COMPETITION IN MOBILE TELEPHONY IN FRANCE AND GERMANY*

by

LUKASZ GRZYBOWSKI
University of Cape Town

and

CHIRAZ KARAMTI†
Telecom Paris—ENST

This paper analyses the development of mobile telephony in France and Germany in 1998–2002. We conduct this analysis in relation to the anti-trust investigation initiated by the French competition authority in 2002 due to exchange of strategic information and a share-fixing agreement between network operators. The results suggest a significant difference between price elasticities of demand in these two countries. Moreover, consumers perceive mobile telephony as a substitute for fixed-line connection in France and as a complement in Germany. In the time period of the share-fixing agreement among French network operators there were no adverse shifts in the levels of prices and subscriptions.

1 Introduction

Mobile telecommunications markets in the European Union are oligopolies with a small number of competitors and regulated entry. In recent years, in a few countries, national competition authorities raised concerns about collective dominance and the potential for tacit or explicit collusion in the mobile telecommunications industry. For instance, the Irish and Spanish competition authorities found that there was collective dominance in their mobile markets. Their views were subsequently endorsed by the European Commission and remedies were imposed, i.e. entry of Mobile Virtual Network Operators was allowed in both countries.¹

Also in France, in December 2005, the competition authority Conseil de la Concurrence (CdC) found that three network operators, Orange, SFR and

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¹A Mobile Virtual Network Operator provides mobile services to its customers, but does not have an allocation of spectrum. In general, a Mobile Virtual Network Operator can set its own pricing structures, subject to the pricing structure agreed with the network operators. The first commercially successful Mobile Virtual Network Operator was Virgin Mobile UK, which was launched in the UK in 1999 and in 2007 had over 4 million customers.
Bouygues, shared sales data and conspired to undermine competition.\textsuperscript{2} According to the CdC, the operators shared ‘precise and confidential’ commercial information every month for six years and agreed to freeze their market shares in 2000–2002. The authority stated that ‘the existence of this collusion has been established through the recovery of serious, precise and consistent evidence, including handwritten documents explicitly mentioning an agreement between the three operators’. ‘The market-share deal was concluded at a time when sales were slowing on the maturing French mobile market,’ the authority said, ‘leading to increased prices for consumers as operators sought to squeeze profits from existing clients instead of competing for new subscribers.’ During the investigation, the three mobile networks admitted sharing confidential sales data, but argued unsuccessfully that it had not distorted competition and that they had not sought to freeze market shares.\textsuperscript{3}

This paper provides an analysis of the development of the mobile telecommunications industry in France and compares it with the mobile telecommunications industry in Germany. The empirical analysis is based on aggregate industry-level data on subscriptions and prices in France and Germany in the years 1998–2002 and consists of separate estimations of (i) the demand for mobile subscriptions using the binomial logit model and (ii) reduced-form pricing equations. Because there was evidence of anti-competitive practices in 2000–2002 in France, we analyse whether there are any visible effects of these practices on the market outcomes.\textsuperscript{4}

An initial inspection of data on subscriptions and prices shows an interesting picture of mobile markets in France and Germany. The penetration of mobiles in France was initially higher than in Germany, but this situation was reversed in the middle of 2000 (see Fig. 1). By the end of 2002, penetration in Germany was higher by about 10 percentage points than in France. This


\textsuperscript{3}The total fines imposed on the operators were the second largest in the European antitrust history at this time and amounted to 534 million Euros. Orange vowed to appeal its 256 million Euros fine describing the penalty as ‘unfounded and excessive’. SFR and Bouygues also said that they planned to challenge their respective penalties of 220 million Euros and 58 million Euros in the appeal courts. On the other hand, the French consumer group, UFC-Que Choisir, said that it may pursue the three operators on behalf of customers for civil damages, saying that ‘30 million subscribers had suffered a detriment totaling 1.2 billion Euros’.

\textsuperscript{4}For the purpose of this study we have collected similar pricing data for France and Germany. Unfortunately, data collection was very time-consuming and we were not able to collect the same information on mobile markets in other countries. Therefore, due to data availability, this analysis has focused on France and Germany. Besides differences in market structure and—as shown in this analysis—in demand conditions, an empirical analysis using data from these two countries has allowed us to enhance our understanding of how the development of the mobile telecommunications industry is influenced by demand and supply factors.
change could potentially indicate the presence of anti-competitive practices as suggested by the CdC, but it does not seem to be supported by a comparison of prices in both countries. In the same period, minimum prices of mobile services in France, computed for a defined low-usage basket, were lower than corresponding prices in Germany by about 58 per cent. It is a surprising difference, because the number of competitors, market concentration, market size and the hypothesis of collusion in France, all suggest that we should potentially observe lower prices in Germany.\(^5\)

A few explanations are possible for this situation. First, the French network operators may be drastically more efficient, or marginal cost factors are significantly lower in France. However, due to bigger market size and potential economies of scale, network operators in Germany may be expected to have lower costs than in France. The differences in potential marginal cost factors, such as the costs of labour and capital, are also relatively small between these two countries. Second, there may have been undetected collusion in Germany and competition in France. Third, there are significant differences in price elasticities between these two countries.\(^6\)

Demand estimation sheds light onto the last aspect. Demand for mobile phones is found to be more elastic in France than in Germany. Moreover,

\(^5\)For instance, in this period, the average Herfindahl index in France was 0.39, compared with 0.36 for Germany. In both countries, there was a small decrease in the index value throughout 1998, but afterwards it remained almost unchanged. The initial values in January 1998 were 0.43 for France and 0.40 for Germany and by December 2002 they were 0.39 and 0.34 respectively.

\(^6\)Also, handsets are more heavily subsidized in Germany than in France. However, this comparison is based on low-usage prepaid tariffs, for which consumers have to pay full price for the handset.
demand estimates suggest that there may also be another explanation for observed differences in subscriptions and prices. Consumers seem to perceive mobile telephony as a substitute for fixed-line services in France and as a complement in Germany. Thus, network operators in France may have to compete with fixed-line providers, which results in lower market prices. On the other hand, decreases in fixed-line prices in Germany stimulate demand for mobiles, without imposing competitive pressure on mobile providers. In a separate supply-side estimation, we estimate the dependence of industry-level prices on marginal cost and demand factors. The motivation for this estimation is to test whether prices were higher in the time period of the share-fixing agreement. The estimation results suggest that in years 2000–2002 prices were lower than in the years before.

