Lee, Jongyong; Lee, Duk Hee

Conference Paper

Asymmetry of mobile termination rates and the waterbed effect

23rd European Regional Conference of the International Telecommunication Society, Vienna, Austria, 1-4 July 2012

Provided in Cooperation with:
International Telecommunications Society (ITS)

Suggested Citation: Lee, Jongyong; Lee, Duk Hee (2012) : Asymmetry of mobile termination rates and the waterbed effect, 23rd European Regional Conference of the International Telecommunication Society, Vienna, Austria, 1-4 July 2012

This Version is available at:
http://hdl.handle.net/10419/60353

23rd European Regional ITS Conference
Vienna, Austria, 1-4 July 2012

Asymmetry of Mobile Termination Rates and the Waterbed Effect

Jongyong Lee and Duk Hee Lee

Abstract

This paper empirically analyzes the relationship between asymmetric regulation on mobile termination rates and mobile retail prices, using panel data collected from 20 OECD member countries for 22 quarters. In addition to the asymmetry of mobile access charges, the authors also focus on the impact of a number of variables, such as churn rates, mobile penetration rates, and the market concentration index on mobile operators' retail prices. The results reveal that pricing asymmetry in access services has a positive correlation with mobile retail prices. Therefore, this study supports the assumption that the waterbed effect between the asymmetry of mobile termination rates and retail prices may occur.

JEL Classifications: L51, L88, L96

Keywords: Mobile termination rates, Waterbed effect, Asymmetry of MTRs, Mobile retail Rates, Panel data techniques,

Authors' affiliation: Jongyong Lee*, Senior Researcher, Technology Strategy Research Division, Electronics and Telecommunications Research Institute (ETRI), 218 Gajeong-ro, Yuseong-gu, Daejeon, 305-700, Korea
Duk Hee Lee, Professor, Department of Management Science, Korea Advanced Institute of Science and Technology (KAIST), 335 Gwahak-ro, Yuseong-gu, Daejeon, 305-701, Korea

*Corresponding author: jongyl@etri.re.kr

1. Introduction

To complete telecommunications services between two different networks, interconnection is required. When a call is connected between subscribers of two different networks, the operator of the receiver network usually levies termination rates on the operator of the caller network, as payment for the interconnection. In the mobile service industry, these termination rates constitute a significant element in mobile operators' profits. For example, in the UK, the annual revenue from mobile termination rates (henceforth MTRs) is equivalent to approximately 15% of the total revenue of the mobile industry (Ofcom, 2007).

Recently, regulators have been increasing efforts to cut these rates because mobile operators have an incentive to set high MTRs that will extract the largest possible surplus from fixed users (Genakos and Valletti; henceforth GV, 2011). However, a decrease in MTRs may bring about a change in mobile retail prices; reducing rates could cause retail prices for mobile subscribers to rise. This unexpected result is called the "waterbed effect". The waterbed effect represents a trade-off relationship between wholesale prices and retail prices in relation to two-sided markets (Schiff, 2008). This is relevant to the incentive of mobile providers to recover some costs incurred by providing mobile termination services by restructuring their tariff strategy. It is uncertain whether the waterbed effect is likely to be complete or incomplete in the mobile market. If MTRs are set below the level of costs, under the waterbed effect mobile operators may earn sufficient revenues to cover their costs by setting higher mobile retail prices.

There are conflicting views about the waterbed effect. One side suggests that a decrease in MTRs can induce enhanced consumer welfare by lowering mobile retail prices, because that there is no evidence of the waterbed effect. The other side argues that a partial or perfect waterbed effect may exist in the mobile market, so that reductions in MTRs may not necessarily mean decreases in mobile retail prices.

Interestingly, the waterbed effect between MTRs and retail prices may also occur when MTRs are asymmetric. We define asymmetry as the difference in MTRs across operators within the same country, due to differences in regulation (Lee, et al., 2010). Asymmetric regulation on MTRs is principally to reduce the gap in per-unit costs between incumbents and new entrants to the service, resulting from uneven spectrum assignments and differences in the number of subscribers. However, as most mobile markets around the world are entering the phase of maturity, both cost-related and non-cost-related factors that serve as the rationales for asymmetric regulation of access prices are being eroded. It is not appropriate to keep strong asymmetric regulation in the saturated mobile markets as in the beginning or growing stages. Whilst actively acknowledging recent changes in the mobile market and trying to reflect them, most European regulators

have already curtailed asymmetric pricing schemes designed to reflect only objective cost differences. [1] Additionally, countries currently with partly symmetric or asymmetric rates have announced plans for a date by which symmetry will be achieved (BEREC, 2010; Cullen International; henceforth CI, 2011). In Korea, as explained later in this paper, asymmetric regulation of MTRs is also being gradually reduced over time and full symmetry will be adopted in 2013 (KCC, 2010).

However, the effectiveness of asymmetric regulation of mobile access pricing is associated with the correlation between an indicator representing asymmetry of MTRs induced by regulation and retail prices to mobile customers. If they move in the same direction because the correlation is positive, this means that a waterbed effect may exist between them and relaxation of asymmetric regulation of MTRs could promote consumer welfare by lowering mobile retail rates. The indicator means the intensity of the asymmetric regulation imposed on operators within countries leading to differences in MTRs. In practice, in most countries, MTRs of the incumbents are strongly regulated but those of the new entrants are unregulated or only mildly regulated.

This paper empirically investigates the waterbed effect between asymmetric regulation on MTRs and mobile retail prices, using panel data collected from 20 OECD member countries for 22 quarters between 2002Q3 and 2007Q4. The authors also evaluate the impact of other factors, such as churn rates, mobile penetration rates, and the market concentration index on mobile operators' retail prices. MTRs asymmetry is measured using the index introduced by GV (2011) that assesses differences between the maximum MTRs charged by an operator and all the other MTRs charged within the same country. To address the endogeneity of MTRs asymmetry variable, an estimation strategy using instrumental variables is employed in the fixed effect regression. Based on the results we examine whether the waterbed phenomenon exists with respect to asymmetric MTRs and measure its economic significance compared with those provided in the existing literature. Therefore, our results give implications on evaluating the effectiveness of asymmetric regulation of MTRs.

The article is organized as follows: The next section provides a brief overview of the related literature about waterbed effects. For convenience, the literature has two categories: waterbed effects between MTRs and retail prices, and those between asymmetry of MTRs and retail prices. The subsequent sections describe the econometric model and the method of analysis, and present empirical results and their discussions. The last section provides brief conclusions.

[1] For example, Austria, the Czech Republic, Denmark, Estonia, Greece, Hungary, Lithuania, Malta, the Netherlands, Portugal, Sweden, and the UK have adopted fully symmetric MTRs, i.e., all mobile operators charge the same rate.

