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ESMT Working Paper 17-04

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Static or Dynamic Efficiency - Horizontal Merger Effects in the Wireless Telecommunications Industry*

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Abstract

This paper studies five mergers in the European wireless telecommunication industry and analyzes their impact on prices and capital expenditures of both merging carriers and their rivals. We find substantial heterogeneity in the relationship between increases in concentration and carriers' prices. The specifics of each merger case clearly matter. Moreover, we find a positive correlation between the price and the investment effects; when the prices after merger increase (decrease), the investments increase (decrease) too. Thus, we document a trade-off between static and dynamic efficiencies of mergers.

JEL classification: L22, O33, G34, L96

Keywords: telecom mergers, static and dynamic efficiency, difference-in-difference

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1 Introduction

Market structure has an important effect on the static and dynamic efficiency of markets. A standard microeconomic argument suggests that a more competitive market puts more pressure on firms to exploit ways to reduce production costs and increase efficiency. Firms will face low profits and therefore will try to “escape competition” (Aghion et al. 2005) by lowering their cost of production. However, the incentives to invest will not only affect static efficiency (in the form of lower prices), but also dynamic efficiency (in the form of increased investment into long-term improvements). In concentrated markets, mergers and acquisitions will affect market structure significantly. Consequently, the behavior of firms may well change as a result of a merger in the industry, both for the merging and the non-merging firms. Hence, we study whether and how indicators of static and dynamic efficiency are affected by a merger in the industry.

Therefore, the core question we ask in this paper is if within-market mergers have led to *increased static and/or dynamic efficiency*, and if there is *a tradeoff between the two*? The answer to these questions will be relevant both to policymakers and to firms operating within such industries. Policymakers will pursue dual goals of static and dynamic efficiency, but may place different weights on either. Further, firms operating in technologically intensive industries may incorporate the expected short- and long-term effects of mergers on their own and their rivals’ efficiency in their decisions to merge.

We study these issues in the wireless telecoms sector in Europe. The markets in this sector can be characterized as still national in scope, displaying large market concentration, and in need of large sunk investments. This is a useful setting because market definition and identification of market participants are easy, and because there have been a series of important mergers in different countries we observe. Moreover, the telecoms sector is an important part of most advanced economies, both for its direct effect of economic growth, but also for its general purpose technology characteristics (Röller et al. 2001; Czernich et al. 2011). In addition, the trade-off between static and dynamic efficiencies is especially relevant in an industry with

significant technological progress, both in terms of infrastructure and in terms of services. A Merrill Lynch report mentions that carriers are being pushed “to seek efficiencies in many areas: network construction and operation (via network sharing and outsourcing), marketing and distribution (via simplified, SIM-only rate plans) and product/development/support (by de-emphasizing walled garden content and services). These trends are being furthered by technology (smarter smartphones that reduce the need for specialized carrier-provided content) and regulation (pushing carriers to de-emphasize early termination fees).”¹

The conventional approach for studying the effects of mergers on firm behavior is a cross-country study comparing markets with mergers to those without a merger. Such studies are informative, but they have several weaknesses: First, comparing markets with and markets without mergers may mask several aspects and could, for example, interpret *ex-ante* heterogeneity across markets that affects the likelihood of mergers as causal drivers of efficiency increases *ex-post*, i.e. following a merger. Second, obtaining one average effect of mergers across countries may be misleading if there is substantial heterogeneity of effects across countries. Even within countries, the merging firms and the rival firms may react differently to a merger.

We therefore choose a multiple-single-case approach: We study five mergers in four European countries that increased market concentration considerably² and look at the effects of mergers on two outcomes: *prices* as a measure of static efficiency, which is determined by the current firm’s market power and costs, and *capital expenditures* as a measure of the firms’ investment incentives. While we have no way of statistically comparing the five cases, we see interesting patterns: In two of the five cases, the effect on static efficiency is positive, in two, it is negative (in one it is insignificant), but in nearly all scenarios, merging as well as rival firms’ prices moved mostly in the same direction. Moreover, we find a positive correlation between the price and the investment effects. In the markets with an increase in price (i.e., a decline in static efficiency), all firms reported an increase in capital expendi-

¹*Global Wireless Matrix 1Q10*. BofA Merrill Lynch.

²Of these 5 mergers two are from four to three firms (4-to-3) and three are from 5-to-4 firms. There were two mergers in the Netherlands, 5-to-4 and then 4-to-3, and one merger in Austria, Denmark, and Greece.

ture, suggesting a stronger focus on dynamic efficiency; the opposite effect prevails in the markets that saw a decrease in prices after a merger. This points to a tradeoff between static and dynamic efficiency: while two countries provide indicative evidence for an increase in static efficiency at the expense of less investments, the other two displayed higher investments into future infrastructure at the expense of higher post-merger prices.

In a narrow sense, we contribute to the literature on merger effects, especially in the as yet understudied telecommunications industry. However, our results make two broader points: i) mergers have to be assessed for their static and dynamic effects on the evolution of an industry and ii) the effects of mergers are highly context-specific, even in the same industry. From a policy point of view, it is also notable that competition policy may interact with science and technology policy in the sense that investments for infrastructure may be affected by competition policy instruments. This calls for an integrated view on these two policy aspects. Finally, we also contribute to the literature on firms' innovation strategies (e.g. Coad et al. 2008, Beneito 2003 and De Faria et al. 2010), which reiterates the important point that market structure affects innovation performance, but also suggests that the choice of partner, in our case in a merger, may be crucial for successful innovation.

2 Prior Literature

Merger effects have been widely studied across multiple academic fields, such as economics, management and finance. A significant number of economic studies focus on consumer welfare and find anti-competitive effects of mergers in many industries (e.g., McCabe 2002, in the journal market, and Dafny 2009, in the hospital market). Weinberg (2007) surveys the economics literature on this topic and finds that most mergers examined by this literature resulted in increased prices, at least in the short term, which defines them as anti-competitive. Such short-term effects of increased pricing power due to mergers are also confirmed in the strategy literature (e.g., Moatti et al. 2015, in global retail industry).

Further, there are a number of studies that conclude that merger-related efficien-

cies can outweigh the increase in market power rendering mergers pro-competitive, especially in the longer term. For instance, Focarelli et al. (2003) find that the short-term price increases due to mergers were followed by reduction of prices in the longer term in the banking industry in Italy. Also, Connor et al. (1998) show that the average costs and prices increased less for the US hospitals that were involved in a merger. More generally, longer term, dynamic merger efficiencies, were often studied in terms of the impact of mergers on firms' investment and innovation (Morgan 2001). Early economic literature on this topic surveyed in Cohen et al. (1989) and Scherer (1998) seems largely inconclusive. More recent work in the management field does not yield unambiguous results that could easily be generalized across many sectors of the economy either (e.g., Hitt et al. 1996; Zhao 2009; Valentini 2012). Two explanations of the inability to find general conclusions about the role of mergers for dynamic efficiency are that i) the effects may not be linear (Aghion et al. 2005; Cloudt et al. 2006; Sacco et al. 2011) and ii) there may be substantial heterogeneity in the way dynamic efficiencies are realized across industries (Morgan 2001) and firms (Desyllas et al. 2010; Wagner 2011). This paper adds to this literature a simultaneous analysis of static and dynamic efficiencies by investigating pricing and investments in the specific context of mobile telecoms' mergers. This allows us, among other things, to study potential trade-offs between the static and dynamic efficiencies.

As observed by Morgan, "it is clear from the emerging literature on the treatment of competition to innovate that different issues will arise in different industrial settings" (Morgan 2001, p. 182).

In our context most important dynamic efficiencies are in the area of enabling future innovation in various sectors of the economy using mobile telecommunications, in particular mobile internet access and data services, as inputs. The impact of telecommunications on innovation and economic growth is well documented (see e.g., Röller et al. 2001; Czernich et al. 2011) and can even be expected to grow over time, as mobile data services are increasingly enabled, in line with the general purpose technology paradigm (Bresnahan et al. 1995). As a consequence, the measure of dynamic efficiency in our context is best captured by investment in infrastructure,

rather than R&D spending (e.g., Hitt et al. 1996; Cassiman et al. 2005; Szücs 2014), or patenting (e.g., Zhao 2009; Valentini 2012), which are crucial in other contexts, such as the pharmaceutical industry. Further, and related to this point, the dynamic merger effects in our context are more likely to be related to market power and/or efficiency gains (see e.g., Chatterjee 1986; Seth 1990) rather than transfer of knowledge (see e.g., Ahuja et al. 2001).

Thus, the main contribution of this paper is to add to the literature on market concentration and investment in the telecommunication industry, an important driver of overall economy innovation and growth. By pursuing this goal we also aim to foster our understanding of how competition policy, which governs market concentration to a significant extent, may interact with science and other technology related policies to facilitate technological progress. To the best of our knowledge, there is no academic work that specifically investigates the impact of mergers on investment in mobile telecom industry.³ There exists some indirect empirical evidence of it from fixed-line telecom markets. In particular, the increase in competition from entrant telecom operators enabled by the U.S. Telecommunications Act of 1996, was found to bring differentiation of service offerings (Greenstein et al. 2006) and new price plan introductions (Economides et al. 2008). New entry facilitated by the mandated access to European incumbent operators' infrastructure was also shown to bring differentiation of broadband access speed (Nardotto et al. 2015), but lower investment at both the industry and the operator level (Grajek et al. 2012).