The empirical results of this analysis are useful for antitrust investigations of mobile markets. The key step of each competition analysis is relevant market definition, which is also usually the first step in the assessment of market power. Market definition is important in the process of establishing whether particular agreements or conduct fall within the scope of the competition rules. The relevant market definition combines the product market and the geographical market. A relevant product market comprises all those products and/or services which are regarded as interchangeable or substitutable by the consumer by reason of the products’ characteristics, their prices and their intended use.

Based on the assessment of demand-side substitution, the relevant market definition for mobile telephony may comprise fixed-line telephony, which has important consequences for the assessment of market power in this industry. The European Commission and the national competition authorities, in a number of decisions on mobile communications services, used product market definitions that excluded fixed-line communications services. The Commission claimed that mobile communications services cannot be seen as being substitutable for fixed communications services, because of the mobility inherent in all mobile services, i.e. mobile numbers are associated with individuals on the move, rather than with a fixed location. This analysis suggests that fixed-line services can be a substitute to mobile telephony and that product market definition may be, in fact, country-specific.

7Paper 81 of the Treaty establishing the European Community applies to agreements which have as their object or effect an ‘appreciable’ prevention, restriction or distortion of competition. The appreciability test usually requires definition of a relevant market and demonstration that the agreement would have an appreciable effect on competition within that market. Source: ‘Market Definition: Understanding Competition Law’, Office of Fair Trading, December 2004.

The next section provides a short overview of the empirical literature on the telecommunications industry. Section 3 presents a brief history and outlines the current state of the mobile markets in France and Germany. The empirical model and data are presented in Section 4. Estimation results follow in Section 5. Section 6 provides some concluding remarks.

2 Literature

There is a large body of literature on the estimation of demand for telecommunications services using industry- and consumer-level data. For instance, Barros and Cadima (2000) simultaneously estimate diffusion curves for mobile and fixed telephony in Portugal and find a negative impact of mobile penetration on fixed-line density. Okada and Hatta (1999) analyse the demand for mobile and fixed telephony services using Japanese data. They find that own-price elasticities and substitution effect are relatively high. Rodini et al. (2003) estimate the substitutability of fixed and mobile services for telecommunications access using data on US households. Their estimates of cross-price elasticities confirm that second fixed-line and mobile services are substitutes for one another. Doganoglu and Grzybowski (2007) use a nested logit model, in which consumers choose between mobile and fixed-line services to estimate the demand for subscription for mobile telephony in Germany.

Another range of studies analyses the diffusion of mobile technology worldwide using cross-country panel data. For instance, Gruber and Verboven (2001) estimate a logistic diffusion model for mobile subscriptions in the EU. They find, among other results, that the penetration rate of fixed telephony has a negative influence on the diffusion of mobiles. However, the results of similar studies for other countries suggest that mobile and fixed-line services may be complements, for instance Gruber (2001) for Central and Eastern European countries, Gebreab (2002) for African countries and Ahn and Lee (1999) for 64 countries worldwide. Hamilton (2003), using data on African countries, finds that mobile and fixed-line subscriptions may be both complements and substitutes at different stages of market development. In the early stage of diffusion, mobile services may be complementary to fixed-line telephones, but the substitution effect takes over once mobile usage becomes more widespread.

In summary, the results of empirical studies are ambiguous with respect to whether mobile and fixed-line services are substitutes or complements. However, in recent antitrust investigations, as mentioned before, product market definition for mobile communications excludes fixed-line services. This study suggests that mobile and fixed-line services may be substitutes or complements, even for countries that are very similar in socioeconomic terms.
3 Mobile Telephony in France and Germany

The era of mass mobile telecommunications in the EU started in the early 1980s with the first generation analogue systems, such as Nordic Mobile Telephone (NMT), British Extended Total Access Communication System (ETACS) and the German standard (C-450). The licences for providing analogue mobile services were granted to state-owned, fixed-line monopolies, with the exception of France, the UK and Sweden, where duopolies were created. Because of capacity constraints, incompatibility, low quality and security, the analogue systems have been phased out. Meanwhile, the European countries decided to introduce common technology platforms, GSM-900 and later DCS-1800, to allow for pan-European roaming. This time the licences were not exclusively granted to the incumbent operators. Licensing policies varied by country, which allowed for a different number of operators and simultaneous or sequential market entries. After 2000, European governments began auctioning licences for the Universal Mobile Telecommunication System (UMTS) standard, commonly referred to as 3G technology. The main advantage of 3G is much faster data transmission speeds than GSM, which allows for high bandwidth data services including multimedia services, such as real time video and broadband Internet access.

In 2006, there were 83.1 million subscribers to mobile telephony in Germany and 49.8 million in France, which amounts together to about 27.8 per cent of the mobile market in the EU of approximately 478.4 million subscribers. The penetration rate was about 103 per cent in the EU as a whole. Mobile telephony, with revenue of 133 billion Euros, accounted for 46 per cent of total revenues in the telecommunications industry in the EU.

3.1 Germany

In July 1992 Telekom Mobilnet and Mannesmann Mobilfunk started to provide mobile services in Germany using digital networks. The first one was a subsidiary of state-owned telecommunications incumbent Deutsche Telekom, which was later privatized and became T-Mobile, and the second one was a private company, which was later taken over by Vodafone. Later, a third licence was granted to E-plus, which began to provide mobile services in May 1997. Another licence was granted in 1997 to Viag Interkom (later renamed to O2), which started providing mobile services in November 1998.

Network operators may sell services to consumers directly or indirectly through independent service providers (ISPs). In general, an ISP resells airtime on a third party’s mobile network by providing billing and customer care services under its own brand name. In Germany, network operators can commercially decide whether to sign an ISP agreement. According to the German Telecommunications Act the agreements between network operators and ISPs have to be non-discriminatory and ensure fair competition.
between retailers. Typically, the tariffs offered by ISPs reflect the tariffs of the network carriers.\(^9\)

In August 2000, six companies received licences to develop UMTS networks: Group 3G (Quam), T-Mobil, Mannesmann-Vodafone, Auditorium, Mobilcom Multimedia and O2. This technology allows data to be transferred at much higher rates in order to satisfy the demands of multimedia applications. One of the licence winners, Quam, entered the market in November 2001 by signing roaming agreements with incumbent network operators. It attracted about 200,000 consumers but subsequently went bankrupt a year later.