2. Literature review

2.1 Waterbed effects between MTRs and retail prices

Several studies point out that as a waterbed effect is theoretically present in many situations, a reduction in MTRs results in an increase in mobile retail prices. Laffont et al. (1998) argued that perfect waterbed effects exist because of profit neutrality. This means that profits of mobile operators are independent of MTRs. Gans and King (2001) and Carter and Wright (2003) showed that welfare-maximizing MTRs are above the cost of termination in the presence of access externalities, and that a reduction in MTRs results in lowering competition between mobile networks. This creates a situation where subscribers prefer small rather than large networks, because on-net calls become more expensive than off-net calls. Ordover (2009) emphasized that waterbed effects may rely on whether network externalities are more significant than call externalities. This means that a waterbed effect is likely to be strong if the former are relatively larger than the latter, because mobile operators may increase the subscription fees in response to reductions in MTRs. Hausman (2004) strongly supported the generation of a waterbed effect in both monopoly and competition markets, where retail mobile services are offered as a bundle of complementary products. This is based on the idea that in response to a regulated decrease in MTRs, mobile operators aiming to maximize profits, will increase mobile subscription rates. Based on economic theory and empirical evidence, Ofcom (2007) and Frontier Economics (2008) argued that partial or perfect waterbed effects exist in the mobile market, so that reductions in MTRs may not necessarily mean decreases in mobile retail prices.

Most importantly, Schiff's (2008) broad survey highlighted many situations that waterbed effects can generate. According to Schiff, a waterbed effect is a natural outcome of profit-maximizing behavior by a multiproduct firm in network industries, and by a firm in two-sided markets exhibiting both cost and demand interdependence. Through analytical models of competition between networks, Armstrong and Wright (2009) showed that a waterbed effect exists in fixed-to-mobile (FTM) terminations, and whether it is complete or partial depends on market expansion possibilities. Thus, a reduction in FTM termination charges may lead to an increase in subscription charges to mobile subscribers and smaller handset subsidies. However, they explained that high mobile-to-mobile (MTM) termination charges act principally as a means to transfer benefits from mobile networks to their subscribers, due to the positive network effects resulting from price discrimination between on-net and off-net calls. Considering demand heterogeneity in mobile services, Jullien et al. (2010) showed that a partial waterbed effect could occur in MTM calls because the welfare-maximizing MTM termination rates are above cost.

However, some empirical studies have argued that a waterbed effect exists when MTRs are reduced by a regulation requirement. Using panel data for Western European mobile operators, Andersson and Hansen (2009) empirically examined the profit neutrality hypothesis raised in Laffont et al. (1998). They found that there is no difference in mobile operators' profit before and after regulation of MTRs, which indicates that a full waterbed effect exists. The work of GV (2011) was further empirical evidence that supported waterbed effects. In a study estimating how a change in MTRs affects both retail prices and profits, they reported that when access prices are lowered by regulatory actions, retail prices paid by consumers rise on average by about 10%. GV (2010) additionally showed that the waterbed effect affects all mobile subscribers, but its strength depends on the type of tariffs chosen by the mobile subscribers. In particular, the waterbed effect of postpaid subscription contracts is stronger than that of customers with prepaid contracts. This means that postpaid contracts strongly and more quickly respond to MTR regulation.

In contrast to studies that advocate the presence of the waterbed effect, there are also several studies that deny its existence; stating that mobile retail prices would be lowered if MTRs were reduced to cost. Because there is no evidence of waterbed effects, the ACCC (2007) and the European Commission (2008) noted that a decrease in MTRs could induce enhanced consumer welfare by lowering mobile retail prices. This conclusion is supported by two rationales. First, from the theoretical aspect assuming perfect competition in the retail mobile market, rather than increasing retail prices for making calls in response to a regulated cut in MTRs, mobile operators would charge subscribers for receiving calls. Second, from the empirical aspect, evidence suggests that cuts in MTRs leads to lower costs to mobile operators to terminate traffic on other networks, which leads to lower retail call prices. Hurkens and Lopez (2010) stated that there is no waterbed effect at all in a duopoly, but that there is a partial waterbed effect in oligopolies with more than three firms, and socially optimal MTRs always equal costs. Harbord et al. (2010) stressed that welfare and consumer surpluses on mobile networks are a decreasing function of the level of MTRs when allowing for call externalities and a realistic number of networks (more than three).

A number of empirical studies support the arguments against the existence of waterbed effects. First, Veronese and Pesendorfer (2009) and Growitsch et al. (2010) considered the empirical correlation between MTRs and mobile retail prices. They used Merrill Lynch data of revenue per minute (RPM) as a proxy for retail prices. Based on the evidence that MTRs and retail mobile prices tend to move in the same direction, they proposed that a decrease in MTRs tends to result in a decrease in retail prices for mobile voice services. With the objection to arguments based on two-sided markets, Stork (2010) maintained that a waterbed effect does not automatically occur after a reduction in MTRs, and that a positive

correlation between termination rates and mobile retail prices has been found in the benchmarking case study. Using panel data analysis across 13 countries in Europe, Baraness et al. (2008) also showed that a waterbed effect is not applicable in Europe. They stated that a reduction of 1% in average MTRs would bring about a decrease of 0.18% in average service prices. Ultimately, they suggested that glide path regulation, aimed at gradually decreasing MTRs down to the level of costs, has improved the competitiveness of Europe's mobile markets.

2.2 Waterbed effects between asymmetric MTRs and retail prices

Maintaining asymmetric MTRs may be a useful policy for boosting the market position of new entrants when first-mover advantages, such as brand loyalty and calling club effects resulting from entry delay, significantly exist and these factors affect firms' performances in the mobile market (Benzoni et al, 2007; Cricelli et al., 2008; Geoffron and Wang, 2008).

However, asymmetric regulation on MTRs can encourage inefficient operators to enter the market by sending a wrong signal to new entrants (De Bijl and Peitz, 2002; Peitz, 2005). It can also destroy the incentive to cut costs among existing market participants and undermine consumer welfare when the resulting inefficiencies trickle into the downstream markets (Littlechild, 2003; Valletti, 2006). Additionally, asymmetric regulation of mobile access pricing, is an artificial intervention that interferes with the market mechanism, which can lead to regulatory failure, especially when there is no structural need that justifies such a policy, and could hinder the overall progress of access pricing regulation. Therefore, it is important for regulators to limit the use of asymmetric MTRs to cases in which the social benefits exceed the social costs resulting from the regulation. For example, asymmetry of MTRs could be phased out after four years from the date of entry of the new operator, because it takes three to four years for new entrants to reach a market share of 15% to 20% (European Commission; henceforth EC, 2009). It is also desirable to adopt different regulatory approaches for different stages of the market (Lee et al., 2010).