Our analysis also follows the finance literature (Eckbo 1983; Stillman 1983) by allowing for differential effects of mergers on the merging parties and their industry rivals. Indeed, such differential effect of mergers on prices and profitability is typically used to distinguish pro-competitive mergers, which are characterized largely by efficiency-based synergies from anti-competitive mergers, which are characterized largely by market power-based price increases (e.g., Duso et al. 2007; Clougherty et al. 2011; Gugler et al. 2016). A similar approach was also used to study the profitability of alliances (Oxley et al. 2009), responses to hostile takeover attempts

³There exist some industry reports that look at this topic, though; See e.g., Genakos et al. (2015).

(Servaes et al. 2013), and the effects of mergers on R&D spending (Szücs 2014). In our context, the differential effect of mergers across firms in the same market allows for more precise inference about potential trade-offs between static and dynamic efficiencies.

Finally, we also contribute to the literature on firms' innovation strategies. Coad et al. (2008) look at the linkage between innovation and firm growth in high-tech sectors and find that, relative to an average firm that experiences only modest returns, innovation is of great importance for the fastest-growing firms. Beneito (2003) provide an empirical analysis of firms' decision when choosing among R&D investment strategies. De Faria et al. (2010) study cooperation in innovation activities and find that the firms in the high-tech sectors, with higher levels of absorptive capacity, exports and innovation intensity are more likely to cooperate in the innovation process and place greater value on their innovation cooperation partners. We show that mergers that reduce the market price pressure allow firms to focus on investments into long-term improvements.

3 Data

We construct our dataset by using two major sources: the Global Wireless Matrix dataset provided by Merrill Lynch (ML) and the World Cellular Information Service provided by Informa (EMC). Our dataset covers quarterly observations on 62 operators in 17 countries for the period from the last quarter of 1998 to the second quarter of 2011. The dataset contains information on size of the customer base (i.e. the number of mobile phone users), usage intensity measured by the number of minutes of use, revenues, and investments. This information is used to construct our key variables of interest, which are listed in Table 1. The summary statistics are presented in Table 2.

Our first dependent variable, revenue per minute (RPM), is calculated by dividing the monthly voice-only service revenues by the total minutes of use on an operator's network. Service revenues include monthly service charges and usage fees, roaming, long distance, and subscriptions to mobile data services, but exclude equipment

Table 1: Variables' description

Variable	Explanation
RPM_{ijt}	price of carrier i in market j in period t , defined as revenue per minute (RPM), EUR
$Capex_{ijt}$	capital expenditure (Capex) of carrier i in the market j in period t , mln EUR
MOU_{ijt}	average minutes of use (MOU) on carrier i 's network in market j in period t , minutes
$MobPen_{ijt}$	number of carrier i 's users relative to country's population in market j in period t
$FixPen_{jt}$	number of fixed line users relative to country's population in market j in period t
GDP_{jt}	GDP per capita in market j in period t , EUR

Table 2: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Revenue per minute (RPM)	0.215	0.111	0.04	1.056	2170
Capital expenditure (Capex)	82.111	86.927	1.96	764	1597
Minutes of use (MOU)	143.405	48.753	44	334	2201
Mobile penetration rate (MobPen)	0.265	0.162	0	0.823	2929
Fixed penetration rate (FixPen)	0.499	0.13	0.179	0.74	3170
GDP per capita (GDP)	28.533	11.918	5.835	70.314	3145

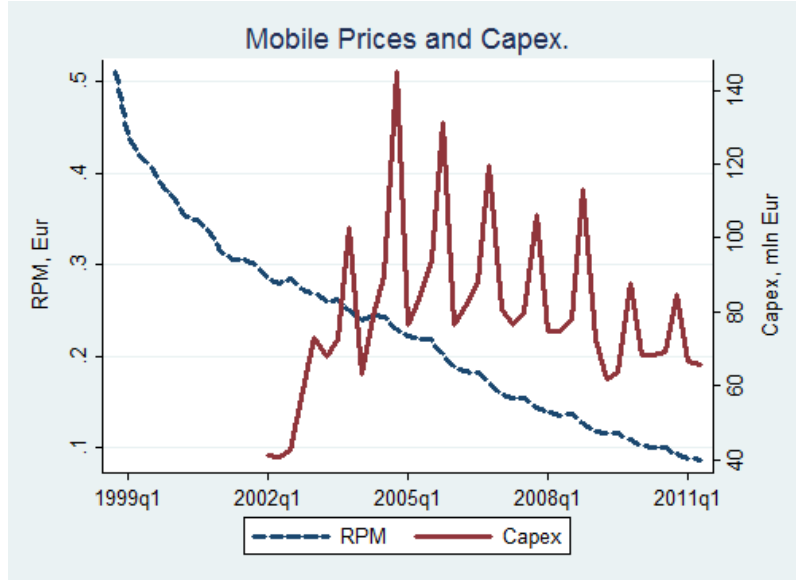
and accessories, and are adjusted for inflation by using Eurostat's consumer price index.⁴ RPM is usually not disclosed by operators, but is calculated by Merrill Lynch, because it arguably constitutes a better proxy for pricing than the average revenue per user (ARPU) commonly reported by operators.⁵ The average RPM in our sample is 21.5 Euro cents and follows a downward trend over time, as shown in Figure 1.

Many previous studies of the wireless telecommunications sector relied on Teligen data, which are different from ours in several respects. Teligen data come in the form of customer bill corresponding to a particular usage profile (low, medium, high) that

⁴Merrill Lynch admits, however, that some operators also include non-service revenues (e.g. equipment sales) in their revenue calculation, while others exclude revenues from roaming by pre-paid card users or from incoming traffic.

⁵ARPU is calculated by dividing service revenues by the average subscriber base. We adopt RPM as our main dependent variable and use ARPU for robustness checks. The results, available upon request, are not sensitive to the price definition.

Figure 1: Evolution of mobile prices and Capex, 1998-2011.



remains fixed over time. These expenditures are computed by picking the cheapest available tariff for each profile. However, this data is only available for the two biggest operators in each country. Therefore, our data has the advantage of allowing us for the analysis of pricing behavior of both the merging carriers and their rivals. This comes at the cost of having a more coarse price measure.

Our second dependent variable is operator’s capital expenditure (Capex). Since innovation in the provision of mobile telecommunications services over the period of our sample was mostly driven by the increased reliability of services coupled with increased speed of mobile data transmission, it is well captured by the Capex, a close proxy for the network build-up. As shown in Figure 1, Capex follows a non-linear trend over time and is highly seasonal in our sample. The Capex series reported by Merrill Lynch start only in the first quarter of 2002, which limits the number of observations we can use to study the operators’ investment behavior.

The average monthly usage time per user (MOU), mobile and fixed penetration rates, and GDP per capita serve as control variables in our analysis. MOU is calculated by dividing the total monthly usage on an operator’s network by the average subscriber base. It is measured in minutes and usually excludes traffic related to

mobile data services, but counts both incoming and outgoing minutes of use. The average MOU in our sample is 143.4 minutes per month. It controls for changes in our price measures (RPM and ARPU) that result from changing intensity of use of mobile phones, for instance due to fixed-mobile substitution, rather than genuine changes in the price plans.⁶ Mobile and fixed penetration rates are defined as the number of cellular users of a given carrier and number of fixed line users (or fixed lines) in a given country divided by that country's population, respectively. The former controls for possibly different pricing strategies used by small vs. large mobile network operators; e.g. penetration pricing may more often be used by the small operators. GDP per capita, routinely used as a demand shifter control, is adjusted for inflation by using the Eurostat's consumer price index.

In the time period of our analysis we observe five horizontal mergers.⁷ Table 3 lists the analyzed mergers and reports the characteristics of the operators involved, such as their individual market shares (in terms of users) at the moment of the merger, their rank according to their size among all carriers active in the corresponding national markets, the market share and the rank of the merged firm two years after the merger, and the number of the operators remaining. While there is substantial heterogeneity in terms of these characteristics across cases, all mergers lead to substantial increases in market concentration.

⁶This control is arguably more important for ARPU, which we use as a price measure in our robustness checks.

⁷Due to the insufficiency of data on prices, the merger in Finland that occurred during the time period analyzed in this study was excluded.

