CROWDING OUT OR COMPLEMENTARITY IN THE TELECOMMUNICATIONS MARKET?

Ricardo Ribeiro (LSE) *João Vareda (FEUNL)*

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Motivation

There is a substantial number of cases where the relationship between products is not clear

- print and online newspapers
- free file-sharing services and recorded music
- file-sharing services and live concerts
- public and private broadcast channels
- online and offline retailing

Paper Objective

This paper aims to study the relationship between fixed and mobile telephony

Technically, mobile is a substitute because users can place and receive voice calls just as they do with fixed service

An alternative view is that fixed and mobile services are complementary, since calls originating from mobile phones benefit fixed phone subscribers

Roadmap

1. The nature of the relationship between fixed and mobile communications is an empirical issue

2. We propose to estimate a structural continuous-choice demand model for the UK communications market

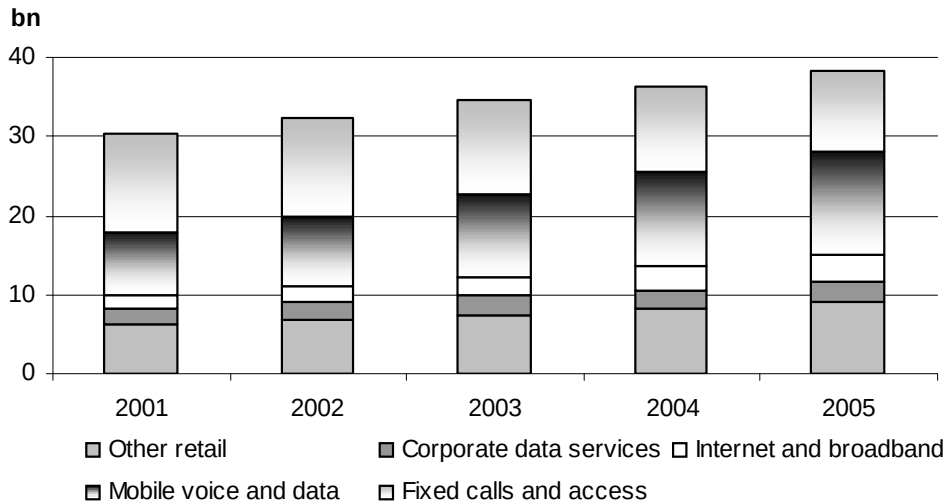
3. Given that the model is micro-founded, we also address the question of how the evolution of the price differential between the two types of communication may affect consumers and firms.

4. Finally, we aim to present some economic policy implications.

Overview Retail Revenues

The industry has a significant contribution to UK GDP (2.2% in 2003 according to the Office for National Statistics)

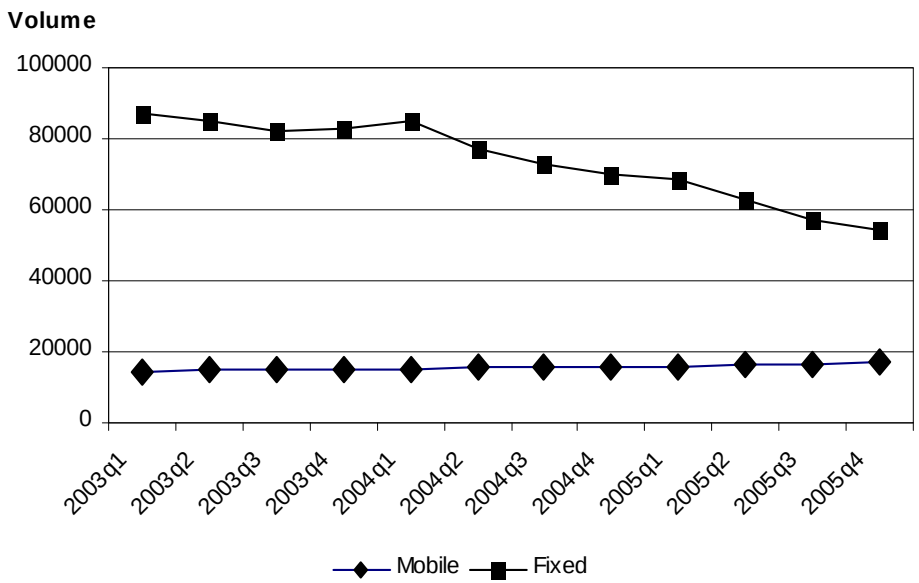
The share of mobile telecoms retail revenue has been clearly increasing over time at the expense of fixed lines



