieved with the help of merger simulation models that are regularly used in merger proceedings.[8]

Merger-induced price effects (regular subscribers)	
price (all segments)	14–20%
pre-paid tariffs	20–30%
post-paid tariffs	13–17%
- sim-only tariffs	10–15%
- contract tariffs	14–18%

Price increase in the period 12/2012 to 12/2014.

We find that due to the mergers, inflation-adjusted prices increased by 14–20% for the average subscriber. Price increases were largest for pre-paid tariffs (20–30%) and less pronounced for post-paid tariffs (13–17%). Within the post-paid segment, price increases were most dramatic for sim-only tariffs. However,

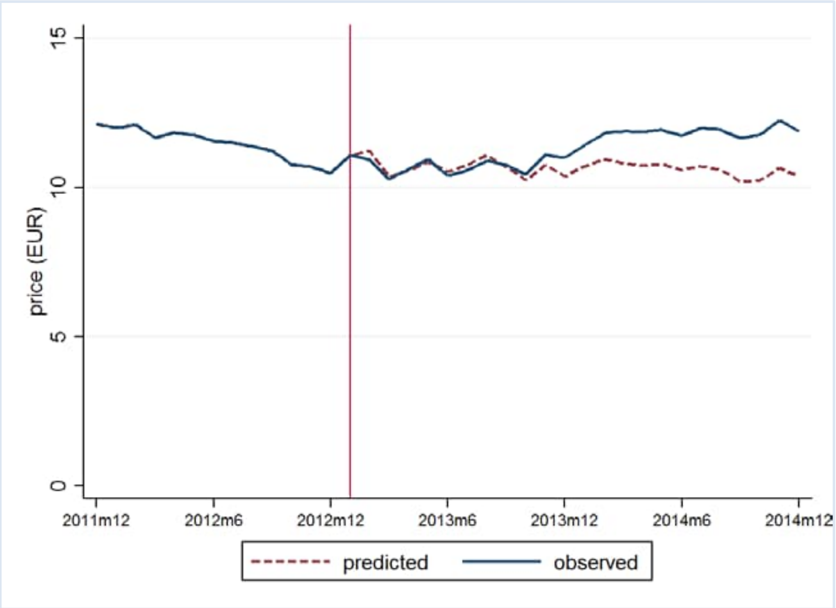
[6] Cf. http://www.reuters.com/article/us-telekomaustria-profit-idUSBRE9AJ0ZD20131120 (20 Nov 2013), retrieved 18 Feb 2016.

[7] Cf. http://futurezone.at/digital-life/preisanstieg-wegen-netzausbau-und-teurer-frequenzen/56.709.623 (19 March 2014, in German), retrieved 18 Feb 2016.

[8] Cf. Davis, P. and Garcés, E. (2009). Quantitative techniques for competition and antitrust analysis, Princeton University Press. The upward pricing pressure (UPP) analyses conducted in the H3G/Orange and TA/Yesss! mergers are sometimes described as "reduced form" mergers simulations.

this could to a considerable extend be explained with increased data usage. Nevertheless, our simulations suggest a merger-induced price increase of 10−15%. In the contract segment, were customers receive handset subsidies and usually are locked in for a period of 24 months, we find a merger-induced price increase of 14−18%.

Figure: Subscriber-weighted average prices.[9]



As illustrated in the figure, observed prices started to increase beyond the predicted level in late 2013, at the time when the end of the "price war" was announced. In 2015 (not pictured) several mobile virtual network operators (MVNOs) entered the market, and according to the price index by the telecom regulator RTR, prices started to decrease again.[10]

Thus, operators were unable to benefit from low competition levels for long. Then again, it is worth mentioning that the remedies imposed in the H3G/Orange merger failed to promote market entry for two consecutive years.

To sum up, effective competition is crucial for the promotion of low prices, attractive products and high consumer welfare also in regulated markets. Clearing problematic mergers or relying on insufficient remedies can impose an enormous burden on consumers and on the economy. Based on the information gathered during the investigation, BWB will continue to monitor the industry and will take further measures where appropriate.

[9] Model 2/I in our report.
[10] https://www.rtr.at/de/pr/PI15022016TK, (15 February 2016, in German)

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1 Introduction

This sectoral inquiry evaluates two mergers in the Austrian mobile telephony market. In 2012, Orange Austria (Orange) sold its business to Hutchinson 3G Austria (H3G) and H3G sold Orange's second brand "Yesss!" to the incumbent Telecom Austria (TA). Prior to the mergers, there were four mobile network operators (MNOs) in the market and Austrian consumers enjoyed several years of falling prices. After the mergers were cleared in the end of 2012, prices started to increase. In the course of 2015, several new mobile virtual network operators (MVNOs) entered the market and prices started to decrease again.

The H3G/Orange merger was the first in a series of four-to-three mobile telecommunication mergers handled by the European Commission and was cleared subject to remedies. The TA/Yesss! merger was handled by the Austrian Cartel Court and cleared without remedies. The mergers were heavily contested at the time when they were cleared and subsequent price increases were seen by many as evidence for their anticompetitive nature.

Yet, network operators claimed that price increases were due to increased data usage and licensing costs.[11] In October 2013, the multi-band frequency auction raised a revenue of more than 2bn Euros, which was unprecedented in Austria.[12] MNOs claimed that they had to pass on these costs to consumers. It is worth mentioning that from an economic point of view, licensing costs are sunk costs (Sutton, 1991). This implies a reversed causality: Bids were high in the frequency auction because MNOs expected limited competition and high prices.[13] The fact that prices decreased after the entry of new MVNOs in 2015 is further evidence that licensing costs are no variable costs that have to be passed on to consumers. Nevertheless, there are alternative explanations for the evolution of prices and it is necessary to account for these effects.

This study attempts to disentangle the merger-induced price effects of the H3G/Orange and TA/Yesss! mergers. Most studies published in recent years compare prices and market concentration in different (European) countries. To the contrary, we conduct an in-depth investigation of the Austrian mobile telecommunications market. We estimate demand and calibrate a "counterfactual" merger simulation model that allows us to predict how prices would have evolved if the mergers had not been cleared.

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[11] Cf. http://futurezone.at/digital-life/preisanstieg-wegen-netzausbau-und-teurer-frequenzen/56.709.623 (19 March 2014, in German), retrieved 18 Feb 2016.

[12] Cf. https://www.rtr.at/en/tk/FRQ_procedures, retrieved 16 Feb 2016. Most frequency blocks were licensed until the end of 2034. Spectrum was reserved for a potential new entrant, but no entry occurred.

[13] Cf. http://www.reuters.com/article/us-telekomaustria-profit-idUSBRE9AJ0ZD20131120 (20 Nov 2013), retrieved 18 Feb 2016.

The organization of this report is as follows: Section 2 describes the mergers and the competitive assessments that were made prior to the mergers. Furthermore, we mention recent studies that are complementary to our investigation. In Section 3, we provide a brief sketch of the industry and outline our market definition and the choice of our price variable. Our dataset and descriptive statistics are presented in Section 4. In Section 5, we outline our structural model. Section 6 contains the empirical implementation of our model. We estimate demand, compute marginal costs from first-order conditions and retrieve counterfactual prices by simulation. Our results are summarized in Section 6.4. Section 7 concludes.

2 The Austrian 4-3 merger(s)

On 7 May 2012, the fourth largest operator on the Austrian market, Hutchison 3G Austria (H3G), notified the acquisition of the third largest operator, Orange Austria Telecommunications GmbH (Orange), to the European Commission. Furthermore, it was announced that the brand "Yesss!" belonging to Orange would be immediately sold on to the market leader Telekom Austria AG (TA). The Commission recognized both transactions as separate and BWB's referral request for the H3G/Orange deal was denied. On 30 May 2012 the TA/Yesss! merger was notified in Austria and the BWB requested the Austrian Cartel Court to open proceedings on 28 June 2012.

In the merger proceedings, BWB, the federal cartel prosecutor (Bundeskartellanwalt), and the Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR) submitted that the H3G/Orange and TA/Yesss! mergers would constitute significant impediments to competition due to unilateral and coordinated effects.

On 26 November 2012, The TA/Yesss! merger was cleared by the Austrian Cartel Court without commitments.[14] On 12 December 2012, the Commission cleared the H3G/Orange merger (minus the Yesss! business) subject to remedies, including:[15]

- A commitment to enter into an upfront MVNO agreement with a new entrant before completing the acquisition of Orange, based on a reference offer[16] and subject to the approval of the Commission.
- A commitment to grant wholesale access to up to 16 MVNOs based on the same reference offer. This commitment was limited to 30 percent of H3G's network and a time period 10 years.
- A commitment to divest spectrum and additional rights to a new entrant in the course of the upcoming multi-band spectrum auction in 2013. The divestment would complement spectrum that was reserved in the auction for entrants.

[14] Decision 26 Kt 47, 48/12 – *TA/Yesss!*.
[15] Case COMP/M.6497 – *H3G/Orange*. The commitments are outlined in para. 518-531 and in Annex III.
[16] Cf. https://www.drei.at/portal/media/bottomnavi/ueber_3/wholesale/2012h3greferen ce offer.pdf, retrieved 19 February 2016.

As it turned out, the remedies failed to attract new entrants in a "timely" and "effective" way.[17] Cable TV provider UPC signed the upfront MVNO agreement but entered the market only two years later, in December 2014. The structural remedies became void because no entrant acquired the divestment spectrum and the spectrum reserved at the multi-band auction. As predicted by the Commission's merger assessment, prices started to increase.

In the course of 2015, several MVNOs entered the market with aggressive offers and prices are now decreasing again. The fastest growing entrant, Ventocom, is a MVNO on the TMA network, rather than the H3G network. Ventocom has an distribution agreement with food retail discounter Hofer and offers tariffs under the brand Hofer Telecom (HoT). A good distribution network (and low wholesale prices per unit of use) seem to be crucial for successful market entry.

2.1 Ex-ante merger assessments

In the competitive assessments of the mergers (merger assessments), examinations of market shares and Herfindahl-Hirschmann Index (HHI) values were supplemented by price predictions from Upward Pricing Pressure (UPP) analyses. The price predictions are summarized below.