Table 3: List of mergers

Country	Participants	Before merger		2 yrs after merger		
		Market share, %	Operator's Rank	Market share, %	Operator's Rank	Number of rivals
Austria (q2 2006)	T-Mobile	26.8	2	35.1	2	3
	tele.ring	10.3	4			
Denmark (q4 2004)	Telia Denmark	9.3	4	19.8	3	3
	Orange Denmark	12.9	3			
Greece (q1 2005)	Stet Hellas (TIM)	21.0	3	27.7	3	2
	Q-Telecom	6.5	4			
Netherlands 1 (q3 2005)	KPN Mobile	34.9	1	51.2	1	3
	Telfort	15.3	3			
Netherlands 2 (q3 2007)	Ben (T-Mobile)	14.8	3	26.7	2	2
	Dutchtone (Orange)	12.2	4			

4 Methodology and Results

We adopt a difference-in-difference approach to investigate differences in pricing and investment between the merging firms and the rest of the market. The diff-in-diff approach looks at changes in these differences after the merger takes place. A similar methodology, for instance, is used by McCabe (2002), who looks at the mergers of scientific journals. Our approach differs in that we explicitly exclude the competitors in the own market from the control group to avoid contamination of the control group by merger spillovers. For instance, if a merger reduces the competitive rivalry in a given market, both the merging parties and the rivals may respond by increasing their prices. In the context of the wireless industry, due to the institutional and regulatory setup, each national market constitutes a relevant market. Thus, our control group consists of operators in markets where no merger took place.⁸

We define our pricing model as:

⁸Whether that constitutes a proper comparison group depends on the plausibility of the assumption that, following the merger, the trend of the unobserved counterfactual would remain parallel to that of the control group, which in general is impossible to test. However, one indication that this requirement indeed holds is the fact that both trends are parallel in the pre-merger period, which in conjunction with the assumption of no cross-market spillovers and no other structural change with differential impacts on the treatment and control groups suggests that our difference-in-difference results are reliable. A visual inspection of the trends suggests that this is the case (we attach the corresponding figures in Appendix B).

$$RPM_{ijt} = \alpha_0 + \alpha_1 * Merging_{jt} + \alpha_2 * MOU_{ijt} + \\ + \alpha_3 * MobPen_{ijt} + \alpha_4 * FixPen_{jt} + \alpha_5 * GDP_{jt} + c_j + \tau_t + \epsilon_{ijt} \quad (1)$$

and

$$RPM_{ijt} = \beta_0 + \beta_1 * Rival_{jt} + \beta_2 * MOU_{ijt} + \\ + \beta_3 * MobPen_{ijt} + \beta_4 * FixPen_{jt} + \beta_5 * GDP_{jt} + d_j + \phi_t + \nu_{ijt}. \quad (2)$$

In both equations, i indicates a firm, j a market and t a time period. We write the pricing model as two separate equations to stress the fact that the equations are estimated using different samples; we drop all rival firms to all mergers when estimating (1) and all merging firms when estimating (2). Moreover, to obtain merger-specific coefficients for each merger in our data, we estimate the pricing model (1) and (2) five times, i.e. with each set of the merging firms (or rivals) as a separate treatment group. Estimated this way, the effects of mergers on merging firms (in (1)) and on rivals (in (2)) are in each case relative to the same control group, all firms in markets that did not see a merger.

$Merging_{jt}$ and $Rival_{jt}$ are both dummy variables defined as interaction of $MergerMarket_j$ and $Postmerger_t$. $MergerMarket_j$ represents a merger market dummy and is used to control for the systematic difference in prices between the merging (or rival) firms and the control group (firms in markets with no mergers). $Postmerger_t = 1$ for all periods t after the merger and otherwise 0. $Merging_{jt}$ ($Rival_{jt}$) thus measures the change in the difference in prices between the merging firms (rivals) and the control group, subsequent to the merger. Thus, the coefficients on these variables represent the merger effects on the merging and rival firms, respectively.⁹

We also control for the minutes of use (MOU_{ijt}), mobile user penetration

⁹In order for the time series to be consistent, we generate a composite entity by averaging pre-merger observations, using the respective market shares as weights, for the operators that merge.

($MobPen_{ijt}$), fixed line penetration ($FixPen_{jt}$) and GDP per capita (GDP_{jt}) in the pricing model. As explained in the previous section, MOU_{ijt} captures an average volume effect, whereby users who call more minutes pay usually a lower price per minute. $MobPen_{ijt}$ controls for possible effects of market dominance (measured by the percentage of population captured by an operator) on pricing strategy. $FixPen_{jt}$ controls for competition from fixed-line telephony and GDP_{jt} for shifts in overall demand, which both may influence mobile telephony pricing. We also include country dummies and time period dummies in both equations.¹⁰

To measure dynamic effects of mergers, we investigate levels of investment in addition to the operators' pricing. The model's specification is as before, except for the dependent variable, which is now capital expenditure:¹¹

$$\begin{aligned} \text{Log}(Capex_{ijt}) = & \gamma_0 + \gamma_1 * Merger_{jt} + \gamma_2 * MOU_{ijt} + \\ & + \gamma_3 * MobPen_{ijt} + \gamma_4 * FixPen_{jt} + \gamma_5 * GDP_{jt} + l_j + \lambda_t + \xi_{ijt} \end{aligned} \quad (3)$$

and

$$\begin{aligned} \text{Log}(Capex_{ijt}) = & \delta_0 + \delta_1 * Rival_{jt} + \delta_2 * MOU_{ijt} + \\ & + \delta_3 * MobPen_{ijt} + \delta_4 * FixPen_{jt} + \delta_5 * GDP_{jt} + m_j + \psi_t + v_{ijt}. \end{aligned} \quad (4)$$

The investment model is specified analogously to the pricing model. Thus, the treatment and the control groups, the main variables of interest and the control variables in (3) and (4) are the same as in (1) and (2). Unlike in the pricing model, however, the Capex of the pre-merger entities is defined as a sum, rather than an average, of the Capex expenditures by the acquirer and the target.

Austria

¹⁰Note that $Postmerger_t$ and $Merger_j$ are omitted from the equations (1) and (2), because the former is co-linear with time period and the latter with the country dummies.

¹¹The log-linear specification was chosen here because the level of Capex (unlike price) depends on the market's size.

The merger in Austria involved T-Mobile, owned by the German Deutsche Telekom and accounting for approximately 25% of the market, acquiring tele.ring, a price-aggressive maverick that doubled its market share in the three years prior to the merger and came to control 10% of the market. Due to its competitive behavior, tele.ring was believed to exert more competitive pressure on its rivals than its market share would suggest. In its decision, the European competition authority identified non-coordinated effects and could not rule out coordinated effects resulting from the merger, but cleared it subject to remedies. T-Mobile committed to sell some of its mobile sites to the other operators (in particular to H3G, the smallest carrier on the market that was lacking network infrastructure and frequencies necessary to challenge the other operators) and either sell or return a frequency package.¹²

Table 4: Price and investment effects of the Austrian merger

	RPM		Rivals		Capex		Rivals	
	Merging	se	coeff.	se	Merging	se	coeff.	se
	coeff.				coeff.			
Merging/Rival	0.006	0.006	-0.061***	0.006	-0.297*	0.130	-0.333**	0.123
Minutes of Use	-0.000***	0.000	-0.000***	0.000	0.003***	0.001	0.003***	0.001
Mobile Penetration	-0.006	0.008	-0.008	0.008	1.348***	0.137	1.352***	0.137
Fixed Penetration	0.035	0.022	0.033	0.022	0.762*	0.328	0.748*	0.328
GDP p.c.	0.002***	0.000	0.002***	0.000	0.012*	0.005	0.012*	0.005
Number of obs	1690		1691		1064		1064	
F-statistic	197.238		198.790		90.220		89.294	
F-test p-value	0.000		0.000		0.000		0.000	
R-squared	0.867		0.871		0.808		0.808	
Root MSE	0.038		0.038		0.458		0.457	

Merging/Rival represents the treatment dummy: it equals 1 in the post-merger period for the merging firm in the Merging pane and for rival firms in the Rivals pane.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The estimation results for the Austrian market suggest that, while in general prices for the mobile services experienced a downward trend in the post-merger period (see Appendix B), post-merger prices in Austria declined also relative to the control group. These results are in line with the European Commission's report (2015) that

¹²Case No COMP/M.3916. T-MOBILE AUSTRIA/TELE.RING. Commission decision of April 26, 2006, available at http://ec.europa.eu/competition/mergers/cases/decisions/m3916_20060426_20600_en.pdf

finds that on aggregate there was a statistically significant price decrease in the range of -2% to -20% as a result of this merger in Austria. Our results further suggest that the price reaction to the merger was to a larger extent driven by the rivals, as can be seen by the magnitude and significance of the Merging/Rival coefficient in the RPM equations. At the same time we find that the merger had a statistically significant negative effect on investment by both the merging firms and the rivals. We thus observe a tradeoff between the static and dynamic efficiencies in the Austrian merger case: lower prices charged by the operators after the merger increased the static efficiency in the market; this effect was countered by a drop in capital expenditures, however, which we interpret as a decrease in dynamic efficiency.

Denmark

In Denmark TeliaSonera, the fourth largest mobile operator, purchased the third-ranked Orange in 2004, leading to a combined market share of around 20%. The merger took place in a period when Denmark already had the lowest mobile telephony prices in the EU, as well as one of the highest churn rates. TeliaSonera was ranked third after the merger and was expected to challenge the market leaders, TDC and Sonofon, as it was looking to expand its customer base and cut costs by closing down one of the networks. The merger was cleared by the competition authorities, as it did not appear to create or strengthen a dominant position, nor pose any other threat to effective competition in the Danish market for mobile telephony.¹³

Following the merger, there was a general price increase for both merging firms and their rivals in Denmark. The effect was stronger for the merger participants (7.3 cents) than for their rivals (6.0 cents). Note that while the merger in Denmark was technically 5-to-4, the fifth competitor, 3 (Hutchison), only accounted for 1% of the market (in fact, in its analysis of the case, the EU Commission talks of a four-player market), and the change in concentration was more of a 4-to-3 nature.