In 2003, in Germany there were four network operators—T-Mobile, D2 Vodafone, E-Plus and O2—and about twelve ISPs. Only O2 has not reached an agreement with any ISPs. Of these firms, only eight had significant market shares—network operators T-Mobil (29.9 per cent), D2 Vodafone (27.7 per cent), E-Plus (9.3 per cent) and O2 (6.3 per cent), and ISPs Debitel (12.7 per cent), Mobilcom (6.5 per cent), Talkline (3.2 per cent) and Drillisch (2.4 per cent). The remaining ISPs accounted for only about 2.0 per cent of subscribers.\(^{10}\)

3.2 France

In March 1992 two licences for digital mobile services GSM 900 were granted to the fixed-line incumbent operator France Telecom Mobiles and Société Française de Radiotéléphonie (SFR).\(^{11}\) This duopoly structure existed until June 1996, when a third network operator, Bouygues Telecom, entered the market after being granted a licence to operate digital technology GSM 1800.

After entry, Bouygues gained market share quite rapidly, which led to a significant decrease in industry concentration. This entry fostered competition, which resulted in lower prices and a proliferation of new tariff plans. The penetration rate in France grew from 4.2 per cent for the year 1996 to 63.5 per cent for the year 2002. However, in spite of growing penetration rate, from 1998 onwards the distribution of market shares among the mobile providers remained quite stable. The most recent entrant, Bouygues, did not manage to extend its market share considerably, with about 15.9 per cent of subscribers by the end of 2003. France Telecom remained the market leader with an almost stable share of 48.8 per cent, followed by SFR with a share of 35.3 per cent.\(^{12}\)

\(^9\)As discussed in the section on the data, the industry-level prices are computed using minimum tariffs of network operators only.

\(^{10}\)Source: http://www.RegTP.de.

\(^{11}\)France Telecom marketed mobile services under the brand Itineris until May 2001 and afterwards changed its brand name to Orange. The main shareholders of SFR are Vivendi Universal and Vodafone.

\(^{12}\)Along with the three network operators, mobile services in France are also provided by Mobile Virtual Network Operators. However, by June 2005 they had only about 40,000 consumers in total.

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In June 2001, the French government awarded two out of four UMTS licences to France Telecom and SFR using a ‘beauty contest’. Bouygues and several other players pulled out of the bidding due to the high licence price. In 2002, the French authorities altered licence conditions and published a new call for applications for the allocation of the two UMTS licences not issued in the first round. Only Bouygues applied this time and received the licence in October 2002.

4 Empirical Analysis

4.1 Demand Side

All consumers are assumed to have access to fixed-line services. They decide between continuing to use fixed telephony only, also or subscribing to mobile services. The utility derived by consumer $i$ from using fixed-line telecommunications services in period $t$ is given by

$$U_{it} = \eta - \alpha t p_{it} + \gamma_t V_t + \xi_{it} + \epsilon_{dit} = \delta_{it} + \epsilon_{dit}$$

(1)

where $r_t$ is the stand-alone value of fixed-line services, $p_{it}$ is the price of a fixed line in period $t$, $V_t$ is the expected network benefit in period $t$, which results from an increase in communications possibilities due to a larger number of mobile users, $\xi_{it}$ is the unobserved utility of fixed-line services, and $\epsilon_{dit}$ is an idiosyncratic taste variable. The mean utility level of using a fixed line in period $t$ is therefore denoted by $\delta_{it}$.

When consumers decide to use mobile services together with fixed line, the utility of the fixed line may change, which is represented by $\lambda \delta_{it}$, where $\lambda \geq 0$. Thus, the utility of using mobile services together with fixed line in period $t$ is given by

$$U_{mit} = \lambda \delta_{it} + r_m - \alpha_m p_{mt} + \gamma_m V_t + \xi_{mt} + \epsilon_{int}$$

$$= (\lambda \delta_{it} + r_m - \lambda \alpha_t p_{it} - \alpha_m p_{mt} + (\lambda \gamma_t + r_m) V_t + (\lambda \xi_{it} + \xi_{mt}) + \epsilon_{int}$$

(2)

where $\delta_{mt}$ is the mean utility level of using fixed-line together with mobile services. After normalizing with respect to the mean utility of using fixed-line services only, i.e. $\delta_{it}$, equation (2) may be rewritten as

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13In December 2005, 87 per cent of households in Germany had fixed-line access, compared with 85 per cent in France; see Eurobarometer (2006). These values should have been higher in the time period of this analysis.

14A number of empirical studies suggest that network effects are present in mobile telephony (see, for instance, Doganoglu and Grzybowski, 2007). The utility of fixed-line and mobile access may depend on the number of current users of telecommunications services. The number of fixed-line users is basically constant in a short period of time and may be represented by the whole population. In addition to voice telephony, mobile firms can offer several other services, such as SMS, MMS, WAP and email, which may themselves be subject to network effects. Thus, lagged penetration of mobile telephony is used in the regressions as a proxy for industry-wide network effects.
When $\bar{\alpha}_t < 0$, which implies that $\lambda < 1$, the utility of fixed-line connection decreases when a consumer acquires a mobile telephone. Thus, mobile and fixed-line services are perceived as substitutes. On the other hand, for $\bar{\alpha}_t > 0$, the utility of fixed-line services increases, i.e. mobile and fixed-line services are complements.15

The probability that consumer $i$ subscribes to mobile services in addition to fixed line in period $t$ may be written as

$$P_{imt} = \Pr(\tilde{\delta}_{mt} + \varepsilon_{iMT} > \varepsilon_{di})$$

When $\varepsilon_{ijt}$ has an extreme value distribution, this probability has a closed form given by

$$P_{iMT} = \frac{\exp(\tilde{\delta}_{mt})}{1 + \exp(\tilde{\delta}_{mt})}$$

which is the same for all consumers and equals the share $s_{mt}$ of consumers choosing in period $t$ mobile services together with fixed line. The share of consumers who choose not to subscribe to mobile telephony in period $t$ is given by $s_f = 1 - s_{mt}$. Following Berry (1994), the observed share of mobile subscribers can be inverted to compute the mean utility of using mobile services together with fixed line, which for the specification in equation (3) may be written as

$$\log(s_{mt}) - \log(1 - s_{mt}) = \tilde{r}_m - \bar{\alpha}_t p_{lt} - \alpha_m p_{mt} + \bar{\gamma} V_t + \tilde{\xi}_{mt}$$

The price elasticity of demand for mobiles in this framework is given by

$$\eta = -\alpha_f p_{jt} (1 - s_{mt})$$

The elasticities of demand with respect to the price of fixed-line services and lagged penetration have analogous formulations.