UPP analysis by the Commission (H3G/Orange). The Commission defined a single market for private and business customers, pre-paid and post-paid customers, voice and data and data only services. Due to data availability, price effects were only analyzed for private customers with post-paid tariffs (voice and data). In particular, the Commission used Mobile Number Portability (MNP) data to compute diversion ratios for post-paid customers. Assuming a price-cost margin of 50%, taking average revenue per user (ARPU) as price variable and considering only "contestable" customers who are willing to switch provider, it was computed that (without remedies) the merger would increase prices by 11.59% to 13.43% for Orange customers and by 13.04% to 17.40% for H3G customers.[18]

UPP analysis by Zulehner et al (2012) (TA/Yesss!). Prof. Zulehner was commissioned by the Austrian Cartel Court as an economic expert in the TA/Yesss! merger.[19] Zulehner et al (2012) computed basket prices using tariff level price data from the Austrian Chamber of Labor and firm level data on the distribution of usage (voice/SMS/data). Prices were combined with brand level revenue-, usage- and subscriber data to generate demand data. Assuming a discrete choice model, demand was estimated and own-price and cross-price elasticities were comput-

[17] Commission notice on remedies (2008/C 267/01).
[18] Case COMP/M.6497 – *H3G/Orange,* section 6.8.
[19] She was asked by the Court to assess the effect of selling Yesss! from H3G to TA, taking the H3G/Orange merger as a given. To the contrary, the clearance of H3G/Orange was conditional on the clearance of TA/Yesss! Thus, the joint price effects of both mergers were never considered in the competitive assessments of the mergers.

ed.[20] Due to time constraints, no merger simulation was performed. Instead, diversion ratios were computed and an UPP analysis was conducted for price-cost margins of 40% to 70%. For a price-cost margin of 60%, it was predicted that prices would increase by 4.9% to 14.8% for Yesss! and by 0.5% to 3.9% for TA. Overall, the predicted price range was 3.2% to 17.2% for Yesss! and 0.3% to 5.7% for TA. Additional price predictions were made for the pre-paid segment. The predicted price increase was in the range of 3.1% to 12.69% for Yesss! pre-paid tariffs and in the range of 0.3% to 5% for TA pre-paid tariffs. As customers are not equally divided among tariffs but cluster in the most attractive tariffs, Zulehner et al (2012) proceeded to compute market-share weighted prices. This had a dramatic impact on the magnitude of the expected price effect. Weighted prices were predicted to increase only by 0.3% to 2%. For the pre-paid segment, a price increase of 0.3% to 2.6% was predicted.

2.2 Ex-post assessments

Recently, a number of studies have investigated the effects of mergers in mobile telecommunication studies. Two of these studies evaluate the price effects of the H3G/Orange (and TA/Yesss!) mergers. Note that merger-induced price effects are over and above price effects resulting from cost effects, e.g. from increased data usage.

Price-concentration study by Genakos et al. (2015). The authors investigate the effects of mergers on prices and investment in the mobile telecommunications sector. The authors consider a panel of 33 OECD countries with quarterly data over the period 2002Q3-2014Q2. Their main data source is the Teligen database, which contains basket prices (one user profile), usage information and tariff components. Teligen only contains data from the two biggest operators in each country. The authors regress prices on product characteristics and a market structure variable (the number of operators or HHI computed from revenue data). The authors predict that the H3G/Orange (and TA/Yesss!) merger increased prices by 6.6%, with a 90% confidence interval from 1.0% to 12.2%.

Diff-in-Diff analysis by RTR (2016). The Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR) investigated the impact of the H3G/Orange (and TA/Yesss!) merger on prices of tariffs offered to new subscribers. They use a difference-in-difference (diff-in-diff) methodology that has been developed together with the Commission and the Dutch Authority for Consumers and Markets (Agguzzoni et al, 2015). Their panel contains quarterly data for 2011-2014 from Austria and ten other EU countries where no merger or entry occurred in this period. Basket prices for smart-phone users and traditional (voice only) users are constructed with tariff data from the Tarifica database and country-specific usage data. Prices are computed as unweighted averages over the four cheapest tariffs (given a particular usage) of each operator. Contrary to Teligen, Tarifica contains the main brands of all MNOs and some MVNOs. For smartphone users,

[20] Cf. Section 5.

the study finds that the mergers increased prices by 50.4% to 90.2% after two years. For traditional users, the study finds merger-induced price increases of 22.3% to 31.3% after two years.

3 Industry background and some definitions

The mobile telecommunications industry consists of several markets, including wholesale markets, markets for call termination and international roaming, and end user markets for private and business customers.

Technological progress is an important driver of the mobile telecommunications industry. Transmission technology developed from first generation (1G) to 2G and 3G networks. Currently 4G networks are introduced. Each of these technologies increased transmission capacities and brought new business opportunities. Investment in network capacities is cyclical. After high network coverage rates have been achieved once, new investments usually involve the roll-out of the latest technological hardware.

Like many network industries, the mobile telecommunications industry is heavily regulated.[21] Among other things, the Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR) regulates prices in upstream markets for call termination and international roaming. Market entry is regulated by the allocation of mobile spectrum via auctions.[22]

3.1 Market definition

In our ex-post evaluation, we consider the market for mobile telephony services to private customers ("relevant market", "market for mobile telephony"). These services comprise bundles containing voice, short messages and possibly mobile data services. Data-only services are excluded. Pre-paid and post-paid tariffs are considered to be different sub-segments belonging to the same market. The geographic market definition is national (Austria).

As outlined by Davis and Garces (2009, chap. 5), merger simulation techniques allow to skip market definition, because price reaction effects are considered directly in the model. In particular, the market definition can never be too wide, because products with a cross-price elasticity of zero will not affect each other's prices. However, it is still necessary to ensure that markets are not defined too narrow.

In the H3G/Orange merger, the Commission defined a market for mobile telecommunication services to end customers, containing private and business customers, voice and data and data-only tariffs and pre-paid and post-paid tariffs. Since we did not obtain data for business customers and data-only tariffs, we can-

[21] Cf. Gruber (2002, 2005).
[22] Compare §43 Telecommunications Act, available at https://www.rtr.at/en/tk/TKG2003.

not include them in our merger simulation and have to investigate whether they are part of the same market.[23]

In the merger assessment, the Commission found that business contracts cannot be chosen by private customers and that data only services are no [functional] substitutes for voice and data tariffs. Therefore, demand side substitutability suggests that these services belong to different markets. However, the Commission argued that MNOs catering to one type of customer would have the technological possibility to cater also to other customer segments. Therefore, the Commission concluded that supply side substitutability would imply the existence of a single market for end customers, consisting of private customers and business customers and voice and data tariffs as well as data-only tariffs.[24]

Using the merger simulation framework outlined in subsequent sections, we have computed the price effect from monopolizing the relevant market in 2012. According to our simulation, monopolization would have led to an increase of average subscriber-weighted prices from 11.39 to 48.72 Euros. Thus, a SSNIP test would certainly be satisfied and demand side substitutability suggests that business tariffs and data only tariffs do not belong to the same market.[25]

The Commission Notice on Market Definition suggests that supply-side substitutability should only be taken into account in the market definition stage "[if] its effects are equivalent to those of demand substitution in terms of effectiveness and immediacy. This means that suppliers are able to switch production to the relevant products and market them in the short term (4) without incurring significant additional costs or risks in response to small and permanent changes in relative prices."[26] Qualitative information and marketing data provided by the MNOs suggests that operators who launch or reposition a new brand incur significant sunk costs in the form of market research, product positioning and advertising. Arguably, this entails "significant additional costs and risks" for providers who are not yet offering voice and data tariffs to private customers. Therefore, we conclude that supply-side substitutability is unlikely.

Summing up, we conclude that our market definition is wide enough for the Austrian market in our observation period from 2011 to 2014. However, the emer-

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[23] At the beginning of our ex-post evaluation, MNOs informed us that no aggregate data are available for business customers. The Commission faced similar data restrictions as we did. Therefore, price effects were only computed for private customers with post-paid tariffs (voice and data).

[24] Case COMP/M.6497 – H3G/Orange, Sections 5, para. 34-35 and 52.

[25] We used demand model 2, introduced in Section 6.

[26] Commission Notice on the definition of relevant market for the purposes of Community competition law (97/C 372 /03), para. 20. The example given in para. 23 is instructive: "Examples where supply-side substitution did not induce the Commission to enlarge the market are offered in the area of consumer products, in particular for branded beverages. Although bottling plants may in principle bottle different beverages, there are costs and lead times involved (in terms of advertising, product testing and distribution) before the products can actually be sold."

gence of new services (such as bundles containing mobile telephony, fixed line internet and cable television) might lead to very different market definitions in current or future mergers involving mobile telecommunication services.

3.2 Product definition, quantity and price variables

A mobile phone tariff is a bundle of services, typically including voice telephony, short messages and mobile data. It is useful to consider these different services as characteristics of a single service "mobile telephony". Further characteristics include network coverage, customer service and handset subsidies.

Payment can be in advance (pre-paid) or on a monthly basis (post-paid). Post-paid tariffs typically contain contingents of included voice-, short message- and data usage.

Contracts might be terminated at any time (sim-only) or might entail a lock-in period. The typical lock-in period is 24 months. Operators argue that lock-in is needed to recoup handset subsidies.

Quantity variable. Our quantity variable is the number of subscribers per tariff per month ("regular subscribers"). This number includes all customers that are newly enrolled in a particular month at a particular service provider ("new subscribers") as well as subscribers who enrolled in an earlier period and customers who switched between contracts offered by the same operator.

Note that the merger assessments use the number of contestable or new subscribers as quantity variables. According to our data, this excludes about 98% of all customers from their analysis. Furthermore, while advertising is primarily targeted to new subscribers, many subscribers switch between tariffs of the same operator. Finally, operators do not only adjust the prices at tariff launch but also for existing tariffs and for regular customers.

Price variable. Mobile telecommunication services are offered as a bundle and pricing is typically non-linear, with usage contingents, monthly fees, one-off fees and possibly minimum revenues. In studies of mobile telecommunication services it is customary to aggregate this vector of prices to a single price variable. A top-down approach is to use average revenue per user (ARPU) as price variable. However, as highlighted by Genakos et al (2015), providers generate revenue from different sources, including roaming and termination charges. Dividing revenue by the number of users might therefore yield prices that are quite different from the average monthly bills paid by users. An alternative (bottom-up) approach is to compute the bill paid by customers with certain user profiles. The expert report by Zulehner et al (2012) and the ex-post studies by Genakos et al (2015) and RTR (2016) use basket prices.