The Capex results imply that both merging firms and their rivals significantly increase investment spending after the merger. Thus, the Danish merger results also

¹³Case No COMP/M.3530. TELIASONERA AB/ORANGE A/S. Commission decision of September 24, 2004, available at http://ec.europa.eu/competition/mergers/cases/decisions/m3530_en.pdf

Table 5: Price and investment effects of the Danish merger

	RPM		Rivals		Capex		Rivals	
	Merging	se	coeff.	se	Merging	se	coeff.	se
	coeff.		coeff.		coeff.		coeff.	
Merging/Rival	0.073***	0.012	0.060***	0.008	0.470***	0.130	0.310**	0.103
Minutes of Use	-0.000***	0.000	-0.001***	0.000	0.003***	0.001	0.002***	0.001
Mobile Penetration	-0.008	0.008	-0.010	0.008	1.349***	0.137	1.366***	0.135
Fixed Penetration	0.020	0.022	0.008	0.021	0.526	0.317	0.412	0.326
GDP p.c.	0.002***	0.000	0.002***	0.000	0.010	0.005	0.009	0.005
Number of obs	1678		1729		1064		1094	
F-statistic	165.963		166.209		106.491		99.693	
F-test p-value	0.000		0.000		0.000		0.000	
R-squared	0.863		0.861		0.822		0.813	
Root MSE	0.038		0.038		0.459		0.458	

Merging/Rival represents the treatment dummy: it equals 1 in the post-merger period for the merging firm in the Merging pane and for rival firms in the Rivals pane.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

indicate a tradeoff between static and dynamic efficiencies; while Danish operators raised prices after the merger, they also increased infrastructure investments.

Netherlands

In 2005, the incumbent and market leader KPN acquired Telfort (ranked 3rd at that time). While the merged entity was expected to control about 50% of the market, the merger was cleared unconditionally by the Dutch competition authority on the grounds that the remaining three operators in the Netherlands – one of the few remaining countries with five carriers at that time—were all subsidiaries of strong international players capable to exert sufficient competitive pressure to prevent the creation or strengthening of a dominant position.

The Dutch market then experienced the second merger in 2007, when T-Mobile acquired Orange. The European Commission concluded that Orange was not a price maverick, as it was mostly active in the prepaid segment, unlike the rest of the carriers, and was not seen as a close substitute to T-Mobile. Nor was a collective dominant position by the three remaining operators expected to be a likely threat.

The case of the Netherlands is unique in our study in that its market was exposed to two successive mergers. This is interesting from the perspective of the commonly

Table 6: Price and investment effects of the first Dutch merger

	RPM		Rivals		Capex		Rivals	
	Merging	se	coeff.	se	Merging	se	coeff.	se
	coeff.		coeff.		coeff.		coeff.	
Merging/Rival	-0.004	0.005	0.026***	0.006	0.275*	0.122	0.294*	0.123
Minutes of Use	-0.000***	0.000	-0.000***	0.000	0.003***	0.001	0.003***	0.001
Mobile Penetration	-0.007	0.008	-0.005	0.008	1.349***	0.137	1.388***	0.137
Fixed Penetration	0.033	0.022	0.027	0.022	0.799*	0.328	0.619	0.323
GDP p.c.	0.002***	0.000	0.002***	0.000	0.012*	0.005	0.010*	0.005
Number of obs	1690		1733		1051		1098	
F-statistic	186.655		172.148		87.087		89.378	
F-test p-value	0.000		0.000		0.000		0.000	
R-squared	0.867		0.866		0.807		0.800	
Root MSE	0.038		0.038		0.457		0.463	

Merging/Rival represents the treatment dummy: it equals 1 in the post-merger period for the merging firm in the Merging pane and for rival firms in the Rivals pane.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

stated hypothesis that 4-to-3 mergers are significantly more harmful than 5-to-4 mergers (see, e.g., Csorba 2015). It is important to mention that the analysis is somewhat complicated in the case of the Netherlands: identifying the merger effects here is more problematic due to the overlap of the pre- and post-merger periods, as the close succession of the second merger (approximately two years after the first one) makes it difficult to disentangle the effects of each event. The results that we report for the Dutch market suggest that the effect on investment was substantially more pronounced as evidenced by statistically significant (albeit only at the 10% level) and positive coefficients for both the merging firms and the rivals for both mergers, while in case of price we only observe an increase in the rivals' prices following the first merger. These results are robust to modifying the definitions of pre- and post-merger periods between the two mergers, but due to the aforementioned constraints, there is not too much room for resetting the date in the alternative specifications.

Thus, we again observe some trade-off between static and dynamic efficiencies, at least in case of the first merger, where an increase in the prices of the rivals was accompanied by a higher level of the investment expenditures, albeit the exact distinction between the effects of the first and the second merger is difficult in the Dutch case.

Table 7: Price and investment effects of the second Dutch merger

	RPM		Rivals		Capex		Rivals	
	Merging	se	coeff.	se	Merging	se	coeff.	se
	coeff.		coeff.		coeff.		coeff.	
Merging/Rival	-0.002	0.005	0.001	0.006	0.373*	0.176	0.293*	0.146
Minutes of Use	-0.000***	0.000	-0.000***	0.000	0.003***	0.001	0.003***	0.001
Mobile Penetration	0.017*	0.007	0.006	0.007	1.377***	0.158	1.351***	0.151
Fixed Penetration	0.024	0.031	0.027	0.030	1.107	0.640	1.107	0.636
GDP p.c.	0.001***	0.000	0.001***	0.000	0.011*	0.006	0.010	0.006
Number of obs	817		839		728		741	
F-statistic	184.900		177.615		113.049		112.731	
F-test p-value	0.000		0.000		0.000		0.000	
R-squared	0.826		0.826		0.831		0.827	
Root MSE	0.019		0.019		0.423		0.423	

Merging/Rival represents the treatment dummy: it equals 1 in the post-merger period for the merging firm in the Merging pane and for rival firms in the Rivals pane.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Greece

In Greece, TIM Hellas, the third largest operator, acquired Q-Telecommunication, the youngest and the smallest player on the market. TIM Hellas continued to be third-largest operator after the merger. Even though the merger led to a reduction in the number of carriers from four to three, it was not expected to raise competition concerns, as Q-Telecom was not regarded as a price maverick, and, moreover, it was expected that TIM Hellas would compete more actively with the two large incumbents. The EU competition authority approved the merger.¹⁴

The estimated merger effect on prices in Greece was unambiguously negative, both for the merging operators and their rivals. This result can be explained by the fact that, in line with the market description above, having acquired a larger share of the post-merger market, the third-ranked operator switched to a more aggressive behavior to challenge the two big players and gain a larger share, which at the same time triggered a symmetric response by the incumbents.

While the prices clearly went down after the merger, the estimated coefficients

¹⁴Case No COMP/M.4036. TPG IV / APAX / Q-TELECOM. Commission decision of January 13, 2006, available at http://ec.europa.eu/competition/mergers/cases/decisions/m4036_20060113_20310_en.pdf

Table 8: Price and investment effects of the Greek merger

	RPM		Rivals		Capex		Rivals	
	Merging coeff.	se	coeff.	se	Merging coeff.	se	coeff.	se
Merging/Rival	-0.109***	0.017	-0.119***	0.018	-0.027	0.263	-0.169	0.175
Minutes of Use	-0.000***	0.000	-0.001***	0.000	0.003***	0.001	0.003***	0.001
Mobile Penetration	-0.007	0.008	-0.021**	0.008	1.352***	0.137	1.337***	0.132
Fixed Penetration	0.015	0.023	-0.018	0.025	0.751*	0.326	0.928**	0.324
GDP p.c.	0.002***	0.000	0.002***	0.000	0.012*	0.005	0.013*	0.005
Number of obs	1684		1722		1050		1078	
F-statistic	165.946		165.057		89.312		87.942	
F-test p-value	0.000		0.000		0.000		0.000	
R-squared	0.868		0.860		0.810		0.804	
Root MSE	0.039		0.042		0.459		0.460	

Merging/Rival represents the treatment dummy: it equals 1 in the post-merger period for the merging firm in the Merging pane and for rival firms in the Rivals pane.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

from the Capex equations are negative but not statistically significant. Thus, the Greek merger neither supports nor refutes the hypothesized tradeoff between static and dynamic efficiencies.

Summary of the Merger Results

Overall, the estimation results suggest that, while most of the wireless markets experienced a decrease in prices over the corresponding period, this effect was softened by weaker competition in some markets that were exposed to mergers. In three out of five mergers that we analyze, weaker competition led to higher prices charged by the merging firms and/or their rivals after the merger. In two cases, however, namely in Austria and Greece, mergers led to a further decrease in prices of merging firms and/or rivals. This can be explained at least to some extent by the specificities of these mergers. In the Austrian case, thanks to the remedies attached to the merger, H3G, the smallest carrier on the market was significantly strengthened by acquiring network infrastructure and frequencies it needed to challenge the other operators. In the Greek case, the third-largest operator was also significantly strengthened by acquiring the forth-largest one.