Retail Revenue, Source: Ofcom, 2006

Overview Retail Volumes

Retail volumes have been following a similar trend with the share of mobile telecoms call volumes clearly increasing over time at the expense of fixed lines

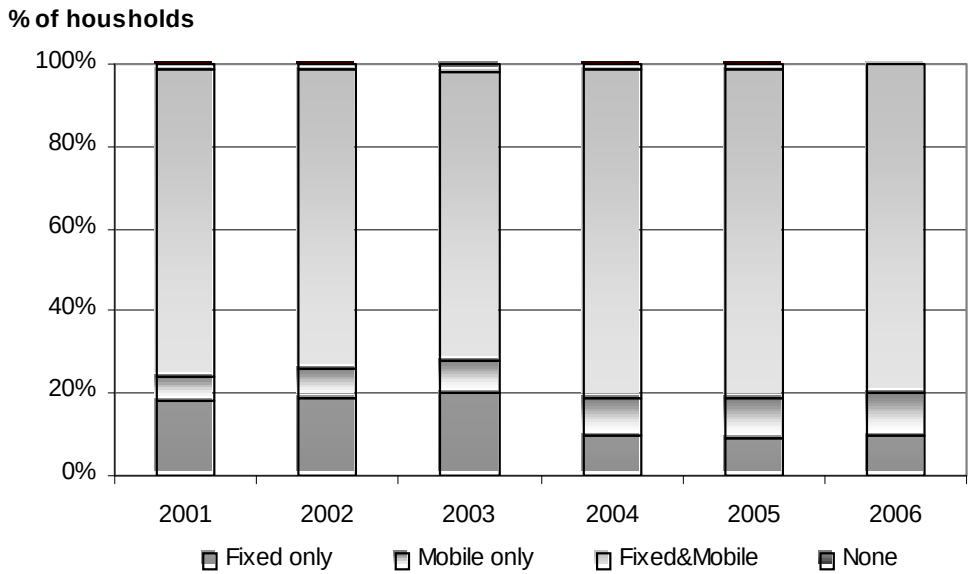


Total Call Volumes, Source: Ofcom, 2006

The retail revenue and volumes trends suggest the existence of substitutability between these two types of services

Household Penetration

The increasing proportion of households that rely on both mobile and fixed telephony suggests a complementarity



Household Penetration, Source: Ofcom, 2006

Calls to fixed lines still constitute the biggest share of an average subscriber's mobile use

Overview Competition Framework

Six main network operators

- Mobile: Vodafone, O2, T-Mobile and Orange

  After a slow start from these two last networks, since 2000 the four operators became very similar in terms of market shares

- Fixed: BT and NTL: Telewest

  BT is still the biggest player with more 56% of the volume of fixed calls in 2005 against a market share near 14% for NTL: Telewest

Fixed-Mobile Substitution

TABLE 1 - PRIOR STUDIES

	Complements	Substitutes
Rodini et al. (2003)		x
Sung et al. (2000)	x	x
Ahn and Lee (1999)	x	
Taubman and Vagliasindi (2004)	x	x
Hamilton (2003)	x	x
Okada and Hatta (1999)		x

Impact of Fixed Phone on Mobile Phone Diffusion

- Gruber and Verboven (2001a) find that the stock of fixed phones has a negative influence on the diffusion of mobile phones in all members of the European Union
- Gruber (2001) obtains the opposite result that mobile telecommunications are a complement to fixed line telecommunications in Central and Eastern Europe
- Barros and Cadima (2000) study a complementary question, and find a negative effect of the mobile phone diffusion on the fixed-link telephony penetration rate

Telephony Communications Modelling

- Doganolu and Grzybowski (2006) estimate a nested logit model to estimate the demand for subscriptions of mobile telephony
- Lee et al. (2006) estimate switching costs in the Korean mobile telecommunications using a random coefficients multinomial model
- Grzybowski (2007) uses a multinomial and mixed logit model to estimate switching costs in mobile telephony
- Okada and Hatta (1999) estimate an Almost Ideal Demand System for the Japanese telephony industry

Modelling Approach

We propose to estimate a structural continuous-choice demand model following Pinkse et al. (2002), Pinkse and Slade (2004), and Slade (2004) with distinct advantages over the models under the standard approaches