We use a basket price that has been constructed in cooperation with RTR. Similar price baskets are used in the RTR "new customer price index" published in the RTR communications report (RTR, 2015). Since we have usage data on the tariff level, prices are not computed for representative customers, but for the average usage profile per tariff.

The price variable contains monthly fees and fees from the use of voice telephony and short messages beyond included usage. For older tariffs, data usage fees might amount to several 100 Euros per MB. Hence minimal data usage might amount to monthly bills of more than 1000 Euros. Frequently, such bills are settled or contested in court. Therefore, the RTR suggested to exclude fees for data usage outside of data contingent. As a robustness check, we excluded data usage only for very old contracts and/or for contracts where data usage is very expensive. The summary statistics of the price baskets are virtually the same. Therefore, we have decided to stick with the procedure suggested by the RTR.

Handset subsidies, annual fees and set-up fees are divided over a 24 month period and added to the monthly basked price. Roaming charges and extra charges are excluded. This is common practice in the computation of basket prices for mobile telecommunications. Prices are gross prices including value added tax.

4 Dataset and descriptive statistics

4.1 Dataset

Our data comes from information requests to the Austrian MNOs TA, H3G and TMA. This data covers all brands operated by the MNOs, and all MVNOs and resellers that are owned and/or controlled by the MNOs. During our observation period, there was only one operator on the Austrian market that was independent from the MNOs. This operator, Vectone, is a MVNO on the TA network. According to an information request from 2012, Vectone had a market share of less than 1% in 2011 and specialized on international telecommunication. Therefore, we excluded this operator from our investigation.

For every mobile phone tariff for private customers, we requested monthly data on the number of regular subscribers, the number of new subscribers, monthly fees, annual fees, usage fees, extra charges, handset subsidies, average usage of voice, short messages (SMS) and data and various other attributes, such as download speed reduction thresholds.

We received monthly data for the years 2011 to 2014. Since the mergers were cleared in November and December 2012, our observation period includes two years before and two years after the merger. MNOs submitted information on behalf of the mobile virtual network operators (MVNOs) on their networks. Thus, our main dataset contains all available tariffs offered to Austrian private customers during our observation period.

In addition to tariff data, we requested data on monthly expenditure on sales and customer service expenditure, customer acquisition and retention costs, expenditure for advertising and marketing and the number of subsidized handsets. Some

MNOs reported difficulties to allocate these expenditures correctly to individual tariffs. Furthermore, we had the impression that MNOs had slightly different cost definitions.[27] Therefore we used this information only to compute industry trends that could be used as cost shifters in the demand estimation.[28]

Data cleaning is discussed in Appendix A.1. Price and cost data were deflated using the Harmonized Consumer Price Index (HCPI) published by Eurostat. All monetary values are gross values including value added tax. To reduce seasonal effects, we computed moving averages of all variables.

4.2 Descriptive statistics

In this section we briefly describe our dataset. Quarterly averages of key variables are presented in Table 1 (pre-merger period) and Table 2 (post-merger period). As illustrated in Figure 1, the number of subscribers peaked at the time of the merger. However, this is not only due to reduced demand. Some MNOs reported that many inactive customers were dropped from their databases after the merger. In Appendix A.1, we outline how we deal with inactive customers (who no longer user their SIM-card) and other distortions. The evolution of new subscribers suggests a seasonal pattern, with demand peaking around Christmas. MNOs report that this is due to special offers made in the pre-Christmas season.

Tables 1 and 2 suggest that the number of users per tariff decreased steadily over time. This indicates an increasing number of tariffs and hence, more product differentiation. Indeed, the average number of tariffs doubled over our observation period. The number of launched tariffs peaked after the merger and decreased in 2014.

Note that the rest of the variables is reported for the cleaned, deseasonalized and HCPI deflated dataset used in our empirical analysis, in particular to mitigate bias from inactive subscribers.

Average use remains steady for voice telephony, and declines for SMS, probably due to new online messaging services. To the contrary, there is a striking increase in data usage. In the last quarter of 2014, the average number of MB was more than 13 times as large as at the beginning of our observation period.

[27] For example, one MNO might treat some expenditures as sales costs, while other MNOs might treat them as customer acquisition costs.

[28] We also requested yearly data on revenues, costs, voice/SMS/data traffic and investment activity at the MNO level. However, it turned out to be impossible to isolate the costs pertaining to the relevant market and we could not use this data for our investigation.

Figure 1: Number of subscribers.

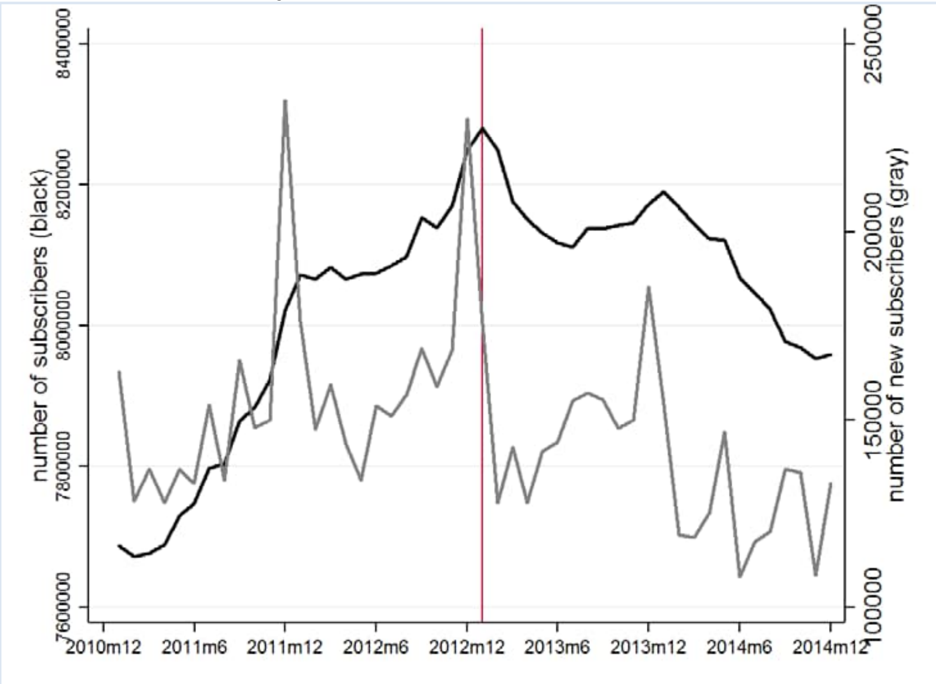

Figure 2: Subscriber-weighted average prices by segments.

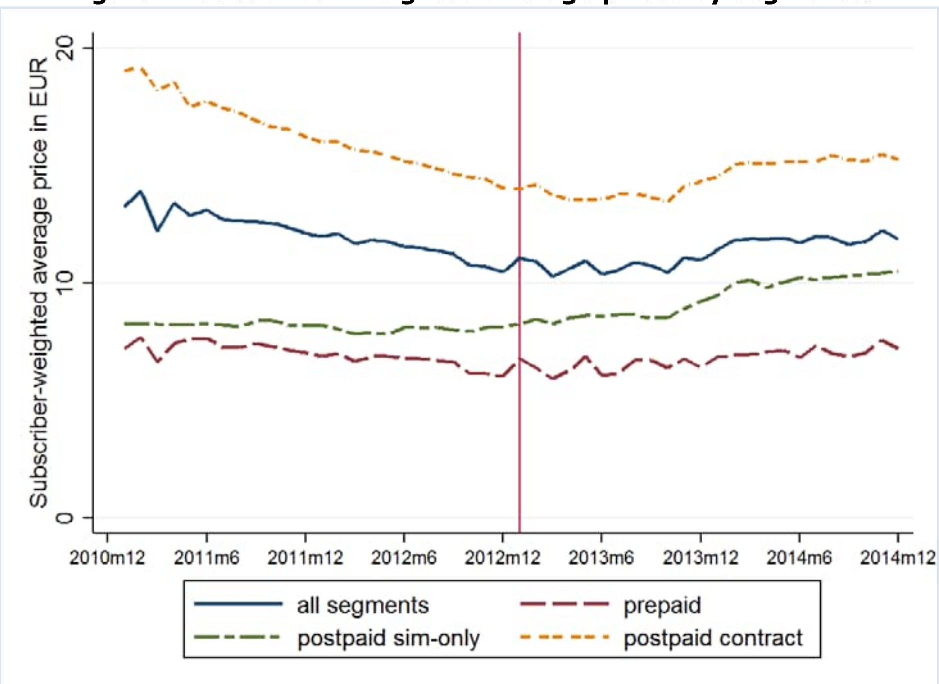

Table 1: Descriptive Statistics I: pre-merger period.

year	2011				2012				mean
quarter	q1	q2	q3	q4	q1	q2	q3	q4	
average no. of subscribers									
regular (mn)	7.68	7.72	7.82	7.95	8.07	8.07	8.11	8.19	7.95
new (k)	142.14	132.67	151.67	178.44	160.76	143.86	158.99	186.97	156.94
per tariff (k)	18.28	16.51	15.40	14.63	13.65	13.02	12.44	12.14	14.21
average no. of tariffs									
existing	420	468	508	543	591	620	652	675	559.63
launched	17	19	17	15	21	10	15	15	16.13
average use									
voice (min)	161.60	166.50	168.50	176.50	180.90	182.10	181.70	183.90	175.21
sms (no.)	49.06	53.08	54.77	64.80	63.93	64.51	58.98	62.36	58.94
data (MB)	14.32	18.96	25.04	34.15	44.30	55.71	62.41	75.01	41.24
average costs per subscriber (EUR)									
advertising	1.12	1.06	0.98	1.01	0.94	0.83	0.75	0.86	0.94
sales	5.77	5.62	5.38	5.80	5.27	4.70	4.86	5.80	5.40
average price per subscriber in different segments (EUR)									
pre-paid	7.17	7.58	7.33	7.16	6.86	6.86	6.72	6.11	6.97
post-paid	17.79	17.00	16.39	15.59	14.96	14.48	13.91	13.34	15.43
- sim-only	8.27	8.25	8.27	8.27	8.03	7.96	8.07	8.07	8.15
- contract	18.79	17.92	17.21	16.48	15.89	15.40	14.87	14.32	16.36
all segments	13.10	13.13	12.65	12.34	11.92	11.72	11.37	10.64	12.11
subscriber-based market shares of different segments									
pre-paid	44%	41%	41%	39%	38%	36%	35%	37%	39%
post-paid	56%	59%	59%	62%	62%	64%	65%	63%	61%
- sim-only	5%	6%	6%	7%	7%	8%	9%	10%	7%
- contract	51%	53%	53%	55%	55%	56%	56%	53%	54%

The evolution of subscriber-weighted prices is illustrated in Figure 2. Overall, prices decreased pre-merger, flattened in the first months after the merger and started to increase at the end of 2013. The overall effect is mirrored in the pre-paid segment, although at a lower level and with higher volatility. The post-paid segment is further sub-divided in lock-in contracts ("contracts") in and post-paid sim-only ("sim-only") tariffs. Prices for sim-only tariffs increased during the entire observation period. This seems to be mainly driven by increased data usage. To the contrary, the price of lock-in contracts evolves in the same way as the overall market.