Along with price and network effects represented by lagged penetration, dummies for the entry of O2 and Quam are used in the estimation for Germany, because demand could increase if consumers have a preference for variety. For France, a dummy for the share-fixing period 2000–2002 is used in order to test whether there was any detrimental effect on subscriptions. Moreover, in both countries a dummy for November and December is

15Note that nobody gives up fixed-line connection. Substitution/complementarity with fixed line influences the speed of diffusion of mobiles. In reality, some consumers resign from fixed line. Unfortunately, there are no data available in the form of time series on the percentage of consumers who have mobile phone only, fixed line only and mobile plus fixed line together.
included to account for higher demand in the months preceding Christmas. We also use a time trend to control for improvements in the quality of handsets and other technological innovations. However, the time trend is collinear with lagged penetrations, which causes estimation problems, as discussed in the section presenting estimation results. The total number of consumers who can make subscription decisions, i.e. market size, is assumed to be equivalent to total population in each country.

The demand for mobile subscriptions is regressed on the market prices, which are endogenous and require the instrumental variables estimation method. The other explanatory variables from the model are exogenous and may be used as instruments. In particular, price indices for fixed-line services are assumed to be exogenous because fixed-line markets in France and Germany were liberalized on 1 January 1998. There have been many entries and increasing competition, especially in the national and international markets. Also, entries of O2 and Quam were regulated and may be considered as exogenous. Because of the autocorrelation of the error term we cannot use lagged penetration as an instrumental variable and instead include time trend in the list of instruments.

In addition, to fulfil the order condition for identification, we have to find at least one variable that has a causal effect on price but does not have a direct causal effect on demand. Marginal cost factors are commonly used as instruments for prices in the empirical literature. Moreover, as in Hausman (1996) and Nevo (2001), we use as instruments prices in other markets, i.e. market prices in Germany are used as instruments for prices in France and vice versa. These are valid instruments under the assumption that prices in France and Germany are correlated through common shocks to marginal costs, while demand shocks are independent. Thus, the following set of instruments is used for Germany: $Z_t = (\text{time}_t, \text{o2}_t, \text{quam}_t, \text{christmas}_t, \text{price—fixed}_t, \text{capital}_t, \text{labour}_t, \text{price—france}_t)$, and analogously for France but without entry dummies. The identifying assumption is the mean independence of the demand shocks, given by $\tilde{\xi}_{mt}$, with the set of instruments, i.e. $E(\tilde{\xi}_{mt} | Z_t) = 0$.

4.2 Supply Side

In addition to demand estimation, the supply side is estimated separately for each country by a simple reduced-form regression of average market prices on demand and cost factors. The purpose of this estimation is to test whether prices were higher in the time period of the share-fixing agreement and whether there is a dependence between mobile and fixed-line prices.16

16As we discuss in the section presenting estimation results, we refrain from stating that the price effects observed are due to the share-fixing agreement.
The reduced-form pricing equation may be derived as follows. Assuming that there are $N_{jt}$ symmetric firms in country $j$ in period $t$, the firm’s profit function in each country can be written as

$$\Pi_{jt} = (p_{jt} - MC_{jt})S_{mjt}M_t$$

where $p_{jt}$ is the monthly basket price for mobile services, which construction is discussed in the data section, $MC_{jt}$ represents marginal costs on country level, $M_t$ is country population and $S_{mjt}$, as defined before, is the share of consumers choosing mobile services together with fixed line. Therefore, given our utility function specification equation (3) and following the derivation in Berry (1994), the first-order condition may be written as

$$p_{jt} = MC_{jt} + \frac{1}{\alpha_m(1 - S_{mjt})}$$

where the market share $S_{mjt}$ is determined by logit equation (5). Using the first-order approximation of the exponential function ($\exp(\delta_{mt}) \approx 1 + \delta_{mt}$) and the specification of mean utility function in equation (3), the linear approximation of the pricing equation (8) may be written as follows:

$$p_{jt} = \frac{MC_{jt}}{2} + \frac{2 + \hat{r}_m}{2\alpha_m} - \frac{\hat{\alpha}_t}{2\alpha_m} p_{jt} + \frac{\hat{\gamma}}{2\alpha_m} V_t$$

The equilibrium price depends on demand factors, i.e. the price of fixed line, network effects approximated by lagged penetration and marginal cost determinants $MC_{jt}$, which are represented by the country-level cost of labour and capital. We use also in the regression, as explanatory variables, dummy for Christmas sales, dummies for entry of Viag and Quam in the case of Germany and a dummy for the period of share fixing in the case of France.

We append to equation (9) a stochastic term $\epsilon_{jt}$ representing unobservable demand and supply shocks as well as measurement errors that are assumed to be normally distributed and mean independent with the explanatory variables. Under this assumption, the ordinary least squares (OLS) method is a consistent estimation strategy.17

17Because of data limitations, i.e. lack of firm-specific cost factors, and difficulties with estimation of firm-specific demands, we refrain from estimating a structural model of demand and supply. Figure 3 shows changes in network operator prices in France, and Fig. 2 in Germany. It may be difficult to explain observed price movements by changes in marginal cost and demand factors. In particular, in France, Bouygues seems to set almost constant prices between 1998 and 2002. There is also no visible dependence on competitors’ prices. Hence, the estimation of a pricing equation is problematic and, given data limitations, a simple linear pricing regression seems to be the only viable approach.
4.3 The Data

The estimation of the aggregate demand function for mobile subscriptions requires data on market price and demand factors. For estimation of the reduced-form pricing equation, in addition to demand factors, information on marginal costs is needed. For each country there are 60 monthly observations from January 1998 to December 2002.