- it is micro-economic founded on an indirect utility function from which, via Roy's identity, a demand system is derived
- does not *a priori* restrict the different products to be either strong substitutes, independent or strong complements
- incorporates a structural (and not a add-hoc) error term

Individual Consumer Demand

Consider J inside options, $j = 1, \ldots, J$, and an outside option, $j = 0$, that aggregates all other products

The indirect utility function of consumer h is given by

$$u_h(p, y_h) = \sum_{i=1}^{J} \gamma p_i y_h - \sum_{i=1}^{J} a_{hi} p_i - \sum_{i=1}^{J} \sum_{j=1}^{J} b_{hij} p_i p_j$$

The demand system can be derived by Roy's identity

$$q_{hm}(p, y_h) = -\frac{\partial u_h(p, y_h)/\partial p_m}{\partial u_h(p, y_h)/\partial y_h} = -\frac{\gamma y_h - a_{hm} - 2\sum_{i=1}^{J} b_{hmi} p_i}{\sum_{i=1}^{J} \gamma p_i}$$

Aggregated Consumer Demand

Normalizing $\sum_i \gamma p_i = 1$ and aggregating the individual demand functions, we obtain

$$q_m(p, y) = a_m + \sum_{j=1}^{J} b_{mj} p_j - \gamma y$$

Aggregate demand function is completely deterministic, thus we introduce the random utility hypothesis in a way akin to Pinkse et al. (2002)

$$a(x_m, \xi_m) = \sum_{k=1}^{K} \beta_k x_{mk} + \xi_m$$

The unobserved characteristics ensure that the error term is structurally embedded in the model

$$q_m(x, p, y) = \sum_{k=1}^{K} \beta_k x_{mk} + \sum_{j=1}^{J} b_{mj} p_j - \gamma y + \xi_m$$

Dimensionality Problem

Map the $\{b_{ij}\}$ parameters in the characteristics space

$$b_{ii} = \sum_{k=1}^{Kd} \lambda_k x_{ik} \quad \text{and} \quad b_{ij} = \sum_{k=1}^{Kc} \delta_k \left(\frac{1}{1 + 0.01 \left| x_{ik} - x_{jk} \right|} \right)$$

The model to be estimated becomes

$$\begin{aligned} q_{mt}(x, p, y) &= \sum_{k=1}^{K} \beta_k x_{mkt} + \sum_{k=1}^{Kd} \lambda_k x_{mk} p_{mt} \\ &+ \sum_{k=1}^{Kc} \sum_{j \neq m} \delta_k \left(\frac{1}{1 + 0.01 \left| x_{mk} - x_{jk} \right|} \right) p_{jt} - \gamma y_t + \xi_{mt} \end{aligned}$$

Elasticities

The own- and cross-price elasticities predicted by the model for any given products m and n, are the following

$$\varepsilon_{mm}(x, p, y) = \left(\sum_{k=1}^{Kd} \lambda_k x_{mk}\right)\left(\frac{p_m}{q_m(x,p,y)}\right)$$

$$\varepsilon_{mn}(x, p, y) = \sum_{k=1}^{Kc} \delta_k \left(\frac{1}{1+0.01\left|x_{mk}-x_{jk}\right|}\right)\left(\frac{p_n}{q_m(x,p,y)}\right)$$

Products m and n, for all $m \neq n$, are substitutes if $\varepsilon_{mn} > 0$, independent if $\varepsilon_{mn} = 0$, and complements if $\varepsilon_{mn} < 0$

Data Sources

- Information on call volume, call revenues and network size from Ofcom - Office of Communications
- Market-level cross-sectional time series for the United Kingdom telecoms market, disaggregated by operator (BT, Vodafone, O2, ...) and quarter (from 2003:1 to 2005:4)
- Complemented with data with information on the number of employees, operational costs and costs with employees from the AMADEUS database
- Income information was obtained from the ONS - Office for National Statistics

Raw Data

TABLE II - SUMMARY STATISTICS

	Mean	Std
Call Volume (millions of minutes)	12,092	16,781
Call Revenue (£millions)	776	538
Price (£)	0.115	0.055
Network (000's)	14,550	6,883

TABLE III - DISAGGREGATED MEANS AND STANDARD DEVIATIONS

	Mean		Std	
	Mobile	Fixed	Mobile	Fixed
Call Volume (millions of minutes)	3,891	28,493	461	21,160
Call Revenue (£millions)	594	1,140	117	811
Price (£)	0.152	0.041	0.169	0.004
Network (000's)	13,707	16,235	948	11,831

Reduced-Form Results

TABLE IV - FIXED/MOBILE CORRELATION

Variable	
MOBILE VOLUME	-3.070 **
	(-2.20)
TREND	-2,230 ***
	(-8.65)
CONSTANT	119,257 ***
	(5.71)
R-squared	0.957

FIXED VOLUME as independent variable.