It is interesting to note that the sim-only segment gained market shares compared to the pre-paid and contract segment. This might be explained by the emergence of a new generation of affordable smartphones that decreased the demand for subsidized smartphones.

Table 2: Descriptive Statistics II: post-merger period.

year	2013				2014				mean
quarter	q1	q2	q3	q4	q1	q2	q3	q4	
average no. of subscribers									
regular (mn)	8.24	8.13	8.13	8.15	8.17	8.10	8.02	7.96	8.11
new (k)	148.57	138.03	155.84	161.31	130.51	126.58	124.96	125.75	138.94
per tariff (k)	11.46	10.25	9.90	9.60	9.44	9.07	8.78	8.63	9.58
average no. of tariffs									
existing	719	793	821	850	865	893	912	922	846.94
launched	18	50	25	24	7	15	5	8	18.97
average use									
voice (min)	183.40	188.60	184.60	184.70	182.20	182.40	184.70	188.90	184.94
sms (no.)	53.55	50.45	43.99	44.32	38.63	37.48	35.00	36.07	42.44
data (MB)	90.19	108.50	121.90	131.90	143.60	156.90	179.30	198.50	141.35
average costs per subscriber (EUR)									
advertising	0.91	0.94	0.88	0.85	0.74	0.70	0.77	0.98	0.85
sales	5.81	5.55	5.59	6.12	5.56	4.77	4.61	4.97	5.37
average price per subscriber (EUR)									
pre-paid	6.35	6.42	6.55	6.55	6.92	7.02	7.07	7.30	6.77
post-paid	12.96	12.66	12.75	12.92	13.80	13.98	14.11	14.18	13.42
- sim-only	8.33	8.58	8.61	8.91	9.88	10.03	10.23	10.43	9.37
- contract	13.99	13.56	13.76	13.98	14.90	15.13	15.29	15.32	14.49
all segments	10.76	10.65	10.74	10.85	11.71	11.84	11.86	11.97	11.30
subscriber-based market shares of different segments									
pre-paid	33%	32%	32%	33%	30%	31%	32%	32%	32%
post-paid	67%	68%	68%	68%	70%	69%	68%	68%	68%
- sim-only	12%	12%	13%	14%	15%	16%	16%	16%	14%
- contract	55%	56%	55%	54%	54%	54%	52%	52%	54%

5 Analytical Framework

5.1 Demand model

As discussed, mobile phone tariffs can be interpreted as single service or product consisting of a vector of characteristics. Discrete choice models have been developed to model demand for this kind of products (Anderson et al 1992, Train 2009). The multinomial logit model, the nested logit model and the random coefficients logit model are important members of the class of discrete choice models. From these three models, the multinomial logit model is the simplest. However, it imposes strong assumptions on the form of cross-price elasticities. Random coefficients logit is the most general model. However, it imposes huge data requirements and does not permit analytical solutions of demand systems.

We consider the nested-logit model. This model permits greater flexibility in substitution patterns, but retains analytical tractability. In the nested-logit model, it is assumed that customers follow an hierarchical decision making process. In particular, in the one-level nested logit model, consumers first decide between groups of products and then between products within groups.[29]

Utility. There are $1,\dots,L$ consumers, who choose a product j from the set $B = \{0,1,\dots,J\}$. Product 0 is an outside good. Thus, L can be interpreted as potential market size. Products are partitioned in $g \in \{0,1,\dots,G\}$ groups with group 0 containing only the outside good. The set of products is partitioned in groups $g \in \{0,1,\dots,G\}$, where group g consists of goods $j \in B_g$ and group 0 consists only of the outside good. Following Berry (1994), Train (2009) and Björnerstedt and Verboven (2015), consumer i's utility from product j and period t,[30]

$$u_{ij} = \delta_j + \epsilon_{ij} \,,$$

is partitioned into a mean utility term $\delta_j = \boldsymbol{x_j\beta} - \alpha p_j + \zeta_j$ and an individual random utility term ϵ_{ij}. Mean utility δ_j depends on a vector of observable product characteristics $\boldsymbol{x_j}$, unobservable product characteristics ζ_j and price p_j. The coefficients α and $\boldsymbol{\beta}$ represent marginal utility. The mean utility of the outside good is normalized to zero ($\delta_0 = 0$).

Choice probabilities. Consumers first decide between groups and then choose a product within a group. As utility maximizers, consumers choose the alternative that gives them the highest utility. However, their preferences are heterogeneous due to the random utility term ϵ_{ij}. If ϵ_{ij} follows a general extreme value distribution and if there is independence from irrelevant alternatives (IIA) within nests and "independence from irrelevant nests (IIN)" (Train, 2009), aggregate choice probabilities are given by logit functions. In particular,

$$s_g = \frac{e^{(1-\sigma)I_g}}{\sum_{\ell=0}^{G} e^{(1-\sigma)I_\ell}} \,,$$

is the marginal probability of choosing group g and

$$s_{jg} = \frac{e^{\delta_j/(1-\sigma)}}{\sum_{k\in B_g} e^{\delta_k/(1-\sigma)}}$$

is the conditional probability of choosing product $j \in B_g$ given that g has been chosen. The inclusive value

$$I_g = \ln \sum_{j\in B_g} e^{\delta_j/(1-\sigma)}$$

[29] In this section, we briefly outline the two-level nested-logit model, i.e. the model with only one nest. Compare Train (2009) and Björnerstedt and Verboven (2015) for the derivation of nested-logit models with more than two levels.
[30] In the following, we drop time subscript $t \in \{1,\dots,T\}$ whenever it is irrelevant to the (static) demand model.

is the log of the denominator of s_{jg}. As argued by Train (2009), $(1-\sigma)I_g$ represents the expected utility of choosing group g. Note that s_{jg} depends only on the mean utility level δ_j and not on the random utility term ϵ_{ij}. Mean utility is divided by the factor $1-\sigma$, with $0 \leq \sigma < 1$. This factor parametrizes the cumulative distribution of the random utility term ϵ_{ij}. Note that the nested-logit model reduces to the multinomial logit model if $\sigma = 0$. The aggregate probability of choosing product $j \in B$,

$$s_j = s_{jg} * s_g,$$

is then simply the probability of choosing group g times the probability of choosing j within group B.

Aggregate demand and demand estimation. Aggregate demand for product j is given by choice probabilities times the number of consumers L,

$$q_j = s_j * L.$$

As illustrated by Berry (1994), choice probabilities can be inverted to

$$\delta_j = \ln(s_j) - \sigma \ln(s_{jg}) - \ln(s_0),$$

which can be transformed to $\ln(s_j) - \ln(s_0) = \delta_j + \sigma \ln(s_{jg})$, or

$$\ln(s_j/s_0) = \boldsymbol{x_j \beta} - \alpha p_j + \sigma \ln(s_{jg}) + \zeta_j.$$

The coefficients $\alpha, \boldsymbol{\beta}$ and σ can be estimated by linear regression, using market shares as choice probabilities and unobservable characteristics as error term. Note that $s_j = q_j/L$ is the market share of product j in the entire market (including the outside good) and that $s_{jg} = s_j/\sum_{k \in Bg} s_k$ is the market share of product j in group g.

Price elasticities. Using the notation introduced by Björnerstedt and Verboven (2015), the price elasticity of demand in the single-nest model is given by

$$\eta_{jk} = \frac{\partial q_j}{\partial p_k}\frac{p_k}{q_j} = \alpha\left(\frac{1}{1-\sigma}D_{jk}^1 - \frac{\sigma}{1-\sigma}s_g D_{jk}^2 - s_j\right)p_j,$$

with dummy variable D_{jk}^1 equal to one if if $j = k$ and equal to zero if $j \neq k$. Dummy variable D_{jk}^2 is equal to one if both products belong to the same nest ($j, k \in B_g$) and zero if they belong to different nests.

In the following, we denote the own-price elasticity by η_{jj}, the cross-price elasticity within nests by η_{jk} with $j, k \in B_g$. The cross-price elasticity of products that belong to different nests is denoted by $\eta_{j\ell}$, with $j \in B_g$ and $\ell \notin B_g$.

Consumer surplus. Consumer i chooses the alternative that maximizes mean utility δ_j plus random utility ϵ_{ij}. The *expected* utility of group g depends on δ_j and on the probability of choosing product j, which is implied by δ_j and the distribution of ϵ_{ij}. As mentioned, this implies that expected utility of group g is given by $(1-\sigma)I_g$, where inclusive value I_g is the log of the denominator of s_{jg}. Likewise, the expected utility from the entire choice set depends on the expected utility of group g and the probability of choosing group g. Following Train (2009, sec. 3.5 and sec. 4.2) and Ivaldi and Verboven (2005), this implies that consumer i's expected utility from the entire choice set is given by the log of the denominator of s_g:

$$I = \ln\left(\sum_{g=0}^{G} e^{(1-\sigma)I_g}\right) = \ln\left(\sum_{g=0}^{G} e^{(1-\sigma)\ln \sum_{j\in B_g} e^{\delta_j/(1-\sigma)}}\right) = \ln\left(\sum_{g=0}^{G}\left(\sum_{j\in B_g} e^{\delta_j/(1-\sigma)}\right)^{1-\sigma}\right).$$

Consumer surplus is expected utility expressed in monetary terms. Therefore, inclusive values have to be divided by the marginal utility of money. As utility decreases in price, and prices are expressed in monetary terms, it follows that the marginal utility of money is given by the negative coefficient of price (i.e. α). Train (2009) highlights that the absolute level of expected utility is not known. It follows that, individual consumer surplus is given by

$$CS = \frac{1}{\alpha}I + C = \frac{1}{\alpha}\ln\left(\sum_{g=0}^{G}\left(\sum_{j\in B_g} e^{\delta_j/(1-\sigma)}\right)^{1-\sigma}\right) + C,$$

where C is an unknown constant.[31] Changes in individual consumer surplus are given by

$$\Delta CS = \left(\frac{1}{\alpha}I^{new} + C\right) - \left(\frac{1}{\alpha}I^{old} + C\right) = \frac{1}{\alpha}\left(I^{new} - I^{old}\right).$$

Thus, we can analyze the impact of policy decisions (and mobile phone mergers) on consumer surplus without knowing C.