In contrast to the above discussion about waterbed effects between MTRs and retail prices, empirical studies that focus on the asymmetric regulation of MTRs are relatively rare in the literature. GV (2011) analyzed how asymmetric regulation on MTRs affects retail prices and the profit margins of operators, through an index of termination pricing asymmetry standing for the difference in MTRs between mobile operators. They confirmed the waterbed effect with respect to asymmetric MTRs. Meanwhile, Baraness et al. (2008) showed different predictions for how waterbed effects may work in terms of asymmetric regulation of MTRs. They directly reviewed the effects of asymmetric regulation of MTRs on retail prices, using an asymmetric regulation indicator, obtained from the difference in MTRs between the market players and their relative market shares.

However, their study assumed that new entrants' benefits from asymmetric regulation are proportional to their market performance. Based on the result that asymmetric regulation in Europe reduced the average service price by 0.31% to 0.82%, they proposed that asymmetric regulation in setting MTRs promotes market competition, through aggressive pricing strategy between differently sized mobile operators. Their subsequent study about the impact of asymmetric regulation on market performance at operator level (Baraness et al., 2011), also advocated an asymmetric regulation approach for entrants in terms of sustainable long-term completion objectives, through empirical results that asymmetric regulation might reduce incumbent profit by 0.57%, but also increase entrants' market shares by 0.47%.

Our study focuses on empirically examining whether the waterbed effect with respect to asymmetric MTRs exists and if so, measuring its economic significance. It is reasonable that regulators apply normally equal measures to all operators within the wholesale market for call termination, where all mobile operators irrespective of their size, may exercise significant market power. In certain exceptional cases, asymmetry of MTRs based on differences in dates of market entry and scale, can be permitted for the later entrant/smaller operator as part of an entry-assistance policy. However, long lasting higher post-entry profits with no specific sunset period, such as 4 years from the date of entry of the operator concerned, will attract inefficient entry and are likely to raise prices for mobile customers. This is associated with the fact that such a policy not only may give a disincentive to the smaller operators to innovate and expand, but also that the incumbents will increase their off-net retail prices to compensate for the higher rates of off-net wholesale termination to the new entrants. That is, asymmetric MTRs will eventually be passed onto consumers of the originating operator, in the form of higher retail prices as unintended consequences of regulation.

In order to test the hypothesis that asymmetry in MTRs, induced by regulation, will increase the prices of mobile customers, this paper employs the idea of GV (2011) about the index of asymmetry and similar data sources. This study will be instrumental in the literature as an interesting extension in terms of the following points. First, in addition to the asymmetry index, we consider other factors, such as mobile penetration situation, subscriber churn rates, and market concentration index that affect retail prices in different econometric models. Second, our dataset with more quarters covers different countries. Third, we provide an economic magnitude of the waterbed phenomenon identified so that the reader can compare our results with the ones of previous research. Fourth, this study explicitly offers policy implications towards asymmetric regulation on MTRs through the waterbed effect resulting from asymmetric MTRs.

3. Methodology and data

3.1 Empirical model

Generally, MTRs in the mobile market are regulated in most countries. However, details of regulatory schemes in place for setting MTRs vary from country to country. Access pricing regimes differ depending on the country, in terms of both regulatory stringency and actual prices authorized. However, the asymmetry in termination charges tends to be greater in countries where there is a marked disparity between incumbents and new entrants in terms of firm size and market power. Although monopoly bottleneck is a phenomenon not necessarily correlated to the size of the operation, in practice, regulators tend to be more lenient towards new entrants concerning termination charges. In other words, the general regulatory stance towards new entrants in a mobile market has been explicitly asymmetric in most countries, and regulators have either allowed providers to set their termination charges significantly higher than corresponding prices charged to incumbents, or have overlooked such behavior, under the rationale that this will help boost their market position.

For this reason, the highest termination rate charged in a given period is a good indicator of the extent to which mobile telecom regulation in a country favors new entrants. In a study on regulatory intervention in MTRs, GV (2011) proposed an index of termination pricing asymmetry, to determine how such asymmetric regulation affects retail prices and profit margins of the operators. In the present study, drawing on the methods used in previous studies on asymmetric regulation of mobile access charges, we express the disparity in MTRs resulting from asymmetric regulation in the following index form:

$$Asymmetric\ \ MTRindex_{jct} = \begin{cases} 0, \text{ if MTR}_{jct} \text{ is not regulated} \\ \dfrac{MaxMTR_{ct} - MTR_{jct}}{MTR_{jct}}, \text{ if MTR}_{jct} \text{ is regulated} \end{cases} \quad (1)$$

In equation (1), MTR_{jct} is the mobile access rate charged by firm j of country c during quarter t, $MaxMTR_{ct}$ is the highest access rate charged in country c during quarter t, and $AsymmetricMTRindex_{jct}$ is the asymmetry index of firm j of country c during quarter t. The asymmetry index receives the value of 0 if there was no regulation on access charges during a given period. The value of the asymmetry index depends on the degree of regulation to which an operator is subjected; the smaller the access charge differential, the smaller the value of the asymmetry index, and similarly, the greater the access charge differential, the

greater the value of the asymmetry index. If, for instance, the value of the asymmetry index is 1, then the maximum ratio between the highest and lowest access charges is 2:1. The asymmetry index is likely to have a value between 0 and 1, as a situation in which its value exceeds 1 is rather unlikely.

By using the asymmetry index as an independent variable in a regression equation in which retail prices are set as dependent variables, we can determine the effect of asymmetric regulation on retail prices. However, the asymmetry index is not the only factor influencing retail mobile prices. Several factors related to regulation, subscribers, marketing, and competition may become additional independent variables concerned with mobile retail prices. Table 1 lists those factors considered independent variables.

Table 1 Factors influencing retail mobile prices

Regulatory Factors	Existence of regulation on MTRs*; degree of asymmetric regulation among mobile operators*; level of MTRs; existence of wholesale market regulation; type of arrangement for paying mobile retail rates (calling party pays or receiving party pays)
Subscriber Factors	Number of mobile subscribers; *rate of mobile penetration; subscription types (prepaid or postpaid)*
Marketing Factors	Existence of handset subsidy regulation; on-net call discount rate; *subscriber churn rate*; number of subscribers using mobile number portability
Competition Factors	Situation of spectrum allocation; number of competing carriers; number of mobile virtual network operators (MVNOs); *market concentration index (HHI)*; market shares of the largest and second largest operators

Note: Factors reflected in our estimation model are in italics

However, the actual number of independent variables that can be used for empirical analysis is limited, because this depends on the availability of data as well as the degree of their correlation with the other independent variables. For instance, the number of carriers might have some explanatory effect on prices, but in this study, it showed a high correlation with the market concentration index, known as the Herfindahl–Hirschman Index (HHI), and the Pearson correlation coefficient between them was –0.82. Hence, we chose: the asymmetry index, HHI, national mobile penetration rate, churn rate, and the dummy variable of a prepaid contract, as the independent variables influencing the dependent variables, and

entered them into a regression equation. The model for the estimation is expressed as follows:

$$\ln P_{ujct} = \beta_0 + \alpha_{ujc} + \beta_1 Asymmetric\ MTRindex_{jct} + \beta_2 \ln(HHI)_{ct} + \beta_3 \ln(Penetratio\ n)_{ct} + \beta_4 \ln(Churn)_{jct} + \beta_5 Prepaid_{ujct} + \varepsilon_{ujct} \quad (2)$$