Further, our results suggest a positive relation between the estimated effects of

mergers on prices and investment. In all four markets we studied, the direction of the effects on prices and investments was the same. That is, higher prices coincide with higher investment, and lower prices with lower investment. This suggests that the impact of mergers on the consumer welfare extends beyond the price changes and includes, among others, dynamic effects resulting from higher levels of investments. These dynamic effects also need to be given proper consideration in the merger evaluation process. In the case of mobile telecommunications market in Europe, all mergers over the last two decades resulted in efficiencies, either static or dynamic, but never both at the same time. Moreover, the static and dynamic efficiencies seem to be negatively correlated, which poses a difficult dilemma for merger policy.

As discussed before, we test the validity of our results by inspecting the pre-merger price and investment paths and checking whether they exhibit common trends. In addition, we plot the residuals from the price regressions using the same set of controls in the pre-merger period and examine whether the prices follow similar trends conditional on the covariates in our model. These figures (Appendix B) largely justify our approach.

We performed further robustness checks where we included additional controls, such as the share of pre-paid customers, fixed line prices, and time since the entry on the market. We also used different definitions of the merger date to account for the fact that the time period between the announcement of the intention to merge and the actual legal, corporate, and marketing changes can span several quarters. We do, however, find similar effects.

We also estimated the specifications where the post-merger period is split in two parts, two years immediately after the merger and the subsequent years. First of all, this allows us to analyze how fast the effect is building up. Second, it could serve as an additional validation check, as the potential deviations in the short-term estimates from the overall results would suggest that the overall effect could have possibly be driven by the factors unrelated to the merger. We report the results in Appendix C, where the dummies *Merging08/Rival08* and *Merging8+/Rival8+* are defined in an analogous way to *Merging/Rival*, except they take the value 1 only

in the first 8 quarters after the merger and only after the first 8 quarters after the merger, correspondingly. As the overall effects are similar, in both the short and long term, with the latter being larger in absolute value in most cases, we conclude that the obtained estimates are consistent with the assumption that the effect accumulates over time as the merging firms complete the consolidation and restructuring processes and their rivals internalize that in their responses.

5 Conclusion

We conducted an ex-post evaluation of five domestic horizontal mergers in the European wireless sector. These markets can be characterized as national in scope, displaying large market concentration, and in need of large sunk investments. Thus, they represent an ideal testing ground for an ex-post evaluation of merger effects on static and dynamic efficiencies. The evidence from the Netherlands and Denmark supports the conventional wisdom of mergers being associated with a higher price level for consumers. The results from Austria and Greece generally show an opposite effect on prices, however. Thus, we provide evidence that no two mergers are the same, and although post-merger price increases often occur, many other factors reflecting the particular setting in which a merger takes place and the specifics of each case have to be accounted for. In particular, the Austrian and Greek cases suggest that strengthening small firms by either allowing them to merge or imposing appropriate remedies in a merger process may lead to downward pressure on prices.

Focusing on the effects of mergers on prices alone, however, ignores important issues, such as changes in product choice and service quality that can have a mitigating effect on consumer welfare. Particularly, the growth in data services has become an important feature of the services offered by mobile carriers over the last decade with associated requirements of huge sunk capital expenditures. Therefore, we analyze both price and investment effects of mergers, i.e. we look at the issue of whether there is a trade-off of static (i.e. price) and dynamic (i.e. investment) efficiency. We find for the five mergers under scrutiny, prices and investment move in the same direction: For those mergers where we find a dominance of market power

effects (Netherlands and Denmark), we also find significant increases in investment spending post-merger. For mergers where we find a preponderance of cost efficiency (Austria and Greece), we do not find significant increases in post-merger investment spending. Thus, we find evidence of a trade-off between static and dynamic efficiencies in mergers in a large sunk cost industry. The fact that mergers do not uniformly lead to an increase or decrease in prices, but that investments move in the same direction as prices suggests a powerful link between the two: While the specificities of each merger may lead to different outcomes overall, the tradeoff between static and dynamic efficiency remains.

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Appendices

A Descriptive Statistics

Table A1: Summary Statistics by Country.

Country	N obs	RPM	Capex	N firms	Minutes of Use	Mobile Pen.	Fixed Pen.	GDP p.c.
Austria	227	0,231	32,397	3,890	151,332	0,254	0,448	32,631
Belgium	153	0,180	37,485	2,941	137,8064	0,270	0,462	31,155
Czech Republic	165	0,180	30,052	2,855	107,9457	0,325	0,298	10,871
Denmark	240	0,184	20,094	4,233	161,5359	0,233	0,603	41,036
France	153	0,181	212,581	3,000	229,8033	0,230	0,579	30,145
Germany	204	0,256	156,514	3,980	99,01981	0,222	0,647	29,935
Greece	189	0,290	37,269	3,212	121,1627	0,309	0,498	19,419
Hungary	153	0,168	21,432	2,843	150,2849	0,272	0,337	10,369
Italy	204	0,203	184,250	3,627	126,7617	0,303	0,433	26,374
Netherlands	255	0,237	44,134	4,196	141,9986	0,213	0,517	33,046
Norway	120	0,207	25,252	2,600	198,6554	0,368	0,526	55,160
Poland	171	0,214	58,421	3,398	99,12053	0,199	0,281	7,814
Portugal	153	0,201	38,558	3,000	125,6226	0,356	0,408	15,362
Spain	181	0,214	112,540	3,420	145,8192	0,261	0,439	23,564
Sweden	204	0,210	19,679	3,647	158,7789	0,274	0,645	35,187
Switzerland	153	0,271	45,063	2,902	116,7843	0,307	0,700	43,161
United Kingdom	250	0,216	147,779	4,580	160,7919	0,208	0,569	35,106
Total (N obs)/Mean	3175	0,215	82,111	3,542	143,405	0,265	0,499	28,533

Table A2: Market Concentration before/after the Merger.

	HHI before	Δ HHI	HHI 1 yr after	HHI 2 yr after
Austria	3008	272	3219	3233
Denmark	3372	240	3593	3618
Netherlands 1	2374	1070	3423	3465
Netherlands 2	3465	361	3726	3772
Greece	3112	275	3396	3382

B Common Trends

The key assumption underlying the validity of the difference-in-difference approach is that the outcome of interest in the treatment and control groups would follow the same time trend in the absence of treatment. While it is generally difficult to ascertain whether this assumption holds, one way to do it, previously suggested in the literature (see, e.g., Hastings (2004)), is to simply visually inspect both trends in the pre-treatment period: if they appear to be parallel (the means, of course, do not have to be the same), one would hope that the control group's post-treatment path would also be parallel to the unobserved counterfactual. One must also keep in mind that, in order for that to hold, the intervention should not influence the units in the control group. In our context, a domestic mobile carrier merger in a given market should not influence the outcomes in other countries. We expect this to be the case due to the fact that wireless markets in Europe are rather distinct because of the still national regulatory structure.

Below we depict the price and investments paths, RPM and Capex, observed over the timespan available in our dataset in the treatment (the merging firm) and control groups (the average across all operators in the countries where no merger took place). In addition, we also account for the possibility that, even if not parallel in general, the price and investment trends could still be parallel conditional on a set of regressors: including these regressors then in the main model would prevent it from being invalidated based on the pre-treatment trends divergence. Therefore, we also plot the residuals from the regressions based on the same specification as in our merger effects model.

B.1 Merging

Figure B1: Austria.