5.2 Oligopoly model

There are $1,\ldots,M$ firms and each firm m has a portfolio of products $B_m \subset B$. Firms set prices and play a static Bertrand game. Firm m's multi-product profit function is given by

$$\pi_m = \sum_{j\in B_m} q_k(\boldsymbol{p})(p_j - c_j) - F_m - H_m,$$

where $q_j(\boldsymbol{p})$ is the demand for product j as a function of price vector $\boldsymbol{p} = (p_1,\ldots,p_J)$, p_k is the price and c_j is the unit cost of product j. Furthermore, firm m may have

[31] Ivaldi and Verboven (2005) and Grzybowski and Pereira (2007) drop C and define "net" consumer surplus $CS^{net} = I/\alpha$. Recall that group 0 consists only of the outside good and note that $\left(e^{\delta_0/(1-\sigma)}\right)^{1-\sigma} = \left(e^{0/(1-\sigma)}\right)^{1-\sigma} = 1$.

reversible fixed costs F_m and non-reversible sunk costs H_m. The profit-maximizing price for products $j \in B_m$ satisfies the first-order condition (FOC)

$$q_j(\boldsymbol{p}) + \sum\nolimits_{k \in B_m} (p_k - c_k) \frac{\partial q_k(\boldsymbol{p})}{\partial p_j} \equiv 0,$$

whenever $\pi_m(\boldsymbol{p}) \geq F_m$. If all FOCs are satisfied for all firms, a static multi-product Bertrand-Nash equilibrium is obtained. As suggested by Björnerstedt and Verboven (2013), the FOCs of all firms can be jointly expressed in matrix notation as

$$\boldsymbol{q}(\boldsymbol{p}) + (\boldsymbol{\theta} \odot \Delta)(\boldsymbol{p} - \boldsymbol{c}) \equiv 0,$$

where demand, price and costs are respectively given by the vectors $\boldsymbol{q}(\boldsymbol{p}) = (q_1(\boldsymbol{p}), \dots, q_J(\boldsymbol{p}))'$, $\boldsymbol{p} = (p_1, \dots, p_J)'$ and $\boldsymbol{c} = (c_1, \dots, c)'$. The ownership matrix $\boldsymbol{\theta}$ has typical element $\theta_{jk} = 1$ if products j and k belong to the same firm and $\theta_{jk} = \phi$ if they belong to different firms. Björnerstedt and Verboven (2013) suggest to parameterize the ownership matrix as $\boldsymbol{\theta} = \boldsymbol{\theta}(\phi)$, where $\phi \in [0,1]$ is a conduct parameter that allows for partial collusion. Note that $\phi = 0$ implies non-cooperative competition, while $\phi = 1$ implies joint-profit maximization and hence monopoly profits. First derivatives are given by the Jacobian matrix $\boldsymbol{\Delta}$ with element $\Delta_{jk} = \partial q_j / \partial p_k$. The operator $\odot$ denotes element-wise multiplication. By inverting first order conditions, we can obtain price

$$\boldsymbol{p} = \boldsymbol{c} - (\boldsymbol{\theta} \odot \boldsymbol{\Delta})^{-1} \boldsymbol{q}(\boldsymbol{p})$$

as a function of marginal costs $\boldsymbol{c}$ and a mark-up $(\boldsymbol{\theta} \odot \boldsymbol{\Delta})^{-1} \boldsymbol{q}(\boldsymbol{p}) > 0$.

Pre-merger marginal costs. As noted by Davis and Garcés (2009), it can be difficult to infer economic costs from accounting data. However, by rearranging the previous equation, and setting conduct parameter $\phi \in [0,1]$, we can obtain marginal costs

$$\boldsymbol{c} = \boldsymbol{p} + (\boldsymbol{\theta}(\phi) \odot \boldsymbol{\Delta})^{-1} \boldsymbol{q}(\boldsymbol{p})$$

from known market prices, quantities and price elasticities.[32]

Merger simulation. First-order conditions can also be used to simulate the effects of mergers or divestitures. A change of firm ownership amounts to a change of the owner-ship matrix from $\boldsymbol{\theta}^{pre}$ to $\boldsymbol{\theta}^{post}$. Changes in marginal costs (e.g. due to efficiency gains in the form of reduced variable costs due to a merger) can be accommodated by changing from $\boldsymbol{c}^{pre}$ to $\boldsymbol{c}^{post}$. Post-merger prices $\boldsymbol{p}^{post}$ and quantities $\boldsymbol{q}(\boldsymbol{p}^{post})$ can be derived iteratively from

$$\boldsymbol{p}^{post} = \boldsymbol{c}^{post} - (\boldsymbol{\theta}^{post} \odot \boldsymbol{\Delta})^{-1} \boldsymbol{q}(\boldsymbol{p}^{post}).$$

[32] Note that $\partial q_j / \partial p_k = \eta_{jk} * q_j / p_k$.

Björnerstedt and Verboven (2013) suggest the use of fixed-point iteration, as implemented in their Stata package `mergersim`. This package will be discussed in more detail below.

In ex-post evaluation, post-merger prices are known. As illustrated by Björnerstedt and Verboven (2015), this knowledge can be used to calibrate the (ex-ante) merger simulation until it fits post-merger prices. Alternatively, it might be used to simulate what would have happened if the merger had been prohibited. We call this approach a "*counterfactual*" merger simulation.

5.3 Dealing with dynamics

Like in most real-world markets, firms and consumers on telecom markets sometimes face decisions that involve trade-offs over time. For example, MNOs decide whether to invest in network capacities and bid in spectrum auctions for long-term leases. Consumers sign up to mobile phone tariffs and are locked-in contractually or due to high switching costs. Yet, merger simulations typically impose a static perspective, and merger simulations in assessments of telecom mergers are no exception.

In recent years, attempts have been made to estimate dynamic games that allow to endogenize investment, market entry and other dynamic decisions. Yet, these attempts appear not to be without problems.[33] Davis and Garcés (2009) suggest that static merger simulations will remain the state of the art for the time being.

A possible remedy to this problem is to introduce dynamics exogenously. Essentially, this is the approach taken by Björnerstedt and Verboven (2013, 2015) when introducing the partial-collusion parameter $\phi \in [0,1]$. Absent enforceable cartel agreements, collusion has to be self-enforcing. Clearly, the punishment of deviating behavior involves a trade-off between different time periods. Yet, the introduction of $\phi = 1$ induces firms to maximize joint profits *as if* they were playing a dynamic game were collusion is self-enforcing in equilibrium.

Thus, the static Bertrand oligopoly framework outlined in the previous section can be understood as being part of a multi-stage game, were firms decide subsequently about market entry, network capacities, product launch and advertisement and finally compete in prices.[34]

Note that not every dynamic decision has an impact on firms' pricing behavior. For example, if firms are not capacity constrained, investment does not have an im-

[33] Cf. the guide by Doraszelski and Pakes (2007), the survey by Aguirregabiria and Mira (2010) and the examples by Pesendorfer and Schmidt-Dengler, (2010).
[34] We think that this is also a useful way to interpret the "bespoke" merger simulation models advocated by Walker (2005).

pact on prices.[35] However, we have identified a number of factors that might affect prices dynamically because they affect consumers' valuations and/or firms' variable costs. Our strategy for dealing with them is outlined below.

Switching costs. In Austria, many subscribers receive handset subsidies. In exchange, they have to sign up to lock-in contracts. For a typical lock-in period of 24 months, these contracts make it very expensive to switch providers, because a monthly fee has to be paid for the entire lock-in period regardless of use. However, there are other switching costs as well. If consumers search for a new mobile plan, they have to incur search costs. When switching mobile plans, consumers incur an effort cost by having to terminate the contract with their old provider and to inform people about their new mobile phone number. Alternatively, they might port their number to the new provider. However, this involves further effort and a porting fee. Furthermore, consumers might have to pay a set-up fee by their new provider. Relative to basket prices, these fees and effort costs are higher for pre-paid customers than post-paid customers. Thus, both pre-paid and post-paid subscribers face considerable switching costs. We have found very different approaches to deal with switching costs in mobile telephony markets.

Grzybowski and Pereira (2007) evaluate a merger in the Portuguese mobile telecom market. They suggest that there are three types of consumers in the market: (i) new subscribers who just switched to a new provider, (ii) regular subscribers who are not locked-in to a contract and (iii) regular subscribers who are locked in. They suggest to exclude locked-in subscribers from the market. However, as they do not know the number of locked-in subscribers, they adopt the assumption that all consumers with contracts and 50% of prepaid users are locked in.

Grzybowski and Pereira (2011) study switching costs with individual choice data. They argue that switching costs create a causal relationship between past choices and future choices. This could be called an demand side approach towards switching costs. To account for this state dependency, they include a dummy into consumer's utility function that is equal to one if consumer j chose product i in the previous period. However, the authors highlight that there might also be "spurious" state dependency, that comes from tariff fixed effects.

Zulehner et al (2009) have tariff level data in their competitive assessment of the TA/Yesss! merger. They account for state dependency by including the lagged dependent variable $M_{j,t-1} = \ln(s_{j,t-1}/s_{0,t-1})$ as explanatory variable into the estimation equation. This could be interpreted as a supply side approach towards switching costs: Service providers can increase search costs by increasing the number of tariffs and the number of characteristics. They can make it harder for regular customers to leave them, e.g. by offering lock-in contracts, by making it dreadful to

[35] Cf. Belleflamme and Peitz (2015) and Sutton (1991). As there is no rationing of customers in the Austrian market for mobile telephony, it is safe to assume that Austrian MNOs and MVNOs are not capacity constrained.

terminate a contract or by offering loyalty rebates. Furthermore, they can make it easier for new customers to switch, e.g. by offering attractive handset subsidies and handling the cancellation of their contract with their previous provider. Thus, the lagged dependent variable can be regarded as supply shifter that helps to trace out the demand function (Davis and Garcés, 2010). This is the approach adopted in our demand estimation.