In model (2), the dependent variable $\ln P_{ujct}$ is the natural log value of the mobile retail price paid by the customers of operator *j* of country *c* during quarter *t*. The right-hand side of equation (2) is the $AsymmetricMTRindex_{jct}$ described in model (1), and is the asymmetry index of operator *j* of country *c* during quarter *t*. In addition, $\ln(HHI)_{ct}$ and $\ln(Penetration)_{ct}$ are the natural log values of the market concentration index of country *c* during quarter *t*, and the mobile penetration rate of country *c* during quarter *t*, respectively. The term $\ln(Churn)_{jct}$ is the natural log value of the churn rate at operator *j* of country *c* during quarter *t*. Finally, $Prepaid_{ujct}$, allowing for a distinction between prepaid deals and monthly postpaid contracts, is the dummy variable indicating whether a deal for end users of operator *j* of country *c* during quarter *t*, is a prepaid type or not. In model (2), with all other conditions being constant, if the sign of the asymmetry index, the main variable of interest, is positive, then the relationship between the asymmetry of regulation on MTRs and retail prices is complementary. In this case, weaker regulatory asymmetry leads to lower retail prices. In other words, a reduction in access charge differentials causes retail prices to decline, and results in the enhancement of consumer welfare.

3.2 Estimation methods

For estimation, this paper utilizes the pooled ordinary least squares (OLS) as a benchmark model for other estimation frameworks. We also perform a panel data analysis. One of the main advantages of panel data analysis is the ability to control errors in the estimation of time series or individual units. For this reason, panel analysis is more accurate than analysis of cross-section or time-series data. A regression equation frequently leaves out some variables, as not all relevant variables influencing dependent variables can be included. Thus, another advantage offered by panel analysis is the possibility to overcome the limitations associated with omitted variables.

The fixed effect model of this study assumes the existence of individual specific components not considered in the model, and offers proper methods to check for unobservable omitted variables affecting the difference in mobile retail prices in each country. In particular, the fixed effect model makes it possible to eliminate potential bias arising from time-invariant and unobserved heterogeneity using panel data. Generally, in the panel data analysis, there are two large

categories according to the type of error term checking for omitted variables: fixed effects and random effects models. A popular method for determining which of the two models is better suited for a given analysis is the Hausman test.

Asymmetric regulation on MTRs would be endogenous as it responds to market conditions. For example, regulators who perceive competition as intense and on a level playing field, tend to opt for symmetric access prices. Both the pooled OLS and the fixed effect model are unable to provide consistent estimators as they ignore the endogeneity of the variables, which is one of the major problems in the empirical analysis. To address this endogeneity problem, we perform the fixed effects two-stage least squares (FE-2SLS) using instrumentation. For instrumental variables estimation, the order condition that the number of excluded instruments is at least as great as the number of endogenous variables should be satisfied. Instrument validity is satisfied through the goodness-of-fit of the first stage regressions relating each endogenous regressor to the entire set of instruments, in case there are as many excluded instruments as endogenous regressors. Generally, the informal "rule-of-thumb" diagnostics, such as $F > 10$ can be used to evaluate critically the strength of instruments (Baum, 2007). In our FE-2SLS regression, we set an asymmetric MTR index as an endogenous regressor, and chose a dummy variable indicating whether the MTRs are asymmetrically regulated in each country as excluded instrumental variables. Considering the above-mentioned issues, equation (2) is estimated by the models listed as follows:

Model 1: Pooled OLS model
Model 2: Fixed effect model of ordinary panel data analysis
Model 3: Instrumental variables fixed-effects estimation.

3.3 Data for estimation

We used datasets from 20 OECD member countries, whose data on MTRs were available for 22 quarters, namely from the 3rd quarter of 2002 to the 4th quarter of 2007.[2] We consulted documents and reports from various organizations, directly or indirectly relevant to this study's goal of determining the effects of asymmetric regulation of MTRs on retail prices. For the data on MTRs, we used the quarterly MTRs statistics published by Ovum (2008). For mobile retail tariffs, we used the OECD telecom basket data, published by Teligen (2008), providing quarterly information on total mobile bills. We chose the lowest tariff packages

[2] The 20 OECD countries considered in this study were Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Korea, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland and the UK. The total number of observations used in the analysis was 1,516, excluding missing observations.

for all three types of users (high, medium or low volume).[3] For the years in which MTRs were regulated in each country, we followed the regulation chronology for MTRs of GV (2011). Finally, information on mobile penetration rates, subscriber churn rates, and market concentration index was taken from data published by Merrill Lynch (2005, 2008). Data expressed in national currencies were converted into a single currency using the OECD purchasing power parities (PPPs), to facilitate cross-country comparisons. Finally, the descriptive statistics of the variables considered in this study, and information on their correlations are provided in Tables 2 and 3, respectively.

[3] As mentioned in GV (2010; 2011), it is worth noting that the Teligen data only provide information on total mobile bills for the two biggest operators covering 80 percent of the each national market on average and facing similar regulation environments. This means our specific hypothesis about the waterbed effect may be restricted to incumbents' responses to MTR asymmetry with no tariff information related to other mobile operators.

Table 2 Summary statistics

	Mean	Standard Deviation	Quartiles		
			.25	Med.	.75
lnP (Natural log value of the retail price)					
	5.8730	0.6016	5.4546	5.9201	6.3285
MTRID (Asymmetry index of regulation on MTRs)					
	0.1674	0.1895	0.0080	0.1273	0.2285
lnCHU (Natural log value of the churn rate)					
	0.5424	0.3480	0.3364	0.5877	0.7884
lnHHI (Natural log value of the market concentration index)					
	8.1732	0.1715	8.0865	8.1867	8.2611
lnPEN (Natural log value of the mobile penetration rate)					
	4.5739	0.1993	4.4491	4.6001	4.7050

Table 3 Correlation coefficients among variables

Variable	lnP	Asy	MTRID	lnCHU	lnHHI	lnPEN
Asy	0.1665 (0.0000)					
MTRID	0.1858 (0.0000)	0.3386 (0.0000)				
lnCHU	-0.0921 (0.0000)	-0.0210 (0.4139)	-0.1865 (0.0000)			
lnHHI	-0.0212 (0.4084)	0.0435 (0.0906)	0.1363 (0.0000)	-0.1685 (0.0000)		
lnPEN	-0.1302 (0.0001)	-0.0514 (0.0453)	-0.0452 (0.0783)	-0.0687 (0.0074)	-0.2098 (0.0000)	
Pre	-0.3142 (0.0001)	-0.1900 (0.0000)	-0.1912 (0.0000)	0.0099 (0.7002)	-0.1174 (0.0000)	0.0456 (0.0761)

Notes: Asy and Pre are the dummy variable indicating MTRs are asymmetrically regulated and prepaid contracts, respectively. The significance levels of the coefficients of correlation (p-value) are in parenthesis.