Asymptotically robust t-ratios in parentheses.

Reduced-Form Results (cont.)

TABLE V - VOLUME CORRELATIONS

Pairs	Correlation	*p-value*
BT/Vodafone	-16.915	0.000
BT/O2	-3.825	0.161
BT/T-mobile	12.113	0.030
BT/Orange	-7.932	0.098
ntl:Telewest/Vodafone	-1.981	0.000
ntl:Telewest/O2	-0.774	0.019
ntl:Telewest/T-mobile	1.347	0.118
ntl:Telewest/Orange	-0.736	0.309

Identification

The demand specification may give rise to an hypothetical correlation between the regressors and the error term

- As a result, OLS estimates could be inconsistent and instrumental variables techniques are, therefore, required

Our estimation procedure relies on two identification assumptions:

- First, we will assume, as it is standard in the literature, the unobserved characteristics to be mean independent of the observed ones
- Second, we will assume two operational ratios to be valid instruments: the ratio of operational costs to volume and the ratio of costs with employees to their respective number

Estimation Results

TABLE VI - DEMAND ESTIMATION RESULTS

Variable	(OLS)	(IV)
PRICE	-1,250,688 ***	-1,293,902 ***
	(-11.83)	(-9.44)
PRICEM	1,092,271 ***	1,028,032 ***
	(8.05)	(4.84)
PRICEN	9.417 **	11.710 *
	(2.28)	(1.98)
DIFNSAME	5,656	24,329 *
	(1.49)	(1.75)
DIFNOTOHER	-611,257 ***	-614,913 ***
	(-6.46)	(-5.32)
INCOME	-0.044	-0.055
	(-1.03)	(-0.93)
Product Dummies	yes	yes
Time Dummies	yes	yes
First stage F	—	—
R-squared	0.997	—

All regressions are based on 128 observations.

Asymptotically robust t-ratios in parentheses.

Firm's Elasticities

TABLE VII - MEDIAN OWN- AND CROSS-PRICE ELASTICITIES

		1	2	3	4	5	6
1	Vodafone (mobile)	-4.647	0.531	0.355	0.494	-0.354	-0.611
2	O2 (mobile)	0.698	-3.993	0.530	0.814	-0.403	-0.631
3	T-Mobile (mobile)	0.577	0.655	-3.926	0.749	-0.478	-0.679
4	Orange (mobile)	0.623	0.779	0.580	-3.961	-0.401	-0.611
5	BT (fixed)	-0.115	-0.119	-0.115	-0.124	-0.767	0.001
6	ntl:Telewest (fixed)	-1.071	-1.009	-0.878	-1.019	0.004	-5.522

Each cell gives the % change in market share of the row's product with a 1% change in the price of the column's product.

Aggregated Elasticities

TABLE VIII - MEDIAN AGGREGATED ELASTICITIES

	Mobile	Fixed
Mobile	-2.319	-1.036
Fixed	-1.011	-1.497

Each cell gives the % change in market share of the row's product with a 1% change in the price of the column's product.

- Mobile calls demand is therefore slightly more elastic than fixed calls with respect to own-price
- The magnitude of these results seem somewhat high. Not surprisingly though as the elasticities refer to i) volume and not subscription and ii) quarterly and not monthly data

Literature Robustness Checks

- Rodini et al. (2003) estimate a own-price elasticity of mobile access demand with respect to the monthly charge is -0.43. Regarding fixed lines subscription, the own-price elasticity is -0.65 for the second fixed line and -0.1 for first fixed line
- Hausman (1999) reports a price elasticity of subscription of -0.51 in the 30 largest U.S. markets
- Ahn and Lee (1999) infer a elasticity of -0.36