One-shot payments and seasonal rebates. Switching costs can induce firms to capture customers with good offers first and to try to increase prices later. In mobile telephony, many subsidies and fees are incurred at the signing of a contract and at the termination of a contract. As noted, the RTR basket price spreads fees and subsidies equally over the 24 months of a typical contract life span. Thus, a dynamic optimization problem is transformed into a static optimization problem.

In the Austrian market it is customary that the best offers to new customers are made in the pre-Christmas season. In particular, subsidies are higher and set-up fees might be reduced during that time. Thus, there is a demand spike around Christmas, but our price variable does not account for its causes. To mitigate seasonal effects, we compute moving averages of our data and include period dummies and time trends into our estimations.

Tariff launch and tariff attributes. In our oligopoly model, firms compete in prices and take the number of products and their attributes as given. Our data reveals that the number of launched tariffs follows a seasonal pattern and that more tariffs were launched after the mergers.

Arguably, voice and data usage are the most important observable characteristics of mobile telephony. The average duration of voice telephony increased slightly over the entire observation period. The average number of included minutes flattened after the merger. Average data use and the average number of included MB seem to have increased at a steady rate.

Therefore we argue that it is without loss of generality to use observed tariff launches and tariff attributes for our counterfactual merger simulation.

Cost trends. Marginal costs can be computed for a given conduct parameter from observed prices, quantities and price elasticities. However, the extend of collusive conduct might be affected by a merger. Moreover, service providers report to have a common marketing and sales strategy for cohorts of tariffs and/or on the brand level. This brand level strategy determines customer acquisition and retention, the level of customer service and other factors. It is likely that these choices determine firms' marginal costs endogenously.

When we compute marginal costs from the FOC, we observe a falling cost trend before the merger. However, this cost trend seems to have reversed in the end of 2013. To the contrary, cost data from network operators does not suggest that the decreasing cost trend was reversed. Unfortunately, this cost data is too aggregated to be of use for our merger simulation. Therefore we regress marginal costs on usage variables, trend variables and fixed effects to predict post-merger marginal costs.

6 Empirical implementation and results

In the implementation of our analytical framework, we use the `mergersim` package introduced by Björnerstedt and Verboven (2013). This Stata package allows to conduct merger simulations for static Bertrand oligopoly models with nested-logit demand. In a first step, `mergersim` prepares variables for demand estimation by computing logged market shares from quantities, nest structure and assumed potential market size. Demand estimation can be done with suitable panel regression methods. The package retrieves price coefficient α and weight coefficient σ from regression output and uses these coefficients to compute own-price and cross-price elasticities for every product in every period and every market that is studied. Elasticities, prices and quantities are used to compute marginal costs. This can be done for different, exogenously specified collusion parameters ϕ. The actual merger simulation computes price and quantity effects subject to changes in owner-ship matrix $\boldsymbol{\theta}$, post-merger marginal costs $\boldsymbol{c}_t$ and pre-merger and post-merger collusion parameters ϕ^{pre} and ϕ^{post}. Furthermore, changes in market shares and consumer surplus are computed.

6.1 Demand estimation

Estimating demand creates an identification problem because equilibrium is jointly determined by demand and supply. Another identification problem specific to discrete choice models arises from the fact that the error term $\zeta_{j,t}$ contains unobservable product characteristics that one would expect to be correlated with price. To the contrary, one could expect that observable product characteristics are uncorrelated with the error term. Thus they are commonly used as instruments. Berry et al. (1995) suggest to use counts and sums of the characteristics of other products of the same firm and of other firms as additional instruments. Björnerstedt and Verboven (2015) use counts of the number of products per nest and per firm as instruments.

For the computation of market shares $s_0, \dots, s_J$ we consider a potential market size of twice the mean number of subscribers per month in our sample.[36] We consider the first-differenced version of the demand equation

$$M_{j,t} = \gamma_0 - \alpha p_{j,t} + \sigma \ln\left(s_{jg,t}\right) + \gamma_1 M_{j,t-1} + \gamma_2 ADV_t + \gamma_2 SAR_t + \gamma_3 D_{pm} + \gamma_4 D_{pa} + \gamma_5 \tau_t + \sum_{z=2}^{12} \gamma_{5+z} D_{z,t} + \zeta_{j,t},$$

[36] This is also the factor used by Björnerstedt and Verboven (2015). Using factors 1.3, 1.5, 2.5 and 3, we obtain similar results. Cf. Appendix A.2.

with dependent variable $M_{j,t} = \ln(s_j)/\ln(s_0)$. Price $p_{j,t}$ and the error term $\zeta_{j,t}$ are elements of mean utility. The constant term is given by γ_0. The lagged dependent variable $M_{ls,t-1}$ accounts for switching costs. Advertising (ADV_t) and sales costs (SAR_t) and dummies for the post-merger period (D_{pm}) and the period after the multi-band frequency auction (D_{pa}) are additional supply shifters. Furthermore, we include a time trend (in first differences, i.e. $\tau_t - \tau_{t-1} = t$) and seasonal effects ($D_{z,t}$ with months $z = 2, \ldots, 12$).

Table 3: Demand estimation output (2SLS/IV, first-differences).

model	(1)	(2)†	(3)	(4)
	Logit	**1 Nest**		**2 Nests**
	Tariff	Payment method/ Tariff	Contract/ Tariff	Payment method/ Brand/Tariff
dep. variable	MS	MS	MS	MS
price p_j	0.334 ***	-0.031 ***	-0.012	-0.032 ***
	(0.062)	(0.013)	(0.008)	(0.013)
Lagged MS $M_{j,t-1}$	0.288 ***	0.036 ***	0.039 ***	0.036 ***
	(0.045)	(0.011)	(0.012)	(0.011)
post-merger	-0.030 ***	-0.072 ***	-0.093 ***	-0.072 ***
	(0.008)	(0.004)	(0.004)	(0.004)
post-auction	0.045 ***	0.035 ***	0.039 ***	0.035 ***
	(0.006)	(0.002)	(0.002)	(0.002)
sales cost SAR_t	0.0533 ***	0.015 ***	0.028 ***	0.015 ***
	(0.014)	(0.003)	(0.003)	(0.003)
advertising cost ADV_t	0.360 ***	0.097 ***	0.159 ***	0.096 ***
	(0.040)	(0.012)	(0.011)	(0.011)
time trend (fd)	-0.001 ***	-0.001 ***	-0.001 ***	-0.001 ***
	(0.001)	(.0001)	(.0001)	(0.001)
constant	0.032 ***	0.016 ***	0.016 ***	0.016 ***
	(0.008)	(0.001)	(0.002)	(0.001)
group share $s_{jg,t}$ ($s_{hg,t}$)		0.881 ***	0.867 ***	0.881 ***
		(0.026)	(0.028)	(0.026)
sub-group share $s_{jh,t}$				0.887 ***
				(0.027)
Root MSE	0.126	0.037	0.039	0.037
F	71	8316	7819	960
observations	24,653	24,653	24,653	24,653
clusters (tarrifs)	849	849	849	849

Monthly dummies included. Standard errors in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level respectively. Statistics are robust to heteroskedasticity and autocorrelation. †) preferred model. Since R^2 has no statistical meaning in the context of 2SLS/IV estimation, model selection is done via Root MSE[37]

As instruments we include the average use of voice telephony, short messages and data, the number of tariffs by month, by firm and month, by nest and month and by firm, nest and month. As proposed by Anderson and Hsiao (1982), we use a first difference estimator and use higher lags of the dependent variable as further instruments.

[37] Cf. Wooldridge (2002), chap. 15.

As can be seen in Table 3, several logit models with different nest structures were estimated.[38] All models but one yield reasonable estimates for the price variable. The exemption is the multinomial logit model (model 1). In the three-level nested-logit model (i.e. model 4 with two nests) the restriction for the subgroup parameters ($\sigma_{g,t} > \sigma_{hg,t}$) is violated.[39]

Our preferred model is the nested logit model with payment form (i.e. prepaid/postpaid) as the nest (model 2). The decision for model 2 is based on the lowest Root Mean Squared Error (Root MSE) on the one hand, and on the failure of significance for the price variable estimate in model 3 on the other.

For the preferred model, coefficients have the expected sign and are significantly different from zero. The estimate for the price variable is negative and highly significant.

The coefficient for $s_{jg,t}$ is between 0 and 1, so the assumptions for the nested-logit model are satisfied ($0 \leq \sigma < 1$). The coefficient for the lagged dependent variable is small but highly significant, which indicates that switching costs do play a role. The positive coefficients for industry expenditure on advertising (ADV_t) and sales (SAR_t) imply that market demand increases (recall that s_0 is an argument in the dependent variable). The negative time trend indicate that market penetration is high. The dummies for the post-merger period and the post-auction period are significant and have the expected sign.

Demand elasticities. Recall that demand elasticities are functions of α, σ, product market shares s_j and group market shares s_g. Own-price elasticities $\eta_{jj,t}$, cross-price elasticities within nests, $\eta_{jk,t}$, and between nests, $\eta_{j\ell,t}$, are computed for every product j and every period t.

Table 4: Demand elasticities.

	mean	sd.	weighted mean
η_{jj}	-3.9118	2.2806	-2.9763
η_{jk}	0.0080	0.0174	0.0399
$\eta_{j\ell}$	0.0003	0.0005	0.0012

Weighted mean is the subscriber weighted average. Demand model 2.

Statistics of the demand elasticities are reported in Table 4. Own-price elasticity is rather high in absolute terms with a mean of -3.9118. However, subscriber-weighted elasticity is lower, indicating that most customers are in less elastic tariffs. Cross-price elasticities are fairly low within groups, indicating highly differentiated products and/or high switching costs. Cross-price elasticities between

[38] We used the `xtivreg2` Stata package by Schaffer (2015).

[39] Cf. Björnerstedt and Verboven (2014, 2015) for the three-level nested-logit model, i.e. the model with two nests.

groups are very low, indicating that there is not a lot of substitution between the pre-paid and the post-paid segment.

The computed elasticities are in line with other studies of mobile telecommunication markets. In the competitive assessment of the TA/Yesss! merger, Zulehner et al (2012) report own-price elasticities of -0.12 to -0.15 in the logit model, of -1.5 to -3.18 in the two-level model (one nest) and -3.9 to -4.5 in the three-level model (two nests). Grzybowski and Pereira (2007) study a merger in the Portuguese mobile telephony market. They report average own-price elasticities of -2.59, -5.82 and -6.41 for the three firms in their sample.