4. Estimation results and discussion

4.1 Empirical results

Table 4 lists the results of the pooled OLS and fixed effect model, the instrumental variable estimation employed in the fixed effects regression.[4]

Table 4 Results of estimation using panel data

Independent variable	Model 1: Pooled OLS		Model 2: Fixed effect		Model 3: Fixed effect IV	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
MTRID	0.383**	0.176	0.125	0.098	0.898****	0.214
lnCHU	-0.165	0.132	0.132***	0.039	0.142***	0.048
lnHHI	-0.416*	0.214	-0.084***	0.268	-0.804**	0.329
lnPEN	-0.431**	0.166	-1.310***	0.15	-1.341***	0.165
Pre	0.367***	0.071	-0.111***	0.029	-0.095***	0.032
No. of Observations	1516		1516		1516	
Clusters	100		100		100	
Within-R^2	0.145		0.42		0.228	
F-test (pooled OLS vs. FE)	–		F(5, 99) = 120.53 [0.000]		–	
Hausman test (FE vs. RE)	–		χ^2 (5)=43.45 [0.000]		–	
Hausman test (FE vs. FE-2SLS)	–		–		χ^2 (2)=64.42 [0.000]	
1st stage Coef.	–		–		0.304***	0.05
1st stage R^2	–		–		0.166	
1st stage F-tests	–		–		F(1, 99) = 36.3 [0.000]	

Notes: MTRID indicates the asymmetry index; lnCHU is the natural log value of the churn rate; lnHHI is the natural log value of the market concentration index; lnPEN is the natural log value of the mobile penetration rate; Pre is the dummy variable for prepaid contracts. Standard errors adjusted for heteroskedasticity and clustered by country-operator-usage. P-values for diagnostic tests are reported in brackets. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively.

[4] STATA 9.2 was used for the estimation in this study.

The F-test for selecting the pooled OLS or fixed effects, and the Hausman test for choosing the fixed or random effect models, yielded that the fixed effect estimator is consistent. However, the fixed effect instrumental estimation is finally selected through the Hausman test, which resulted in the rejection of the null hypothesis, stating that there is no correlation between the endogenous variable and the error term at the 1% level of significance. The first-stage F-test of our IV model with F-statistic 36.3 at the 1% level of significance implies the excluded instrument is not weak.

As Table 4 shows, the churn rate and retail prices had an insignificant substitute relationship in both the pooled OLS, whereas in the fixed effect and IV models, they proved to have a positive correlation at the 1% level of significance. This may be because while most mobile users may change their subscription to mobile operators providing better tariffs with the aim of reducing their retail bills, some customers tend to change mobile providers frequently, in order to upgrade their handset from an outdated model to a newer one. The introduction of mobile number portability allowing end users to change their mobile operators whilst keeping the same phone number, certainly makes this explanation all the more realistic.

Meanwhile, the results of the fixed effect and IV model showed that contrary to expectations, the market concentration index representing HHI and retail prices, had a negative correlation at the 1% level of significance over the period considered, as shown in Table 4. This result comes from the difference in the trend of the two variables. While retail prices were consistently in decline during the period studied, the market concentration index decreased in some countries, but was either constant or increased in others. In particular, in Austria, Denmark, Greece and the Netherlands HHI appeared to increase, whereas the number of mobile operators decreased because of mergers and acquisitions (M&A).[5] Thus, this observed outcome implies that, following entry, the mobile telephony market equalizes in terms of market share, but that retail prices will certainly not decline, because mobile operators have strong incentives to engage in tacit collusion with each other for the purpose of avoiding price competition and sustaining high prices (Busse, 2000; Parker and Roller, 1997). The results further revealed that the rate of mobile penetration had a substitute relationship with the retail price at the 1% level of significance, which may be interpreted as indicating that the higher the rate of mobile penetration, the lower the mobile retail prices. The elasticity obtained from the IV estimation is calculated to be -1.341. According to this result, all other things being constant, a 1% increase in the mobile penetration rate lowers the mobile retail prices by 1.341%. In addition, the correlation between prepaid contracts and mobile retail prices in this study

[5] For the trends of HHI, retail mobile prices, and the number of mobile operators across countries over the period considered, see Figures 1 and 2, and Table 6 in the Appendix.

proved to be negative. Generally, prepaid subscribers are very sensitive to prices due to their budget constraints. They may also prefer to receive calls than to make calls under the calling party pays (CPP) system. Therefore, it is possible that a greater number of consumers choosing prepaid services will lead to lower mobile retail prices.

The central question in this study was regarding the waterbed effect between asymmetry of MTR and retail prices. In the pooled OLS and IV estimation models, government-imposed disparities in MTRs had a significant waterbed effect on retail prices. Over the period considered, asymmetric regulation on MTRs has affected an asymmetric indicator by 30% and at the same time, has increased mobile bills to end users by $0.30 \times 0.898 = 26.9\%$. While countries with higher retail prices have more incumbents and fewer entrants, causing regulators to set larger asymmetries, this approach is inconsistent with our assumption that the asymmetry index of MTRs is an explanatory variable affecting the dependent variable in the model. Thus, we interpret the positive correlation between the asymmetry of regulation on MTRs and mobile retail prices, as meaning that the smaller the access pricing disparity, the greater the decline in retail prices.

Table 5 Comparing the effectiveness of asymmetric regulation on MTRs

	Models	Elasticity	Dependent variable	Impacts of asymmetry of MTRs	Samples
GV (2011)	OLS	0.29	Total mobile bills	↑	24 OECD countries for 2002Q3-2006Q1
	IV	0.93			
Baraness et al. (2008)	FE	0.31	National average prices of mobile services	↓	13 Western Europe countries for 2002-2007
	FE IV	0.82			
Baraness et al. (2011)	GMM	0.47	Market shares of entrants	↑	44 European MNOs for 2002-2007
This study	OLS	0.38	Total mobile bills	↑	20 OECD countries for 2002Q3-2007Q4
	FE IV	0.89			

Table 5 summarizes the impacts of asymmetry of MTRs obtained from this study, and the ones provided in previous studies. Baraness et al. (2008; 2011) have objected to the waterbed effect resulting from asymmetric regulation, as average service prices of end users may decrease and market shares of entrants may increase by 0.82% and 0.47%, respectively, in response to a percentage increase in the entrant asymmetric regulation indicator. In contrast, our study

confirms the empirical evidence of the waterbed phenomenon, as shown in GV (2011), which under a wide set of conditions a reduction in the termination rates by regulators will induce an increase in the mobile retail prices. Particularly, this study emphasizes that the waterbed effect would exist with respect to asymmetric MTRs by regulators. The elasticity of the waterbed phenomenon in this study indicates 0.89, which is similar to that by GV (2011). This implies that if the government adopts a symmetric MTR system designed to calculate a representative mobile access price, based on an efficient mobile operator, and unilaterally applies it to all mobile operators in a certain situation, this system will increase consumer welfare benefits by lowering retail mobile prices.