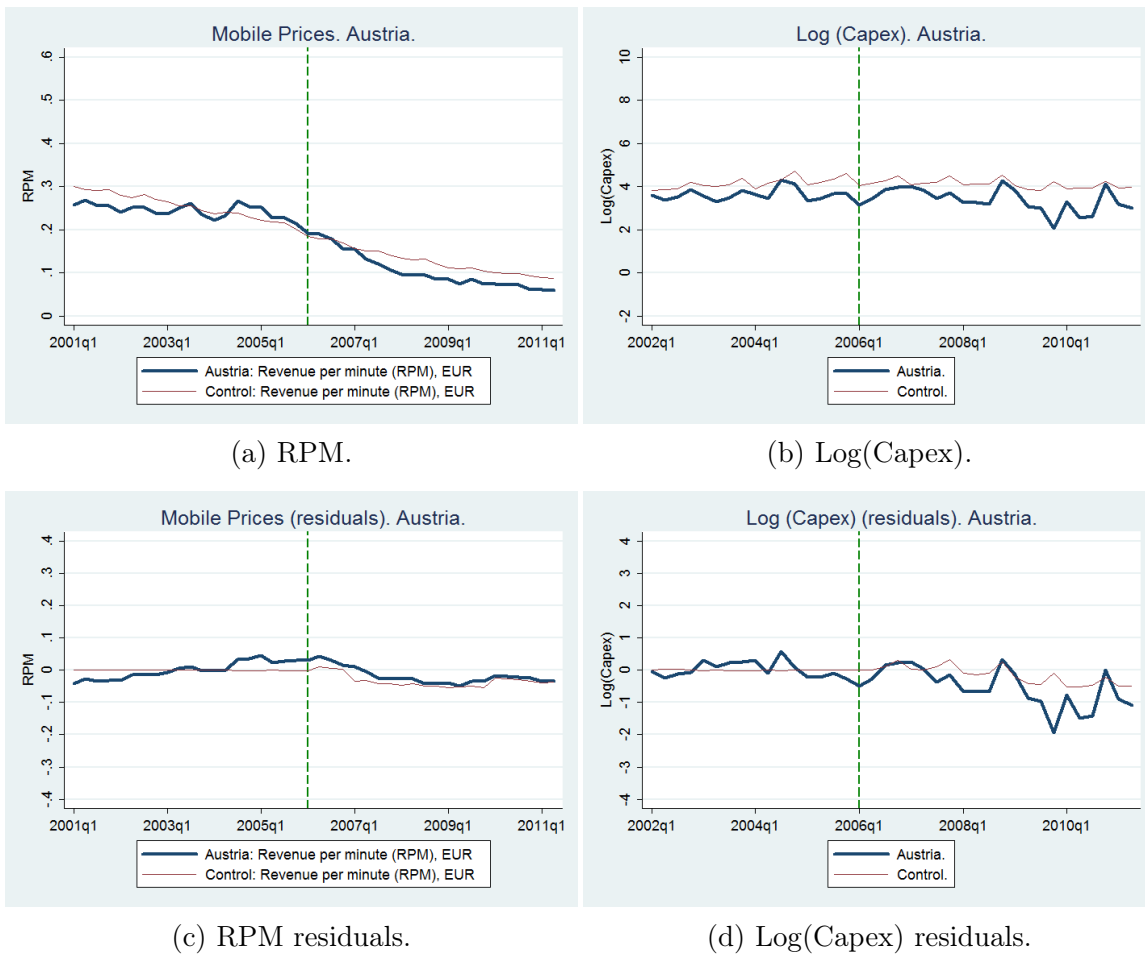
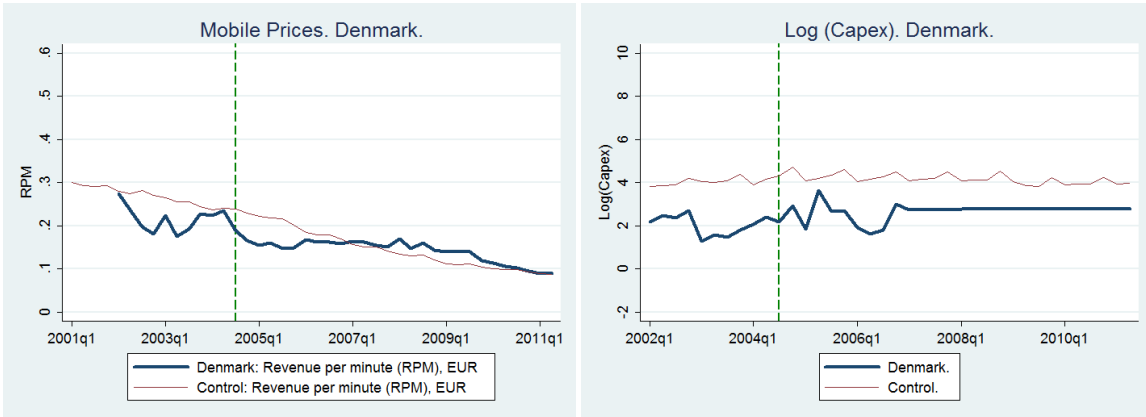
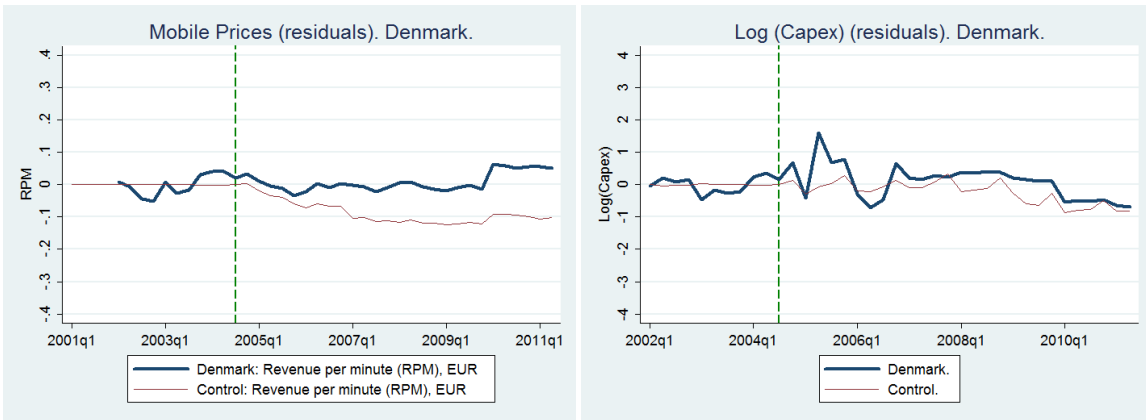


Figure B2: Denmark.



(a) RPM.

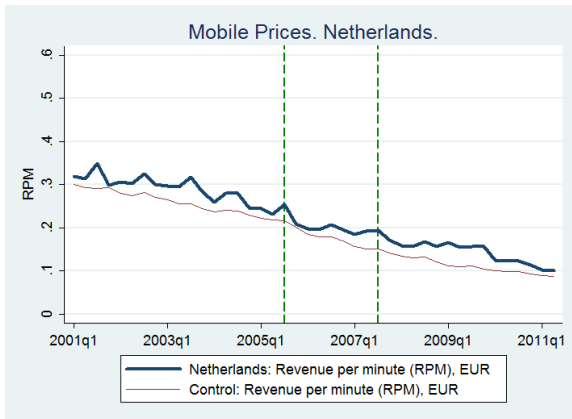
(b) Log(Capex).



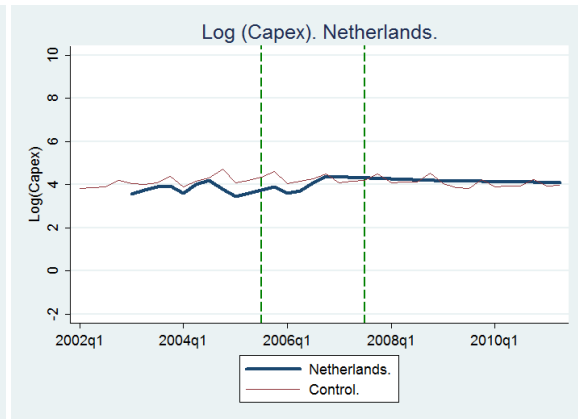
(c) RPM residuals.

(d) Log(Capex) residuals.

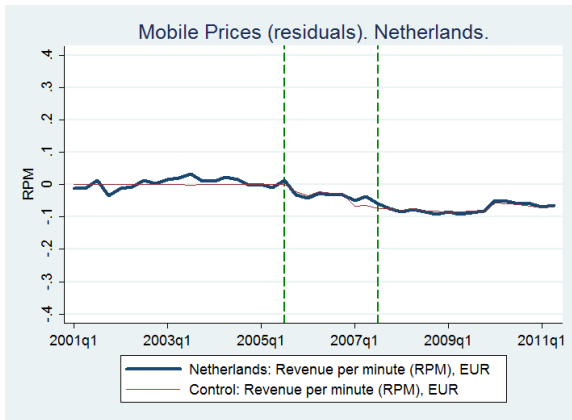
Figure B3: Netherlands.



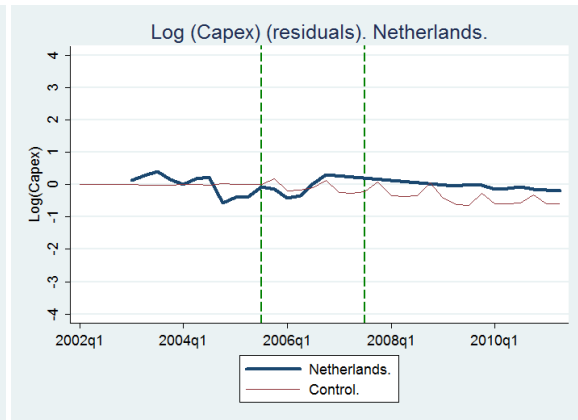
(a) RPM.



(b) Log(Capex).