Firm-level subscription statistics for France were collected from the website of the French Telecommunications and Posts Regulator (ARCEP) and for Germany from the website of the Regulatory Authority for Telecommunications and Posts (RegTP). Unfortunately, precise information on gross sales was not available. For this reason, instead of estimating firm-level demands, this paper focuses on aggregate demands for mobile subscriptions in France and Germany.

The market prices are computed using information on tariffs available each month for consumers in France and Germany, as described below. The computation is based on user profile methodology, which is similar to the one used by the Federal Statistical Office in Germany. A similar approach was also used by the Irish Commission for Communications Regulation in its analysis of wholesale mobile access and call origination.

Data on France were collected from telecommunications magazines: Phone House, Journal de Téléphone, Mobile Magazine in the time period January 1998–December 2002. Tariff information for Germany was collected for the same period of time from the price listings published in telecommunications magazine Connect and on the Internet.

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18When monthly observations for France were not available, they were extrapolated using quarterly data.
19In fact, according to the CdC, exactly confidential information on gross sales was regularly exchanged among network operators in France.
20The Federal Statistical Office provides separate consumer price indices for fixed-line and mobile telecommunications. Four different price indices are computed for mobile services—three different user profiles (infrequent, average and frequent users) and an aggregate index. Network operators bundle different services together and frequently change mobile phone packages and tariffs. Thus, the construction of mobile price indices requires more effort than ordinary price tracking in other industries. Tariffs consist of many components, such as on-net, off-net, fixed-line, time-zone-specific prices, billing intervals and so on. The statistical office uses only the most important ones in the calculation of price indices. Consumers are assumed to be perfectly informed about the range of tariffs available each month on the market. For all tariffs expected monthly bill is calculated for given usage profile. Then consumers choose between the cheapest one offered by each service provider. User profile indices and aggregate index for mobile services are computed using selected bills with appropriate weighting factors. The aggregating function used is the Laspeyre’s formula as a weighted arithmetic mean of price relatives (see Beuerlein, 2000).
21This analysis was the basis for the assessment of collective dominance in mobile telephony in Ireland. See Commission for Communications Regulation (2004).
22There are 2926 tariff–month observations for France and 1457 for Germany in the time period January 1998–December 2002. In the case of Germany, there are also tariffs offered by ISPs, which are not considered in this analysis.
First, firm-level price indices are computed for a consumer who uses mobile services infrequently, so that he is interested in purchasing a prepaid tariff rather than a contract. This is the consumer with the lowest valuation of mobile services and his decision to subscribe determines market demand.

The following algorithm is used for the calculation of firm-specific price indices. An infrequent mobile user is assumed to make on average 15 calls per month (uniform distribution from the interval (10, 20)). The average length of a call is two minutes (Poisson distribution with \( \lambda = 20 \) seconds multiplied by 6). The distribution among destination networks is proportional to the market shares. The peak time is assumed to be the same for all tariffs, between 8 AM and 8 PM on weekdays. The distributions over days and hours of the day are uniform. For the first draw, the bill value is computed for all tariffs available on the market in a given month. The simulation of monthly calls is repeated 1000 times and the average bill value is calculated. The cheapest tariffs offered by each firm constitute firm-specific price indices (see Figs 2 and 3).

Price indices in France and Germany are computed as the share-weighted average of the cost of usage of mobile services for the cheapest tariff on the market offered by each network operator (see Fig. 4). It may be interpreted as an expected market price.

As described in Section 3, two entries took place in Germany in the period of this analysis. The first one, Viag (now O2), entered in November 1998 and the second one, Quam, in November 2001. Only prices of Viag are used in the computation of market prices because the number of Quam users was marginal.

Price indices for fixed-line telecommunications are used in the form provided by statistical offices in France and Germany, as presented in Fig. 5.

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23 There are some differences in the types of tariffs available in France and Germany. Mobile phone services in France are charged for in the following ways: (i) ‘Abonnement’—is a contract that often lasts for up to a year and requires a one-off payment for both handset and contract. Calls are charged per second/minute according to the time of day etc. (ii) ‘Forfait’—is a contract for 12–24 months that provides a varying number of free minutes per month. The use of these free minutes may be restricted to certain times of day, e.g. off-peak, or to certain types of users, e.g. calls to subscribers on the same network. Calls in addition to free minutes, or calls during peak periods, for instance, are charged per second/minute. This tariff was first offered by Bouygues in August 1996. (iii) ‘Carte’—the handset is bought separately and call vouchers are purchased. Vouchers may provide airtime access for a limited or unlimited period. In the first case vouchers expire within a certain period of time if unused. Vouchers are sold in various denominations, with calls per minute typically being cheaper for the larger denomination vouchers. This tariff was first offered by France Telecom in March 1997. In Germany, mainly tariffs of types (i) and (iii) in unlimited version are offered. However, E-plus also offers tariffs of type (ii), which includes a non-transferable monthly volume of minutes.

24 As can be seen in Fig. 2, prices of T-Mobile and Vodafone did not react to these entries, while E-plus reacted with price cuts.

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Unfortunately, these indices are computed using different definitions and are not comparable.\textsuperscript{25}

Demand and reduced-form pricing regressions should include non-price demand factors. Demand for mobile services may depend on the network

\textsuperscript{25}There were drastic decreases in prices of fixed-line services in France and Germany. The drop in prices in France could have been caused by the introduction of carrier pre-selection and fixed number portability that took place in January 2000. In Germany, these regulations were introduced in January 1998.
quality, i.e. reception quality and coverage. By January 1998 the main network operators in Germany (T-Mobile, Vodafone and E-plus) as well as in France (Orange, SFR and Bouygues) were sufficiently established in the market to provide coverage for the whole country. Thus, it may be expected that there were no significant changes in the quality of networks between...
January 1998 and December 2002. Other important issues are handset subsidies and advertising. Unfortunately, due to lack of data on these factors, they cannot be controlled for in this analysis.