4.2 Discussion

The results derived in this study provide economic evidence supporting the view that asymmetric regulation on MTRs will gradually disappear, and that this may have a positive impact on mobile prices. In practice, the asymmetric regulation on MTRs in Europe will decrease rapidly, or end by 2013 or 2014, in accordance with the recommendation requiring MTRs to be set symmetrically. In addition, higher MTRs for new mobile network operators (MNOs) and MVNOs, may be justifiable for up to 4 years from their market entrance, only if they are facing real higher costs (EC, 2008).

Table 6 Policy approach to asymmetry of MTRs across the Europe

Countries using symmetry of MTRs		Undecided countries
	Latvia(February 2012)	
Sweden(2004)	Rumania(March 2012)	
Estonia(November 2007)	Norway(January 2013)	
Austria(July 2008)	Croatia(January 2013)	
Bulgaria(January 2009)	Cyprus(January 2013)	
Greece(January 2009)	Slovenia(January 2013)	Luxembourg
Hungary(January 2009)	Belgium(January 2013)	Germany
Lithuania(January 2009)	Spain(July 2013)	Ireland
Portugal(October 2009)	Italy(July 2013)	Macedonia
The Netherlands(September 2010)	France(January 2014)	
The UK(April 2011)	Czech and Malta (The	
Slovakia(May 2011)	specific point is unknown but	
Denmark(January 2012)	full symmetry has already	
	been in use)	

Note: The point at which full symmetry was adopted or will be introduced is in parenthesis.
Source: CI (2011; 2012a), BEREC (2010)

Table 6 shows the status of asymmetric regulation on MTRs in Europe. For example, Belgium has proposed 89% lower MTRs than the current charge controls, with the introduction of symmetry for three mobile operators as of January 1, 2013 (BIPT, 2010). This is in line with the new approach of the EC. In addition, Ofcom also proposed a pioneering plan, by which the asymmetry regarding mobile access prices is to be complete by March 2011, and MTRs are to be decreased to 0.5 ppm by 2015 using the pure long run incremental cost (LRIC) model suggested by the EC (Ofcom, 2010). Norway and Slovenia have allowed asymmetry of MTRs to new entrants with a view to supporting their national coverage deployment by December 2012. Spain's proposal that all operators including Xfera, the fourth 3G license using Yoigo as its brand will reach full symmetry MTRs, 1.09 € cents per minute on July 1, 2013 was finally accepted by the EC (CMT, 2012). ARCEP, the French regulator, also published a plan to regulate the MTRs of the fourth 3G license: Free Mobile, and two MVNOs, LycaMobile and Omea, and allow these three operators to charge asymmetric MTRs until the end of 2013. While ARCEP mentioned that higher MTRs for these three new entrants reflected the increased costs incurred from their access to established operators, and from the traffic imbalances that handicap them, the EC has cast serious doubt about its market analysis (CI, 2012b). Meanwhile, among the countries where the official approach about symmetry is not yet decided, Luxembourg has allowed asymmetry of MTRs between the two largest operators and the third operator, but the symmetry approach in accordance with the recommendation of MTRs will be taken into consideration at its next market review about mobile termination (EC, 2011). In addition, symmetry will be introduced as a principle in Germany where MTRs of each operator have been separately set.

The argument about full symmetry is still ongoing in Korea where MTRs are calculated every two years (Korea IT News, 2012). With MTRs between 2010 and 2011 being determined, KCC, the regulator, has already published a plan to introduce symmetry in 2013. However, citing that the gap of market share between the biggest operator and the third largest mobile operator in Korea is much larger than that of other countries, LG U+ claimed that asymmetric MTRs should be maintained to enhance competition in the mobile market. According to LG U+, the gap in market share between the first and third providers in Korea and Europe are 32.7% and 25.7%, respectively. SKT strongly objects to asymmetry. Given that KCC will announce MTRs between 2012 and 2013 in the second half of the year, the following points are worthy of consideration. First, if the government reviews the issue that has already been decided in 2010, policy consistency can be undermined. Second, judging from the recommendation of the EC about MTRs, there is no reasonable evidence because LG U+ entered into the mobile market about 15 years ago, and had about 8 million subscribers amounting

to 18% of market share as of 2011. Third, in lieu of asymmetry, enlarging competition in the mobile retail market through licensing new entrants and promoting the success of MVNOs is required for the benefit of mobile customers.

While the argument in favor of asymmetric regulation of MTRs is slightly different from country to country, there are clear trends in phasing out asymmetry and moving into symmetry in MTRs at this moment. The empirical results of this paper imply that the persistence of higher MTRs after a period long enough for the later entrants to adapt to market conditions, may lead to unintended consequences involving inefficient entry and the negative impact on consumer welfare in the form of higher retail prices. This paper concurs with De Bijl and Peitz (2002), Valletti (2006) and the EC (2009) who suggest that an asymmetric intervention should be transitory. Asymmetric regulation policies aimed at creating an equitable competition environment may be undesirable in a situation where new entrants to a mobile market are able to acquire the minimum number of subscribers necessary to ensure the viability of their operations, and secure a stable source of revenue. Thus, additional markups on MTRs for new entrants could be allowed on a temporary basis, for example, during the early growth stage, but not when the market has reached a mature phase. Asymmetric regulation on MTRs is an effective strategy when consumer loyalty toward the incumbent's brand is high, and the degree of substitutability between services is rather low.

5. Conclusions

This study empirically assessed the effects of asymmetric regulation on MTRs on mobile retail rates. Using a panel model, we found that the asymmetry of mobile access prices and the retail price had a positive correlation. This suggests that the waterbed effect between asymmetry of MTRs and retail prices may occur, and that lessening access pricing asymmetry brings about reductions in retail prices, contributing to improvements in consumer welfare. This study provides empirical evidence to support the view that symmetric access rates are more beneficial than asymmetric rates to the interests of consumers in certain situations, and could be used as a reference for improving related regulations. This study draws attention to the fact that the principal goal of economic regulation is to counter monopoly power in the mobile termination market, when actual competition is either not feasible or not sufficiently strong, and it could encourage regulators to explore policy options that are more appropriate to this goal.

However, this paper identifies two aspects for consideration in further research. On the one hand, this study only considered asymmetries of MTRs between the first and the second mobile providers due to lack of available billing data. Greater detail of information on mobile retail bills is required to overcome the data

limitations. On the other hand, the decision on whether or not to adopt asymmetric regulation on MTRs depends on the specific market environment within a country at a given time. Therefore, it is necessary to have a more detailed discussion of the underlying heterogeneity between the countries included in the sample.