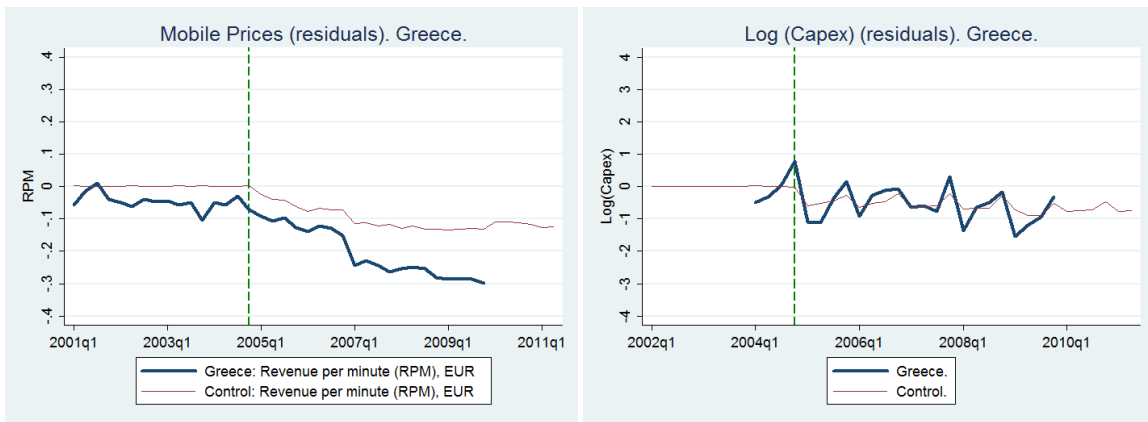
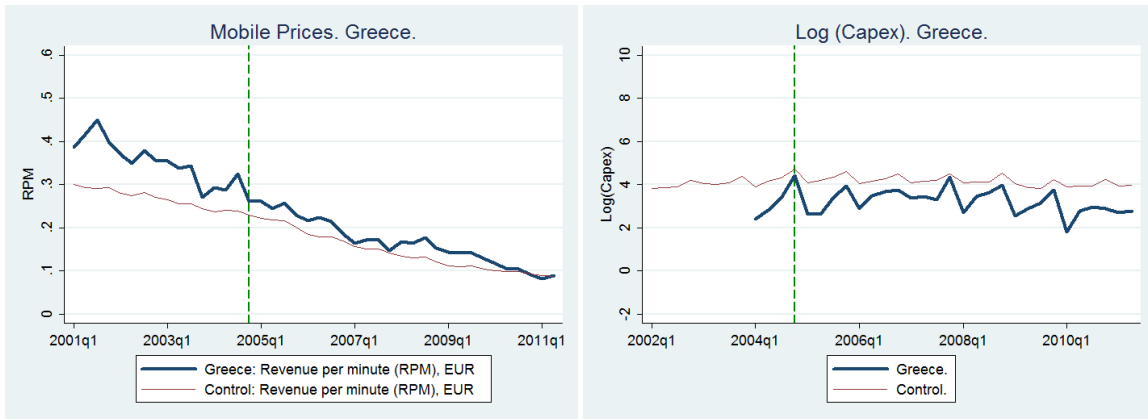


(c) RPM residuals.



(d) Log(Capex) residuals.

Figure B4: Greece.



B.2 Rivals

Figure B5: Austria. Rivals.

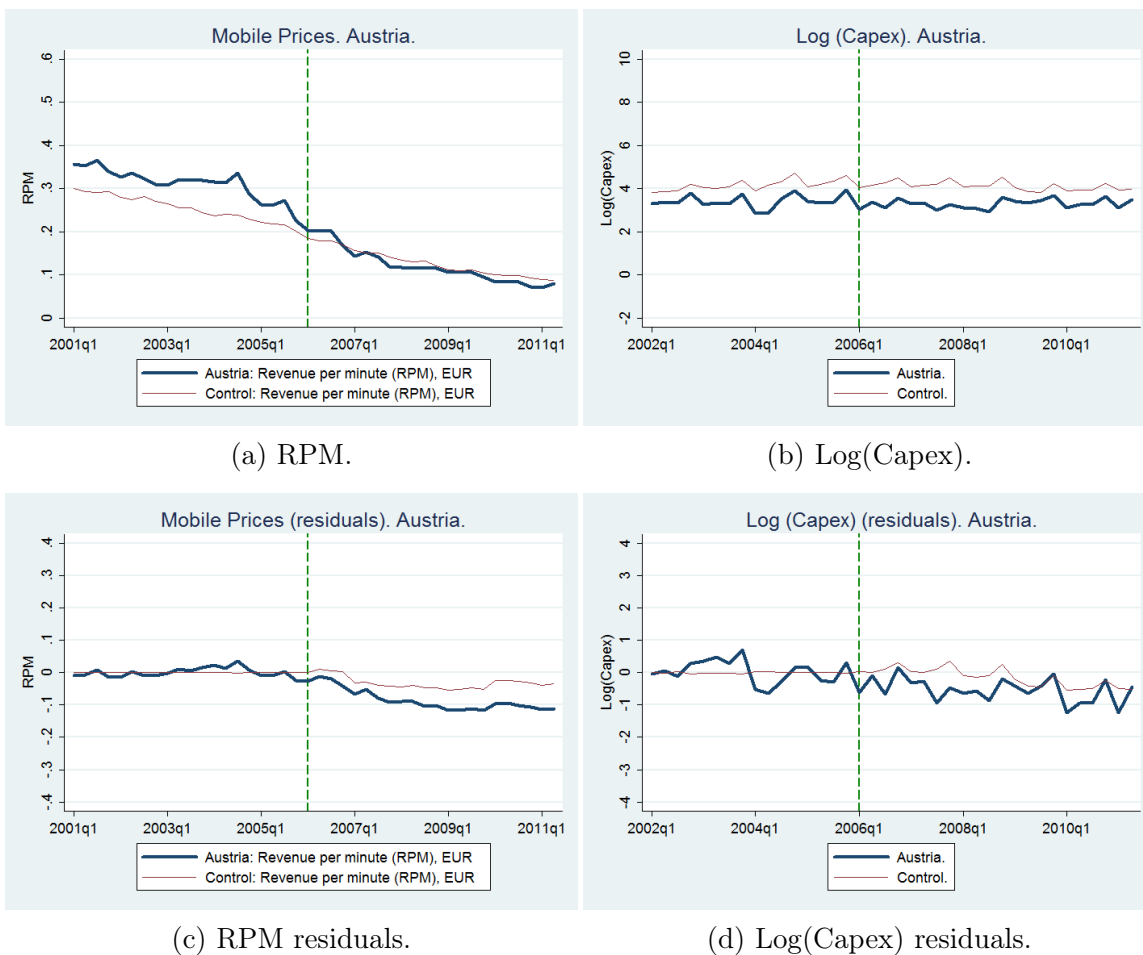
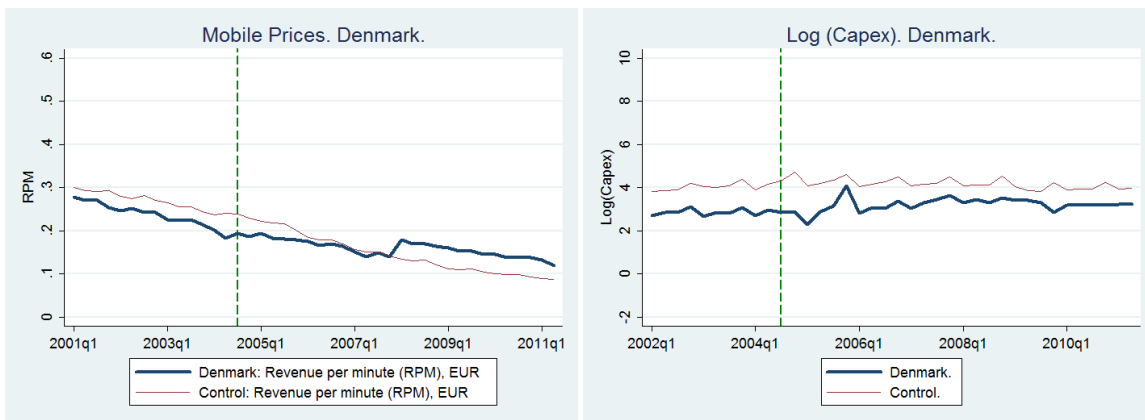
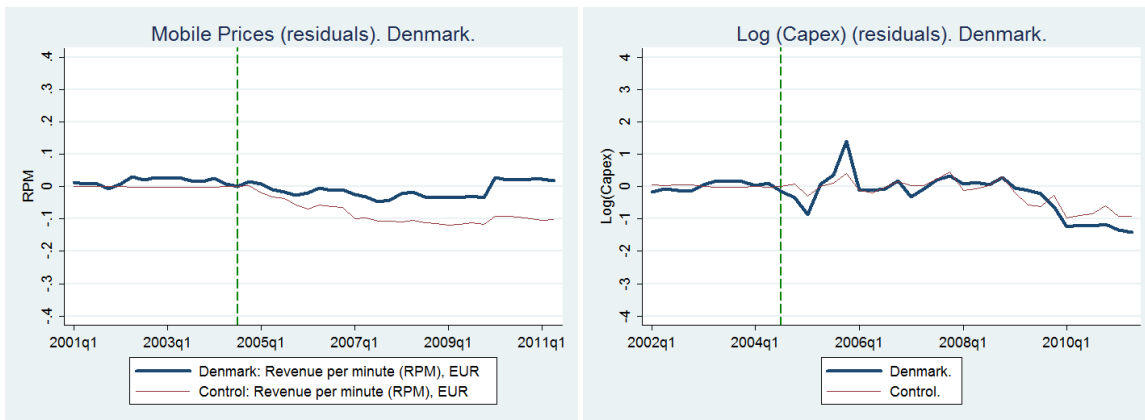


Figure B6: Denmark. Rivals.



(a) RPM.