The statistical offices in France and Germany and Eurostat provide country-level information on potential marginal cost factors, such as the cost of labour and capital (see Table 1). These variables are used as exogenous explanatory variables in the reduced-form pricing regressions and as instruments for prices in demand estimation. As mentioned earlier, we use time trend in the estimation due to collinearity with lagged penetration. Time trend could be a proxy for both demand and cost factors. On the demand side, it may represent improving quality of handsets. On the supply side, it may be a component of the cost function representing technological innovation.

5 Estimation Results

The results of demand estimation using OLS and the generalized method of moments (GMM) for France and Germany are presented in Table 2. The presence of a time trend among explanatory variables results in extremely

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMARY STATISTICS</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Min</th>
<th>Max</th>
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<tr>
<td>Germany</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price T-Mobile (Euro/100)</td>
<td>60</td>
<td>0.1656</td>
<td>0.035</td>
<td>0.126</td>
<td>0.213</td>
</tr>
<tr>
<td>Price Vodafone (Euro/100)</td>
<td>60</td>
<td>0.1647</td>
<td>0.035</td>
<td>0.125</td>
<td>0.212</td>
</tr>
<tr>
<td>Price E-plus (Euro/100)</td>
<td>60</td>
<td>0.1565</td>
<td>0.035</td>
<td>0.106</td>
<td>0.209</td>
</tr>
<tr>
<td>Price O2 (Euro/100)</td>
<td>60</td>
<td>0.1565</td>
<td>0.035</td>
<td>0.106</td>
<td>0.209</td>
</tr>
<tr>
<td>Average price Germany (Euro/100)</td>
<td>60</td>
<td>0.1647</td>
<td>0.034</td>
<td>0.128</td>
<td>0.215</td>
</tr>
<tr>
<td>Price fixed (index)</td>
<td>60</td>
<td>1.0741</td>
<td>0.129</td>
<td>0.958</td>
<td>1.297</td>
</tr>
<tr>
<td>Bonds (%)</td>
<td>60</td>
<td>0.0478</td>
<td>0.004</td>
<td>0.037</td>
<td>0.055</td>
</tr>
<tr>
<td>Labour (index)</td>
<td>60</td>
<td>1.1808</td>
<td>0.044</td>
<td>1.097</td>
<td>1.263</td>
</tr>
<tr>
<td>Lagged penetration</td>
<td>60</td>
<td>0.4215</td>
<td>0.229</td>
<td>0.104</td>
<td>0.707</td>
</tr>
<tr>
<td>France</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price Orange (Euro/100)</td>
<td>60</td>
<td>0.0773</td>
<td>0.021</td>
<td>0.046</td>
<td>0.108</td>
</tr>
<tr>
<td>Price SFR (Euro/100)</td>
<td>60</td>
<td>0.0616</td>
<td>0.019</td>
<td>0.039</td>
<td>0.104</td>
</tr>
<tr>
<td>Price Bouygues (Euro/100)</td>
<td>60</td>
<td>0.0500</td>
<td>0.006</td>
<td>0.041</td>
<td>0.056</td>
</tr>
<tr>
<td>Average price France (Euro/100)</td>
<td>60</td>
<td>0.0679</td>
<td>0.017</td>
<td>0.043</td>
<td>0.102</td>
</tr>
<tr>
<td>Price fixed (index)</td>
<td>60</td>
<td>0.9519</td>
<td>0.046</td>
<td>0.893</td>
<td>1.010</td>
</tr>
<tr>
<td>Labour (index)</td>
<td>60</td>
<td>1.0987</td>
<td>0.057</td>
<td>1.012</td>
<td>1.198</td>
</tr>
<tr>
<td>Bonds (%)</td>
<td>60</td>
<td>0.0488</td>
<td>0.004</td>
<td>0.037</td>
<td>0.056</td>
</tr>
<tr>
<td>Lagged penetration</td>
<td>60</td>
<td>0.3898</td>
<td>0.182</td>
<td>0.102</td>
<td>0.626</td>
</tr>
</tbody>
</table>

26This is confirmed by the statistics on coverage that are available for the network operators in France.
### Table 2

**Estimation of Aggregate Demand for Mobile Services in France and Germany**

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th></th>
<th></th>
<th></th>
<th>Germany</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS I</td>
<td>t</td>
<td>Pr &gt; t</td>
<td>OLS II</td>
<td>t</td>
<td>Pr &gt; t</td>
<td>GMM</td>
<td>t</td>
</tr>
<tr>
<td>Price mobile</td>
<td>-1.403</td>
<td>-10.60</td>
<td>0.001</td>
<td>-1.044</td>
<td>-6.86</td>
<td>0.001</td>
<td>-1.437</td>
<td>-8.61</td>
</tr>
<tr>
<td>Lagged penetration</td>
<td>6.888</td>
<td>15.79</td>
<td>0.001</td>
<td>4.282</td>
<td>19.66</td>
<td>0.001</td>
<td>3.963</td>
<td>23.36</td>
</tr>
<tr>
<td>Price fixed</td>
<td>2.851</td>
<td>5.90</td>
<td>0.001</td>
<td>2.460</td>
<td>4.06</td>
<td>0.001</td>
<td>1.786</td>
<td>4.12</td>
</tr>
<tr>
<td>Cartel dummy</td>
<td>-0.147</td>
<td>-3.41</td>
<td>0.001</td>
<td>0.037</td>
<td>0.91</td>
<td>0.363</td>
<td>-0.007</td>
<td>-0.26</td>
</tr>
<tr>
<td>Christmas</td>
<td>0.063</td>
<td>2.66</td>
<td>0.010</td>
<td>0.062</td>
<td>2.08</td>
<td>0.038</td>
<td>0.125</td>
<td>3.48</td>
</tr>
<tr>
<td>Time</td>
<td>-2.540</td>
<td>-6.50</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-4.063</td>
<td>-7.40</td>
<td>0.001</td>
<td>-3.826</td>
<td>-5.52</td>
<td>0.001</td>
<td>-2.778</td>
<td>-5.34</td>
</tr>
<tr>
<td>Hausman $R^2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.87</td>
<td></td>
</tr>
<tr>
<td>Centred $R^2$</td>
<td>0.99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.99</td>
<td></td>
</tr>
</tbody>
</table>

Price mobile, Lagged penetration, Price fixed, Cartel dummy, Christmas, Time, Intercept, Quam, Christmas, Time, Intercept, Hausman $R^2$, Centred $R^2$.
high variance inflation statistics for this variable due to its correlation of 0.98 with lagged penetrations. Therefore, we discuss estimation results for models without time trend, in which case the coefficients on lagged penetration and other highly correlated variables may absorb the time effect.