References

ACCC (2007), MTAS pricing principles determination 1 July 2007 to 31 December 2008, Final report, November.

Andersson, K. and Hansen, B. (2009), Network competition: Empirical evidence on mobile termination rates and profitability, SNF working paper.

Armstrong, M. and Wright, J. (2009), "Mobile call termination," *Economic Journal*, 119 (538), 270-307.

Baraness, E., Benzoni, L. and Vuong, C. H. (2008), Revisiting the waterbed effects across Europ's mobile markets, TERA Consultants, November.

Baraness, E., Benzoni, L. and Vuong, C. H. (2011), "How does European Termination rate regulation impact mobile operator performance?", *Intereconomics*, 46 (6), 346-353.

Baum, C. F. (2007), Instrumental variables estimation in Stata. Retrieved May 30, 2012 from http://www.wiwi.uni-frankfurt.de/Professoren/entorf/pdf/Topics_Graduate/StataIV.pdf

Benzoni, L., Basque, D., Dacquay, G. and Lagier, L. (2007), The "curse" of later entrants: Theoretical dynamics of non-catching up in a sequential entry market: The case of European mobile market, TERA Consultants, January 2007.

Belgian Institute for Postal services and Telecommunications (BIPT), 2010, Draft decision of the BIPT Council on the analysis of market 7 as listed in the European. Retrieved May 30, 2012 from http://www.bipt.be/ShowDoc.aspx?objectID=3221&lang=en

BEREC (2010), BEREC Action Plan to achieve conformity with ERG common position on symmetry of termination rates, BoR (10) 31.

Busse, M. (2000), "Multimarket contact and price coordination in the cellular telephone industry," *Journal of Economics and Management Strategy*, *9* (3), 287-320.

Cater, M. and Wright, J. (2003), "Asymmetric network interconnection," *Review of Industrial Organization*, 22 (1), 27-46

CMT (2012), La CMT adelanta nueve meses la bajada de precios mayoristas de terminación móvil. Retrieved May 30, 2012 from http://www.cmt.es/c/document_library/get_file?uuid=be9538c3-1266-4357-9ccf-c1411577e780&groupId=10138

Cricelli, L., Pillo, F. D., Gastaldi, M., and Ghiron, N. L. (2008), Mobile networks

competition and asymmetric regulation of termination charges in S. Raghavan, B. Golden, and E. Wasil, Eds., *Telecommunications Modeling, Policy, And Technology,* Springer, 123-152.

Cullen International (2011), Telecommunications: Western Europe, Cross-country analysis, September.

Cullen International (2012a), Telecommunications: Western Europe, Cross-country analysis, Table 17-Mobile termination rates-Glide paths, February 2012.

Cullen International (2012b), Big five update 139, March 29.

De Bijl, P. and Peitz, M (2002), *Regulation and entry into telecommunications markets*, Cambridge University Press.

European Commission (2008), Draft commission recommendation on the regulatory treatment of fixed and mobile termination rates in the EU.

European Commssion (2009), Explanatory note, Commission staff working document accompanying the commission recommendation on the regulatory treatment of fixed and mobile termination rates in the EU.

European Commission (2011), Report on telecom regulatory developments in Luxembourg. Retrieved May 30, 2012 from http://ec.europa.eu/information_society/digital-agenda/scoreboard/docs/regulatory/lu_reg_dev_2011.pdf.pdf

Frontier Economics (2008), Assessing the impact of lowering mobile termination rates, A report prepared for Deutsche Telekom, Orange, Telecom Italia, Telefornica, and Vodafone, July.

Genakos, C. and Valletti, T. (2010), Seesaw in the Air: Interconnection regulation and the structure of mobile tariffs.

Genakos, C. and Valletti, T. (2011), "Testing the "Waterbed" effect in Mobile Telephony," *Journal of the European Economic Association*, 9(6), 1114-1142.

Gans, J. S. and King, S. P. (2001), "Using "bill and keep" to interconnect agreements to soften network competition," *Economics Letters*, 71(3), 413-420.

Geoffron, P. and Wang, H. (2008), "What mobile termination regime for asymmetric firms with a calling club effect?" *International Journal of Management and Network Economics*, 1 (1), 58-79.

Growitsch, C., Marcus, J. S. and Wernick, C. (2010), The effects of lower mobile terminations rates (MTRs) on retail price and demand, A research project for the German BNetzA.

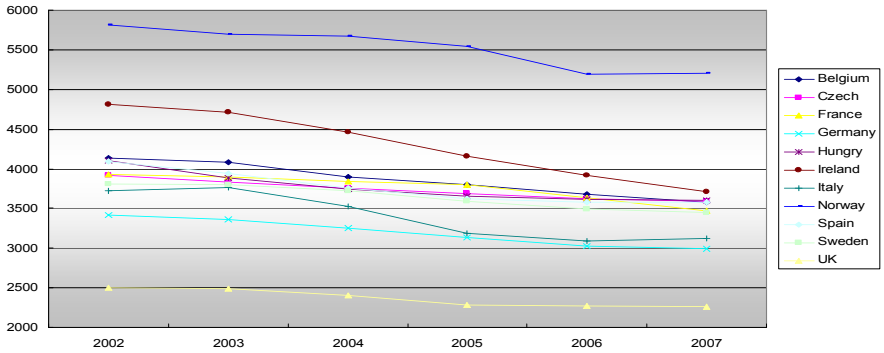
Harbord, D. and Hoering, S. (2010), Welfare analysis of regulating mobile termination rates in the UK (with an application to the Orange/T-mobile merger), Munich Personal RePEc Archive (MPRA), March.

Hausman, J. A. (2004), Economic analysis of regulation of CPP, MIT, November.