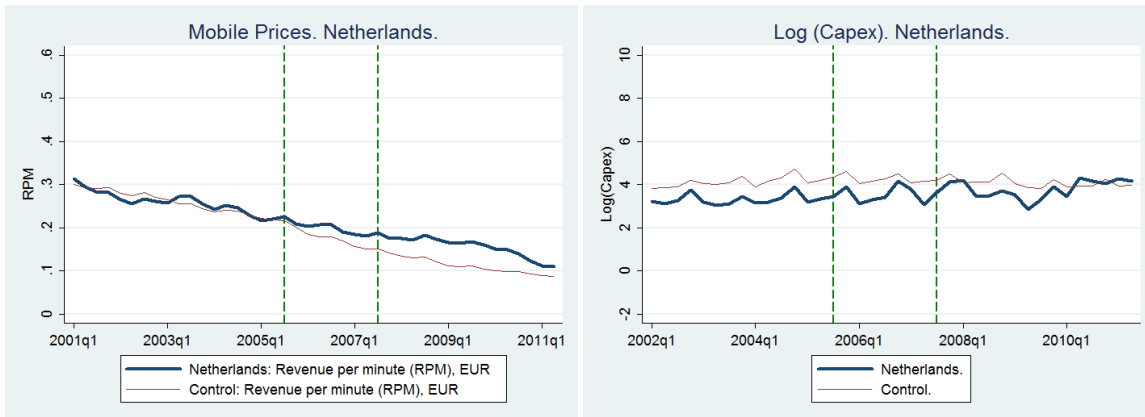
(b) Log(Capex).



(c) RPM residuals.

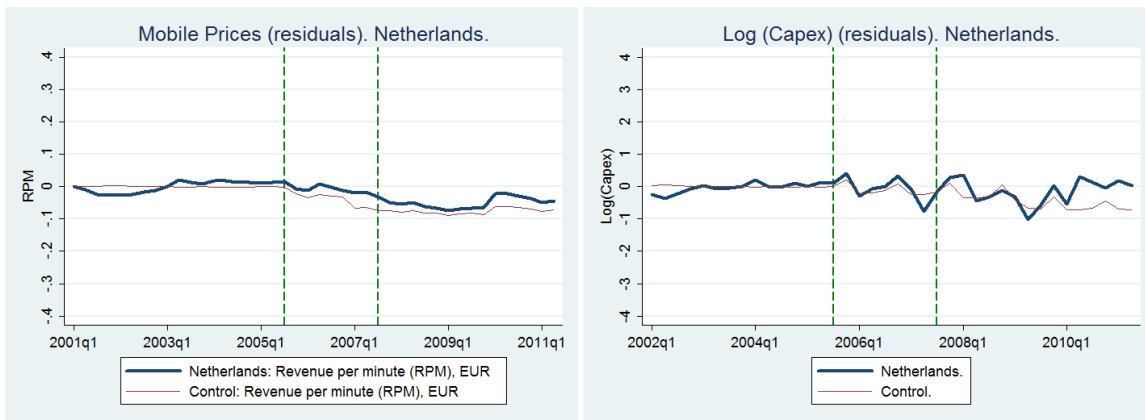
(d) Log(Capex) residuals.

Figure B7: Netherlands. Rivals.



(a) RPM.

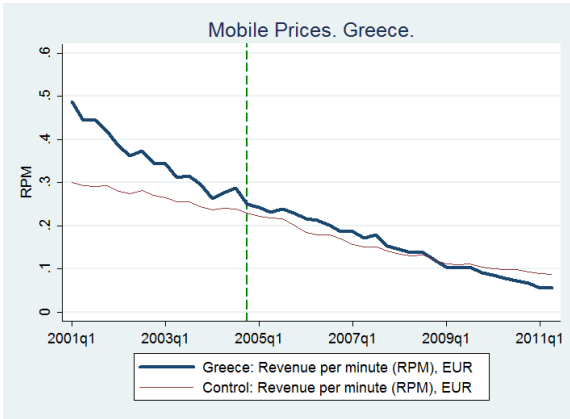
(b) Log(Capex).



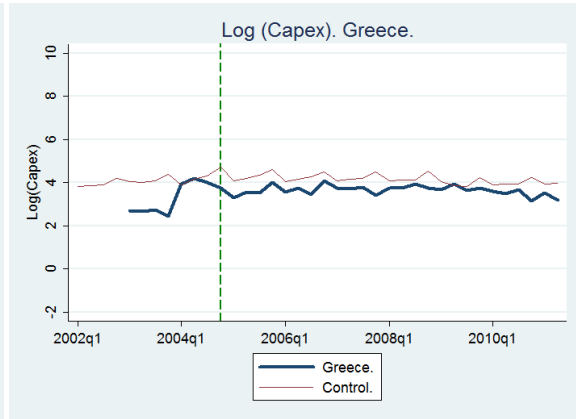
(c) RPM residuals.

(d) Log(Capex) residuals.

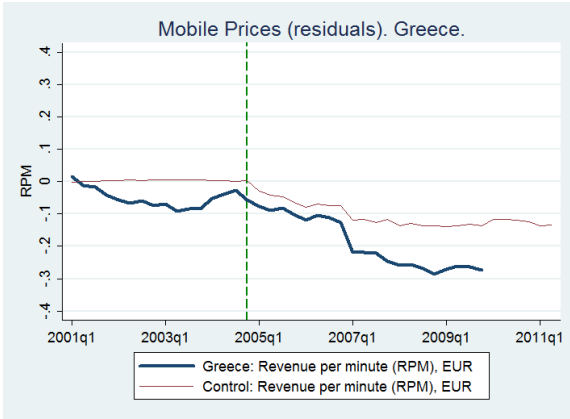
Figure B8: Greece. Rivals.



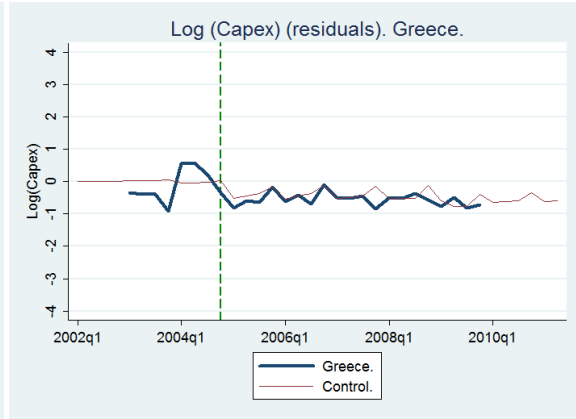
(a) RPM.



(b) Log(Capex).



(c) RPM residuals.



(d) Log(Capex) residuals.

C Short- and Long-term Effects

Table C1: Short- and Long-term Merger Effects.

	Merging		RPM		Rivals		Capex		Rivals	
	<i>coeff.</i>	<i>se</i>	<i>coeff.</i>	<i>se</i>	<i>coeff.</i>	<i>se</i>	<i>coeff.</i>	<i>se</i>	<i>coeff.</i>	<i>se</i>
<i>Austria</i>										
Merging/Rival	0.006	0.006	-0.061***	0.006	-0.297*	0.130	-0.333**	0.123		
Merging08/Rival08	0.012	0.007	-0.047***	0.006	-0.067	0.124	-0.392*	0.153		
Merging8+/Rival8+	0.001	0.006	-0.069***	0.005	-0.441**	0.165	-0.296*	0.132		
<i>Denmark</i>										
Merging/Rival	0.073***	0.012	0.060***	0.008	0.470***	0.130	0.310**	0.103		
Merging08/Rival08	0.030**	0.012	0.032***	0.009	0.001	0.217	-0.055	0.167		
Merging8+/Rival8+	0.091***	0.010	0.075***	0.008	0.676***	0.109	0.530***	0.088		
<i>Netherlands</i>										
Merging/Rival	-0.004	0.005	0.026***	0.006	0.275*	0.122	0.294*	0.123		
Merging08/Rival08	-0.004	0.006	0.025***	0.006	-0.030	0.135	0.145	0.126		
Merging8+/Rival8+	-0.004	0.005	0.027***	0.006	0.445***	0.107	0.381**	0.146		
<i>Netherlands2</i>										
Merging/Rival	-0.002	0.005	0.001	0.006	0.373*	0.176	0.293*	0.146		
Merging08/Rival08	-0.004	0.005	0.003	0.006	0.307	0.238	-0.048	0.168		
Merging8+/Rival8+	-0.000	0.005	-0.002	0.007	0.445*	0.201	0.543***	0.153		
<i>Greece</i>										
Merging/Rival	-0.109***	0.017	-0.119***	0.018	-0.027	0.263	-0.169	0.175		
Merging08/Rival08	-0.091***	0.017	-0.101***	0.018	-0.078	0.282	-0.168	0.211		
Merging8+/Rival8+	-0.121***	0.017	-0.132***	0.019	0.008	0.272	-0.170	0.177		

Merging/Rival represents the treatment dummy: it equals 1 in the post-merger period for the merging firm in the left panel and for rival firms in the right panel. *Merging08/Rival08* and *Merging8+/Rival8+* are analogous, except that they equal 1 only in the first 8 quarters after the merger and only after the first 8 quarters after the merger, correspondingly.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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