According to the Hausman specification test, the null hypothesis of the exogeneity of prices may be rejected for both France and Germany. Thus, GMM estimates are used for interpretation. The coefficients on mobile prices are significant in both countries, and their equality can be rejected statistically. Mean price elasticities for the period analysed and their standard deviations are presented in Table 3. According to the estimation results, price elasticity for mobile subscriptions in France equals on average –0.63 and for Germany –0.35. Therefore, the difference in price elasticities is a possible explanation for at least part of observed price differences.

The coefficient on the price of fixed-line services is negative for France and positive for Germany. Thus, fixed-line services are found to be substitutes in France and complements in Germany. This finding could also be a possible explanation for observed differences in prices and diverging diffusion rates of mobiles between France and Germany. It implies that network operators in France may have to compete with fixed-line providers, which results in lower market prices. On the other hand, decreasing prices of fixed line in Germany stimulate demand for mobiles without imposing a competitive pressure on mobile providers. This hypothesis finds support in the

<table>
<thead>
<tr>
<th></th>
<th>France Mean</th>
<th>France Standard deviation</th>
<th>Germany Mean</th>
<th>Germany Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile</td>
<td>–0.63</td>
<td>0.34</td>
<td>–0.35</td>
<td>0.20</td>
</tr>
<tr>
<td>Fixed</td>
<td>1.04</td>
<td>0.36</td>
<td>–0.71</td>
<td>0.36</td>
</tr>
<tr>
<td>Network</td>
<td>0.80</td>
<td>0.20</td>
<td>0.65</td>
<td>0.15</td>
</tr>
<tr>
<td>Viag</td>
<td>0.06</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

27Variance inflation statistics (VIF) is an index that measures how much the variance of a coefficient (square of the standard deviation) is increased because of collinearity (see Wooldridge, 2000). The VIF values for time trend in the pricing regression are 521 and 140 for France and Germany respectively. In the case of demand estimation using OLS the respective values of VIF are 145 and 58.

28In fact, before 1998, the low-end prices of network operators in France were roughly at the same level as in Germany in January 1998, or even slightly higher. Unfortunately, comparable data on prices of mobile services in Germany before January 1998 are not available. There was a drastic decrease in prices in France before January 1998 when fixed-line telecommunications markets were liberalized. This was mainly due to the introduction of prepaid tariffs but may potentially suggest that there was fierce price competition before 1998 leading to drastic price decreases and prices subsequently stabilized at a relatively competitive level.
results of the household survey conducted by the European Commission across the EU member states (see Eurobarometer, 2006). According to this survey the substitution of mobile and fixed-line subscriptions varies significantly across the EU countries. In one of the survey questions consumers were asked whether they would give up fixed-line connection if the prices of mobile and fixed-line services were equal. The percentage of consumers who answered this question positively was twice as high in France (29 per cent) as in Germany (14 per cent). Also Fig. 6 shows that over a longer period of time fixed-line subscriptions keep decreasing in France and increasing in Germany, which is in accordance with our findings.

The remaining results of demand estimation are as follows. There are significant network effects in both countries, which appear to be stronger in France (see Table 3). If the previous period installed base in France increased by 1 per cent, current period penetration would surge on average by 0.80 per cent. The respective increase in penetration in Germany would be 0.65 per cent.

There is a significant Christmas sales effect in both countries. Moreover, in Germany, the entry of Viag in November 1998 increased penetration, which may be due to consumer preference for variety. However, there was no positive impact on demand due to entry of Quam in November 2001.29

Finally, there was no slowdown in demand for mobile subscriptions in France between 2000 and 2002, i.e. in the period of the share-fixing

---

29As mentioned before, Quam attracted only about 200,000 consumers in the period of one year. Lack of significant product differentiation and own installed base as well as the inability to charge lower prices than the competitors could have been the reasons for its failure.
agreement. The coefficient on the dummy for share-fixing agreement, however, is significant and negative when time trend is included in the estimation. According to the official position of the CdC the share-fixing agreement reduced competition in the market resulting in a slowdown in the adoption of mobile telephony in France.

Table 4 presents estimation results for pricing regressions using OLS. Three specifications are estimated: (i) with time trend; (ii) with yearly dummies; and (iii) without time effects. In the first two cases, as in the demand estimation, there is a severe multicollinearity due to high correlation of time trend or yearly dummies with lagged penetration and other variables. Therefore, we discuss below the results of a third specification. Nevertheless, the significance and sign of the coefficient on the dummy for the period of share fixing remain unchanged for all three specifications.

The estimation of market pricing equations does not provide clear support for the findings on substitution/complementarity of mobile and fixed-line subscriptions that is suggested by demand analysis. The coefficient on the price index for fixed-line telephony is significant and negative for France, which according to equation (9) implies substitution between mobile and fixed-line services. It is insignificant for Germany, however, which suggests that mobile prices are set independently from the prices of fixed-line communications.

In the estimation results, a dummy for the period of share fixing has a significant coefficient but with a negative sign, which suggests that market prices in France were lower in 2000–2002 than in the years before. The pricing regression compares statistically price levels in two time periods but we cannot state that an observed price decrease was due to the share-fixing agreement. However, according to the CdC the three operators simultaneously adopted strategies aimed at consolidating their existing customer bases, which among other things led to price increases in years 2000–2002. This does not seem to be the case in our data.

The coefficient on lagged penetration is significant and negative for both France and Germany, which implies that increasing penetration leads to price decreases. According to equation (9) the expected sign of the coefficient on lagged penetration is positive. However, as already mentioned, this variable is collinear with time trend. Hence, the negative sign on lagged penetration may be due to decreasing marginal costs associated with innovation. In fact, when the time trend variable is used in the estimation of pricing equations, its coefficient is significant and positive for France and negative but insignificant for Germany.