6.2 Cost estimation and prediction

In order to predict how marginal costs would have evolved without the mergers, we compute marginal costs from the first-order conditions and regress them on observed product characteristics in a fixed-effects estimation including a dummy for the post-merger period. Then we predict how marginal costs would have evolved without the merger by setting the post-merger dummy to zero.

Computation of marginal costs ("derived costs"). Marginal costs are computed by solving the first-order conditions outlined in section 5.2 using observed prices and quantities and the price elasticities computed from the demand estimation. Thereby, we use the assumption that firms were not coordinating their behavior before or after the merger.[40]

Cost estimation. We regress marginal costs on observable product characteristics, tariff fixed effects, dummies for the post-merger period and the period after the 4G LTE spectrum auction that was conducted in October 2013. An earlier regression with a dummy for each observation period indicated the possibility of a non-linear decreasing time trend. To account for this possibility, we run regressions with a logarithmic time trend ($\tau_t = \ln(t)$) and a quadratic time trend ($\tau_t = t^2$) in addition to a linear time trend. Monthly dummies are included to account for seasonal effects. The results are presented in Table 5.

The results are very similar for all three regressions. Marginal costs increase in the usage of voice and data. However, the coefficients are very small and the impact per MB data appears to be of lower importance than the impact of minutes of voice telephony. The coefficient for short messages has a negative sign but is insignificant. The difference between pre-paid and post-paid tariffs is captured by the tariff fixed effects, and a dummy for pre-paid tariffs is dropped due to collinearity. The dummy for sim-only tariffs has a positive sign. The coefficient for the number of subscribers is very small and insignificant, indicating that marginal

[40] In their competitive assessments, the Commission and Zulehner et al 2012 regarded coordinated effects as unlikely. To the contrary, BWB and RTR argued that MNO's behavior was already indicative of coordinated behavior pre-merger. Thus, our assumption should be considered as a conservative benchmark.

costs do not depend on quantity. This supports the model hypothesis that marginal costs are linear. The coefficient for new subscribers is very small as well.

Table 5: Cost estimation (OLS, tariff fixed effects).

model	**(I) logarithmic time trend**	**(II) quadratic time trend**	**(III) linear time trend**
dependent variable	marginal costs	marginal costs	marginal costs
avg. voice (min)	0.0058***	0.0068***	0.0062***
	(0.0014)	(0.0015)	(0.0014)
avg. sms (#)	-0.0023	-0.0027	-0.0029*
	(0.0017)	(0.0017)	(0.0017)
avg. data (MB)	0.0024***	0.0024***	0.0025***
	(0.0004)	(0.0004)	(0.0004)
sim-only	0.6300**	0.6510**	0.6350**
	(0.2660)	(0.2770)	(0.2860)
no. subscribers	2.3E-06	4.9E-06	2.6E-06
	(0.0000)	(0.0000)	(0.0000)
no. new subscribers	-0.0002**	-0.0002**	-0.0002**
	(0.0001)	(0.0001)	(0.0001)
post-merger	-1.1910***	-1.4460***	-0.8330***
	(0.0911)	(0.0984)	(0.0954)
post-auction	0.0270	0.4550***	0.5960***
	(0.0738)	(0.0646)	(0.0872)
logarithmic trend $\tau_t = \ln t$	-0.7620***		
	(0.0843)		
quadratic trend $\tau_t = t^2$		-0.0008***	
		(0.0001)	
linear trend $\tau_t = t$			-0.0709***
			(0.0077)
constant	10.6400***	8.7970***	9.6720***
	(0.4640)	(0.4180)	(0.4220)
R^2	0.15	0.15	0.16
F	21.98	20.31	20.65
observations	30,250	30,250	30,250
clusters (tarrifs)	898	898	898

Standard errors in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% level. Monthly dummies and tariff fixed effects are not reported.

The post-merger dummy has a negative coefficient in all three specifications and is highly significant. The coefficient for the post-auction dummy is smaller but has a positive sign. However, there appears to be some interaction with the time trend. A logarithmic time trend implies that the downward trend in marginal costs is quickly decelerating. In this specification, the post-auction dummy is insignificant at the 10 percent level. To the contrary, the quadratic time trend implies slower deceleration while the linear time trend implies no deceleration at all. In both cases, the post-auction dummy is highly significant.

Licensing costs are sunk costs, so the multi-band auction had no effect on firms' (exogenous) marginal costs. However, it might have affected variable costs that are determined endogenously, such as customer acquisition and retention costs. Then again, as the number of network operators decreased, the effect should have been a decrease of variable costs. Thus, in our view, the cost specification with a logarithmic time trend is most plausible. In any case, our cost estimation allows us to disentangle the effect of the merger and the effect of the multi-band auction.

Prediction of post-merger marginal costs. To predict how marginal costs would have evolved without the merger, we set the post-merger dummy to zero and compute the linear effects (time trend and changes in observed variables) and the fixed effects component for cost specifications (I)-(III). Since these cost specifications assume that there was no adjustment period after the merger, predicted marginal costs are above derived marginal costs in 2013. However, as summarized in Table 6, predicted marginal costs are below derived costs in 2014. This may be an indication for collusion.[41] The post-auction dummy is not changed, so cost effects are over and above any (implausible) cost effects of the multi-band auction.

Table 6: Evolution of marginal costs, quarterly averages.

year quarter	2013 q1	2013 q2	2013 q3	2013 q4	2014 q1	2014 q2	2014 q3	2014 q4	mean
derived marginal costs (EUR)	4.87	4.80	4.95	5.08	5.96	6.11	6.14	6.27	5.56
predicted marginal costs (EUR)									
logarithmic trend (2/I)	5.50	5.42	5.53	5.40	5.93	5.89	5.87	5.97	5.70
quadratic trend (2/II)	5.71	5.50	5.54	5.65	6.23	5.99	5.84	5.71	5.78
linear trend (2/III)	5.44	5.27	5.34	5.59	5.95	5.78	5.69	5.59	5.59

Subscriber-weighted averages. Demand model 2.

6.3 Merger simulation

Using the flexibility of the `mergersim` package, we simulate how prices would have evolved from January 2013 to December 2014 if the H3G/Orange and TA/Yesss! mergers had not been cleared.

We consider our preferred nest structure (pre-paid/post-paid) and conduct simulations for the three cost predictions outlined in Section 6.2. Recall that we made the (conservative) assumption that there were no coordinated effects before the mergers. For consistency, we assume that there is no (tacit) collusion in our counterfactual where the mergers are blocked. Using predicted marginal costs implies profit margins in the baseline scenario. Thus, the conduct parameter ϕ is no long-

[41] Recall that we assumed non-cooperative competition ($\phi = 0$) when deriving marginal costs from the first-order conditions. Hence derived marginal costs could be above actual marginal costs in 2014. Also note that the subscriber-weighted averages reported in the table decrease in the merger simulation, because market shares change. This makes the difference between average predicted and derived costs even more pronounced.

er a free parameter in our model. As described in Section 5.3, the number of tariffs is taken as given.

The `mergersim` package carries out numerical optimization for each period and/or market in the panel. We use a dampened fixed point operator with a dampening factor of 0.2. The simulations converged on average after about 60 iterations.

The output of the simulation includes new prices, new quantities and the monthly change in consumer surplus. We compute merger-induced price effects as percentage increase of observed subscriber-weighted prices (p_t^{obs}) over simulated subscriber-weighted prices (p_t^{sim}),

$$\%\Delta p_t = \frac{p_t^{obs} - p_t^{sim}}{p_t^{sim}} \times 100.$$

If not stated otherwise, we report the price effect for December 2014. The total consumer surplus change is computed as the reported change times 24 months. Recall that we cannot determine the absolute level of consumer surplus.

6.4 Main results

The main results from our counterfactual merger simulations are displayed in Table 7. Our simulations suggest that within two years, the H3G/Orange and TA/Yesss! mergers caused a price increase between 14.22% and 19.52%. Consumer surplus decreased by 158.6 to 226.9 million Euros.

Table 7: Merger-induced price effects and consumer surplus effects.

merger effect	(2/I) logarithmic time trend	(2/II) quadratic time trend	(2/III) linear time trend
price (all segments)	14.22%	17.89%	19.52%
pre-paid	19.71%	25.87%	30.05%
post-paid	12.94%	16.08%	17.15%
- sim-only	10.36%	14.79%	15.25%
- contract	14.03%	16.87%	18.25%
consumer surplus	EUR -158.6mn	EUR -210.7mn	EUR -226.9mn

Subscriber-weighted price effect in 12/2014. Total consumer surplus change.

In the following, we discuss the price effects in specification 2/I in greater detail. Additional results from robustness checks are presented in Appendix A.2.

Price growth rates in different sub-segments. Table 8 summarizes the growth of observed and simulated prices over time. While subscriber-weighted prices increased by 13.49% from December 2012 to December 2014, our simulation suggests that prices would actually have fallen by 1% if the mergers would not have been cleared.

Table 8: Price change (%), 12/2012 - 12/2014.

segments	observed	counterfactual	difference
pre-paid	19.75%	-0.16%	19.91%
post-paid	8.22%	-4.56%	12.79%
- sim-only	29.17%	17.00%	12.17%
- contract	8.52%	-5.32%	13.84%
all segments	13.49%	-1.00%	14.49%

Main model (2/I). Subscriber-weighted averages.

In the pre-paid segment, the observed price effect was 19.75%, while our simulation suggests that prices would have fallen slightly without the merger. This gives a merger-induced price increase of 19.91%. In the sim-only post-paid segment we observed a steep price increase of 29.17%. However, this price increase was accompanied by a steep increase in data contingent and data usage and simulated prices increase by 17%. In the (lock-in) contract segment, we observed a more moderate price increase of 8.52%. Prices would have fallen by 5.32% without the merger. Interestingly, the observed price increase for the entire post-paid segment is below both of its sub-segments. This is possible because prices started at a much lower level in the post-paid sim-only segment and the rapid growth of this segment outweighed the price increase within the segment.

Table 9: Evolution of prices, quarterly averages.

year quarter	2013 q1	2013 q2	2013 q3	2013 q4	2014 q1	2014 q2	2014 q3	2014 q4	mean
observed prices (EUR)	10.76	10.65	10.74	10.85	11.71	11.84	11.86	11.97	11.34
predicted prices (EUR)	10.81	10.64	10.85	10.47	10.84	10.72	10.53	10.46	10.66
price increase (%)	-0.49%	0.08%	-0.97%	3.68%	8.06%	10.40%	12.60%	14.40%	6.39%

Main model (2/I). Subscriber-weighted averages.