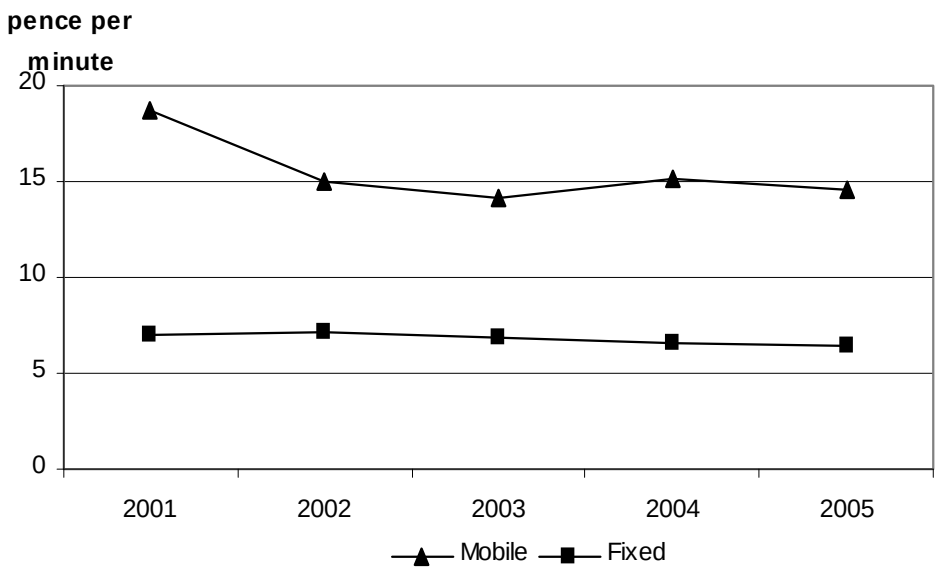
Literature Robustness Checks (cont.)

- Parker and Röller (1997) find an own-price elasticity of -2.5
- Doganoglu and Grzybowski (2005) estimate demand for subscription and finds own-price elasticities between -4.2 and -5.04
- Rodini et al. (2003) estimates a cross-price elasticity of fixed access price on mobile demand of 0.13-0.18 and a cross-price elasticity from mobile access to fixed line subscription of 0.06-0.08

Price Trends

The price differential has decrease around 30% between 2001 and 2005

This trend was mainly due to the 22% decrease in the price of mobile communications against a decrease of 7% in the price of fixed communications



Average charges, Source: Ofcom, 2006

Welfare and Profit Measures

We evaluate the welfare impact results for both consumers and producers as a result of hypothetical future price trends

- Equivalent Variation (EV)

$$u\left(p^0, y + EV\right) = u\left(p^1, y\right)$$

- Change in Profits

$$\Delta \Pi_f = p_f^1 D_f\left(p^1\right) - p_f^0 D_f\left(p^0\right) - mc_f\left(D_f\left(p^1\right) - D_f\left(p^0\right)\right)$$

Welfare Results

TABLE IX - WELFARE IMPACT OF COMMUNICATION PRICE TRENDS

	1 Year	5 Years
Consumer welfare change in £ per subscriber per day	£0.48	£3.25
Profit change in £ per subscriber per day for mobile firms		
$mc_f = 0.05p_f$	£0.03	£0.05
$mc_f = 0.10p_f$	£0.03	£0.04
$mc_f = 0.20p_f$	£0.02	£0.03
Profit change in £ per subscriber per day for fixed firms		
$mc_f = 0.05p_f$	£0.07	£0.28
$mc_f = 0.10p_f$	£0.06	£0.26
$mc_f = 0.20p_f$	£0.05	£0.22

The welfare impact was computed using 2005:4 values as comparison.

Conclusion

- We estimate a structural continuous-choice demand model following Pinkse et al. (2002), Pinkse and Slade (2004), and Slade (2004), and find that at the current diffusion stage, fixed and mobile communications appear to be complements

- Competition generally tends to improve industry performance and productivity. The main concern over competition in these markets derives from the market power held by incumbent fixed network

Conclusion (cont.)

- Our estimates indicate that mobile calls are not substitute, but a complement for fixed calls. Therefore we cannot expect the mobile services to constrain the market power of BT

- On the contrary, the two services appear to coexist in households, each providing consumers with particular advantages. Hence, policies promoting the opening up of incumbent's network aided by regulatory intervention may still be necessary