Finally, the entry of Viag and Quam did not have any impact on market prices in Germany. The Christmas dummy for Germany is significant and negative, suggesting that there are decreases in prices in the period preceding Christmas. However, its coefficient is insignificant for France. The estimates of marginal cost factors differ by country. The costs of labour and capital are
### Table 4

**Estimation of Reduced-form Pricing Equations**

<table>
<thead>
<tr>
<th></th>
<th>OLS I t</th>
<th>Pr &gt; t</th>
<th>OLS II t</th>
<th>Pr &gt; t</th>
<th>OLS III t</th>
<th>Pr &gt; t</th>
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<tbody>
<tr>
<td><strong>France</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price fixed</td>
<td>0.695</td>
<td>1.60</td>
<td>0.116</td>
<td>0.672</td>
<td>1.45</td>
<td>0.152</td>
</tr>
<tr>
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<td>-0.191</td>
<td>-2.05</td>
<td>0.045</td>
<td>-0.171</td>
<td>-5.54</td>
<td>0.001</td>
</tr>
<tr>
<td>Christmas</td>
<td>-0.008</td>
<td>-0.44</td>
<td>0.659</td>
<td>0.015</td>
<td>0.81</td>
<td>0.420</td>
</tr>
<tr>
<td>Lagged penetration</td>
<td>0.723</td>
<td>1.77</td>
<td>0.084</td>
<td>1.826</td>
<td>4.39</td>
<td>0.001</td>
</tr>
<tr>
<td>Bonds</td>
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<td>1.57</td>
<td>0.122</td>
<td>-5.901</td>
<td>-3.43</td>
<td>0.001</td>
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<td>Labour</td>
<td>-3.606</td>
<td>-3.66</td>
<td>0.001</td>
<td>9.311</td>
<td>6.52</td>
<td>0.001</td>
</tr>
<tr>
<td>Year 1999</td>
<td>-0.085</td>
<td>-5.76</td>
<td>0.000</td>
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</tr>
<tr>
<td>Year 2000</td>
<td>-0.027</td>
<td>-1.82</td>
<td>0.075</td>
<td></td>
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<tr>
<td>Year 2001</td>
<td>-0.008</td>
<td>-1.21</td>
<td>0.230</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Intercept</td>
<td>3.718</td>
<td>3.46</td>
<td>0.001</td>
<td>-8.776</td>
<td>-5.21</td>
<td>0.001</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.958</td>
<td>0.947</td>
<td>0.887</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Germany</strong></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Price fixed</td>
<td>-0.232</td>
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<td>0.207</td>
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<td>0.222</td>
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<td>Viag dummy</td>
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<td>0.748</td>
<td>0.026</td>
<td>1.08</td>
<td>0.283</td>
</tr>
<tr>
<td>Quam dummy</td>
<td>0.054</td>
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<td>0.181</td>
<td>0.075</td>
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<tr>
<td>Christmas</td>
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<td>0.002</td>
<td>-0.039</td>
<td>-2.64</td>
<td>0.011</td>
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<tr>
<td>Lagged penetration</td>
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<td>0.036</td>
<td>-0.186</td>
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<td>0.113</td>
</tr>
<tr>
<td>Bonds</td>
<td>-6.591</td>
<td>-4.83</td>
<td>0.000</td>
<td>-5.847</td>
<td>-4.75</td>
<td>0.000</td>
</tr>
<tr>
<td>Labour</td>
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<td>0.43</td>
<td>0.670</td>
<td>2.114</td>
<td>3.28</td>
<td>0.002</td>
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<td>Year 1999</td>
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<td>2.87</td>
<td>0.006</td>
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<td></td>
</tr>
<tr>
<td>Year 2000</td>
<td>0.079</td>
<td>2.22</td>
<td>0.031</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Year 2001</td>
<td>0.026</td>
<td>1.26</td>
<td>0.214</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Year 2002</td>
<td>0.009</td>
<td>0.97</td>
<td>0.338</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>1.123</td>
<td>1.87</td>
<td>0.068</td>
<td>-1.025</td>
<td>-1.40</td>
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<tr>
<td>Adjusted $R^2$</td>
<td>0.954</td>
<td>0.960</td>
<td>0.949</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
insignificant for France. The cost of labour is also insignificant for Germany. The cost of capital has a significant but unexpectedly negative sign.\textsuperscript{30}

6 Conclusion

This paper analyses the development of mobile telecommunications markets in France and Germany in relation to the antitrust investigation initiated by the French competition authority. The empirical analysis is based on aggregate industry data on subscriptions and prices and consists of separate estimation of (i) demand for mobile subscriptions using the binomial logit model, and (ii) reduced-form pricing equations.

Our analysis finds that the price elasticity of demand for mobile services is significantly higher in France than in Germany. Moreover, consumers seem to perceive mobile telephony as a substitute for fixed-line connection in France and as a complement in Germany. Thus, network operators in France may have to compete with fixed-line providers, which results in lower market prices. On the other hand, decreasing prices of fixed line in Germany stimulate demand for mobiles without imposing a competitive pressure on mobile providers.

With respect to the antitrust investigation, the estimation results suggest that in the time period of the share-fixing agreement among French network operators there were no adverse shifts in the levels of prices and subscriptions. In fact, the dummy for the time period of the share-fixing agreement has a significant negative coefficient in the pricing regression. This suggests that market prices in France were lower in 2000–2002 than in the years before even though the share-fixing agreement was in place.

In conclusion, the results of this empirical analysis suggest that the French mobile telecommunications industry may be relatively competitive, if indeed consumers perceive mobile and fixed-line services as substitutes and demand for mobile subscription is more elastic than in Germany. As illustrated and discussed in this paper, the issue of dependences between mobile and fixed-line services may have important consequences for antitrust investigations in telecommunications markets. Therefore, there is a need for further analysis of these dependences based on consumer, firm and industry-level data.

References


\textsuperscript{30}We tested different model specifications in which apart from the costs of labour and capital we used a variable that represents the cost of electronic equipment. It turned out however to be collinear with other explanatory variables causing estimation problems.