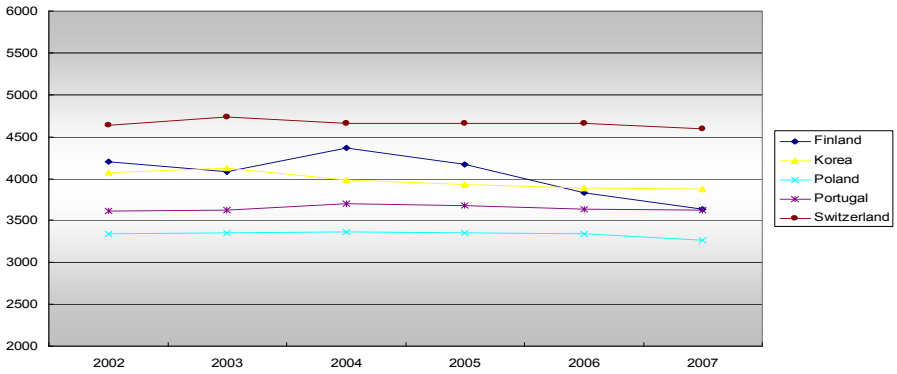
Hukrens, S. and Lopez, A. (2010), Mobile termination, network externalities, and

consumer expectations, IESE Business School, Working paper, WP-850, March.
Jullien, B., Rey, P., and Sand-Zantman, W. (2010), Mobile call termination revisited, IDECI, Working paper, 551, August.
KCC (2010), Determination of fixed and mobile telecommunication networks' interconnection charges in the year of 2010 and 2011, *Press releas*e (in Korean).
Korea IT News (2012), Single interconnection charges as the biggest issue at the next interconnection agreement (in Korean). Retrieved May 30, 2012 from http://www.etnews.com/news/telecom/public/2545066_2562.html
Laffont, J. J., Rey, P. and Tirole, J. (1998), "Network competition I: Overview and Nondiscriminatory pricing," *Rand Journal of Economics,* 29 (1), 1-37.
Lee, J. Y., Lee, D. H., and Jung, C. Y. (2010), "Asymmetric regulation of mobile access charges and consumer welfare with price regulation," *ETRI Journal*, *32* (3), June, 447-456.
Littlechild, S. (2003), Price controls on mobile termination charges, The Vodafone Policy Paper Series.
Merrill Lynch (2005), Global wireless matrix 4Q 05.
Merrill Lynch (2008), Global wireless matrix 4Q 07.
Ordover (2009), Recovering fixed and common costs for mobile networks in Europe, Compass Lexecon, August.
Ofcom (2007), Mobile call termination: Statement.
Ofcom (2010), Wholesale mobile voice call termination: Market review, The second consultation, April.
Ovum (2008), Historical mobile termination charge: Quarterly data.
Parker, P. M. and Roller, L. H. (1997), "Collusive conduct in duopolies: Multimarket contact and cross-ownership in the mobile telephone industry," *RAND Journal of Economics*, *28* (2), 304-322.
Peitz, M. (2005), "Asymmetric access price regulation in telecommunications," *Journal of Regulatory Economics*, *28*(3), 327-343.
Schiff, A. (2008), "The "waterbed" effect and price regulation," *Review of Network Economics*, 7(3), 392-414.
Stork, C. (2010), Mobile termination benchmarking: The case of Namibia, Towards Evidence-based ICIT Policy and Regulation, Research ICT Africa.
Teligen (2008), OECD Mobile basket based on revised OECD baskets of 2002.
Valletti, T. (2006), Asymmetric regulation of mobile termination rates, Working paper.
Veronese, B. and Pesendorfer, M. (2009), Wholesale termination regime, termination charge levels and mobile industry performance, A study undertaken for Ofcom, April.

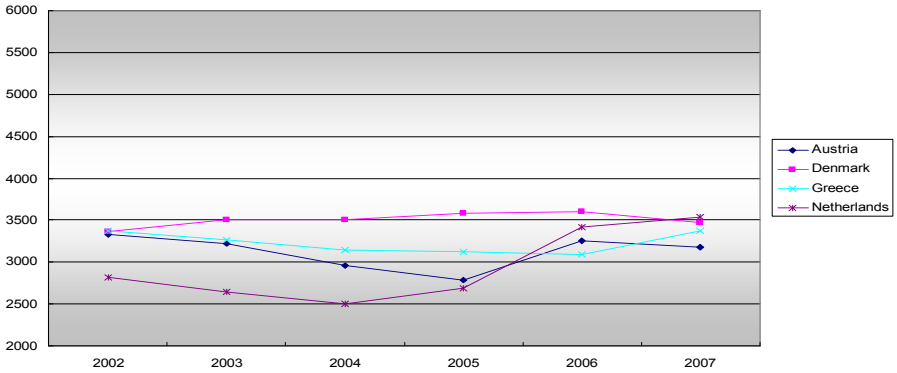
Appendix



(a) Decreased countries



(b) Constant countries



(c) Increased countries

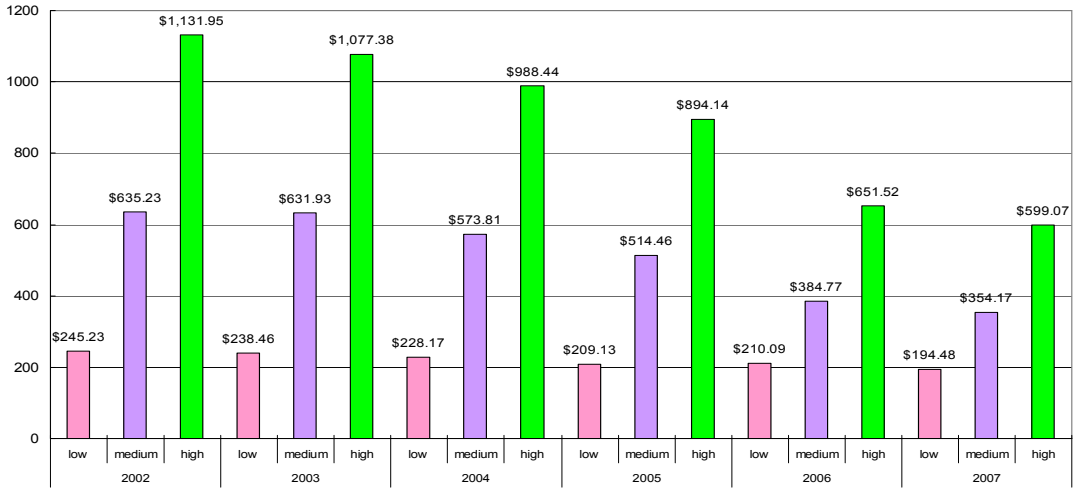
Source: Merrill Lynch (2005, 2008)

Fig. 1 The trend of HHI in each country

Table 6 Change in the number of mobile operators in each country

Austria	5 → 4	Decrease
Belgium	3 → 3	Constant
Czech, the Republic	3 → 3	Constant
Denmark	4 → 5 →4	Constant
Finland	3 → 3	Constant
France	3 → 3	Constant
Germany	4 → 4	Constant
Greece	4 → 3	Decrease
Hungry	3 → 3	Constant
Ireland	3 → 3	Constant
Italy	4 → 3 → 4	Constant
Korea	3 → 3	Constant
Netherlands	5 → 4 → 3	Decrease
Norway	2 → 2	Constant
Poland	3 → 4	Increase
Portugal	3 → 3	Constant
Spain	3 → 4	Increase
Sweden	3 → 4	Increase
Switzerland	3 → 3	Constant
UK	4 → 5	Increase

Source: Merrill Lynch (2005, 2008)



Note: The figures as presented are quarterly averages of consumer expenditures by year in the OECD 20 countries.

Source: Teligen (2008)

Fig. 2 The trend of average retail prices of each user type