Evolution of prices over time. Table 9 suggests that prices were little affected in the first three quarters of 2013. An inspection of predicted marginal costs in Section 6.2 suggests that there might have been some cost savings that were not passed on to consumers. Observed prices started to increase beyond counterfactual prices in the fourth quarter of 2013. For the last quarter of 2014, our simulation suggests a merger induced price effect of 14.4%.

Price effects per provider. Table 10 displays price effects on the operator level. The price effects for the merging parties mask complexity at the brand level, because the brands Orange and Yesss! were cheaper than the brands of the buyers. Therefore, we differentiate between the existing brands of H3G and TA and their newly acquisitioned brands Orange and Yesss!.

From December 2012 to December 2014, Telecom Austria increased the prices of its old brands by 10.50%. According to our simulations, prices would have decreased by 3.84% without the mergers. The average subscriber-weighted price for the brand Yesss! increased by 63.70%, from 4.38 Euros to 7.17 Euros. Without the merger, prices would only have increased by 11.90%.

Table 10: Price change (%), 12/2012 - 12/2014.

operators	observed	counterfactual	difference
TA			
- *w/o Yesss!*	10.50%	-3.84%	14.34%
- *Yesss!*	63.70%	11.90%	51.80%
H3G			
- *Drei*	21.70%	8.54%	13.16%
- *Orange*	1.01%	-14.30%	15.31%
TMA	13.20%	2.40%	10.80%
all operators	13.49%	-1.00%	14.49%

Main model (2/I). Subscriber-weighted averages.

The observed price increase for the Drei brand of H3G Austria was 21.70%, the predicted price increase only 8.54%. The observed price increase for Orange was 1.01%. However, the predicted price decrease was -14.3%.

Sometimes it is argued that price effects should be more pronounced for the merging parties, because their combined demand is less affected by an unilateral price increase than it would have been before the merger (Björnerstedt and Verboven, 2015). We find that T-Mobile Austria increased its price by 13.20%. Our simulations predict a price increase of 9.82%, so the merger-induced price effect is indeed comparatively small.

7 Discussion

Our main results highlight the complexity of the mobile telecommunications market. Average prices can mask a lot of heterogeneity in different sub-segments. In some segments, such as the post-paid sim-only segment, increased data usage was an important cost driver. However, we find that the H3G/Orange and TA/Yesss! mergers led to considerable price effects *in all* segments within a two-year period. The price effects started to materialize in the end of 2013, and it is hardly a coincidence that CEOs of different operators cheered the end of a "price war" in the trade press at the time.[42] We have no data for 2015, but the RTR "new customer price index" suggests that MVNO market entry in early 2015 caused prices to decrease again. Thus, operators were only able to increase prices dramatically for one year until the market intervened again. Then again, telecommunication markets are economically important and our simulations suggest that this short time period might have been sufficient to decrease consumer surplus dramatically.

[42] Cf. http://www.reuters.com/article/deutschetelekom-t-mobile-austria-idUSL5N0IT2E420131108 (8 Nov 2013) and http://www.reuters.com/article/us-telekomaustria-profit-idUSBRE9AJ0ZD20131120 (20 Nov 2013), retrieved 18 Feb 2016.

Compared to commercial databases, we were able to obtain very detailed and comprehensive data on the Austrian mobile telecommunications market. However, data quality and biases (e.g. due to inactive customers) were major challenges in our investigation. We attempted to mitigate these problems by an extensive (and conservative) data cleaning process.

With regard to the scope of our data, we found that the first differences of regular subscribers and the levels of new subscribers generally do not add up. Entry and exit to a given contract occur simultaneously and subscribers frequently exit to the outside good (of not using mobile telecommunication services) or enter from the outside good. In future studies, it might be worthwhile to request the number of entering subscribers and leaving subscribers, where possible with further distinguishing subscribers who switch between tariffs of the same brand. Furthermore, it might be interesting to request the number of locked-in customers and/or the distribution of customer cohorts within a tariff.

We consider a "bespoke" merger simulation model (Walker, 2005) to account for the many intricacies of the mobile telecommunications market. In future studies, it might be worthwhile to consider dynamic models that capture the inter-temporal trade-offs of firms and customers and endogenize the introduction of products, the investment decisions of firms and market entry. Then again, this generalization would add many layers of complexity to an already complex model. The data requirements would probably increase and in the end it will never be possible to endogenize all choices made in a moderately complex market.

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Appendix

A.1 Data cleaning

Data quality turned out to be an important issue in our investigation. Initially, our data contained a lot of outliers. In some instances, we also detected that MNOs provided data in different measurement units. We conducted several rounds of plausibility checks and discussed our findings with MNOs. This helped to revise erroneous entries and to validate outliers.

Together with the MNOs and RTR, we furthermore identified several biases in our data. In some tariffs, customers get money back for every incoming call they receive. Since regulatory price ceilings for termination rates have been lowered in recent years, this implies that these tariffs might have negative average revenues per user ("ARPU"). We were able to mitigate this problem by using a basket price instead of ARPU as our price variable. As mentioned in the main text, for some older tariffs in our sample, data usage fees amount to several hundred Euros per MB. Hence minimal data usage might amount to monthly bills of one thousand Euros and more. RTR suggested that these bills are usually contested and are rarely paid. Again, the use of a basket price helps to mitigate this bias.

From an initial sample of 36,167 observations and 1003 tariffs, we excluded tariffs that are only offered to teenagers ("youth tariffs") and subsidized tariffs that are only offered to certain income groups ("social tariffs"), because they are also excluded in the computation of the RTR price indices. MNOs reported that there are many inactive subscribers in their customer databases. One MNO changed its definition of inactivity during our observation period and inactive customers are dropped from databases in irregular intervals. Thus, there might be significant shifts in market shares that are not caused by changing demand. Furthermore, inactive subscribers can bias average usage profiles and hence prices. To the contrary, some tariffs with few subscribers had very extreme usage patterns that evened out as the number of subscribers increased. Nevertheless, these observations had a large impact on average usage profiles and price levels. To control for distortions from inactive and hyperactive customers, we excluded observations with basket prices in the bottom and top 5 percent of our sample. Our final analysis sample contains 30,250 observations and 949 tariffs.

A.2 Robustness checks

The following robustness checks are made for our main specification (2/I).

Alternative demand function. Björnerstedt and Verboven (2013, 2015) introduce an alternative 'constant expenditure' nested-logit model, where price enters consumers' utility function logarithmically. This gives an iso-elastic demand function, as price enters elasticity only indirectly via market-shares. This functional form implies that average own-price elasticities are lower and that elasticities are less dispersed.

We do not consider the constant expenditure model to be a good approximation of demand in mobile telecom markets. As a robustness check, we conducted a demand estimation with this specification. However, the parameter constraints for coefficients α and σ where not satisfied.

Alternative market size. We follow Björnerstedt and Verboven (2015) and consider a maximal market size of two times the mean number of subscribers per month ($\overline{q_t}$). As a robustness check, we consider market sizes of 1.5, 2.5 and 3 times the mean number of subscribers. Coefficients α, σ and own-price elasticity are within similar range.

Table 11: Alternative market size.

market size (factor × $\overline{q_t}$)	**1.5**	**2†**	**2.5**	**3**
α	-0.0399	-0.0309	-0.0301	-0.0298
σ	0.8804	0.8813	0.8834	0.8847
ϵ_{jj}‡	-3.8176	-2.9763	-2.9583	-2.9537

†Baseline in the main text. ‡Subscriber-weighted own-price elasticity. Model 2/I.

Alternative cost functions. If we derive subscriber-weighted marginal costs from the first order conditions, we obtain a smooth function around the time of the merger. To the contrary, predicted costs increase in the first quarter of 2013 above the level of marginal costs in the last quarter of 2012, because we set the post-merger dummy to zero in our cost predictions. Since it is unlikely that firms were able to realize cost savings instantly, we might predict efficiency gains that are not there. To illustrate that our assumptions are very conservative, we report additional results in Table 12. In cost specification (2/Ia), we exclude the merger dummy completely from the cost estimation. In specification (2/Ib), we exclude the merger dummy from the cost estimation and exclude the time trend from the cost prediction. Thus, we essentially perpetuate the cost level observed at the time of the merger.

Table 12: Merger-induced price effects and consumer surplus effects.

merger effect	**(2/I)** logarithmic trend	**(2/Ia)** logarithmic trend no merger dummy	**(2/Ib)** logarithmic trend no merger dummy prediction w/o trend
price	14.22%	16.05%	9.38%
consumer surplus	EUR -158.6mn	EUR -180.9mn	EUR -91.5mn

Subscriber-weighted price effect in 12/2014.

Alternative counterfactual scenarios. In order to disentangle the price effects of both mergers, we simulate the price effects of both mergers separately. Table 13 summarizes the results for a logarithmic cost trend (model 2/I).

If only H3G/Orange had been cleared and TA/Yesss! had been blocked, the subscriber-weighted average unilateral price increase from clearing H3G/Orange would have been 4.59% (4% in the pre-paid segment). If H3G/Orange had been blocked and TA/Yesss! had been cleared, the average unilateral price increase would have been only 2.48% (10.54% in the pre-paid segment).

Table 13: Alternative counterfactual scenarios.

counterfactual - both mergers blocked	unilateral effects (conduct=0)	coordinated effects (conduct=0.1463)
H3G/Orange cleared, TA/Yesss! cleared	5.79%	14.22%
H3G/Orange cleared, TA/Yesss! blocked	4.59%	12.90%
H3G/Orange blocked, TA/Yesss! cleared	2.48%	10.61%

Price effect in 12/2014 (model 2/I).

The unilateral price increase from clearing both mergers would have been 5.79% (10.73% in the pre-paid segment). Assuming a conduct parameter of zero pre-merger and a conduct parameter of 0.1463 post-merger, the simulated post-merger price in December 2014 matches the counterfactual price increase of 14.22%, as reported in Table 7. This exercise suggests that the observed price effects might to a large extend be due to coordinated effects.

Continuing this exercise to the counterfactual scenarios, we compute that a conduct parameter of 0.1463 would have led to a price increase of 12.90% if only H3G/Orange had been cleared and to a price increase of 10.61% if only TA/Yesss! had been cleared.