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Market structure and investment in the mobile industry[☆]

François Jeanjean[a,*], Georges Vivien Houngbonon[b]

[a] Orange, 78 rue Olivier de Serres, 75505, Paris Cedex 15, France
[b] Institut d'Economie Industrielle (IDEI), 21 Allée de Brienne, 31000 Toulouse, France & Paris School of Economics (PSE), 48 Boulevard Jourdan, 75014, Paris, France

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ABSTRACT

The impact of market structure, that is the number of firms and asymmetry, on investment is an important topic in the mobile industry. However, previous literature remains ambiguous about the direction of the relationship. This paper provides an empirical evidence of the impact of market structure on investment in the European mobile industry. The empirical assessment is based on a Salop model with vertical differentiation. Consistently with the prediction of this model, we find that both the number of operators and market share asymmetry have significant effects on investment. In symmetric markets, investment per operator falls with the number of operators, with larger effects for operators that lose market share more than the average. The industry investment rises with the number of operators in the short run, but eventually falls in the long run due to significant adjustment costs of investment in the mobile industry. These findings suggest that investment should be taken into account when analysing the *welfare* effects of market structure in the mobile industry.

1. Introduction

The impact of market structure, that is the number of firms and asymmetry, on investment has become an important topic in the mobile industry in the context of market concentration as underscored by the 4-to-3 mergers cleared in Austria. The ex-post effects of these changes in market structure have fuelled an ongoing policy debate, particularly in the European Union resulting in tougher scrutiny on future entry and merger in the industry.[1] As a matter of fact, a 4-to-3 merger was cleared in Germany, whereas others have been blocked in Denmark and the United Kingdom. A key issue in the policy debate is whether or not investment in mobile networks is endogenous, that is whether it is affected by market structure.

Existing theoretical literature predicts an ambiguous effect of market structure on investment.[2] In symmetric markets, Vives (2008) finds that investment in cost-reducing innovations falls with the number of firms, provided that demand elasticity is sufficiently small. In asymmetric markets, Schmutzler (2013) shows that the effect of market structure on investment tends to be negative for less efficient firms.

In this paper, we investigate the impact of market structure on investment in the European mobile industry, taking into account adjustment costs of investment. Market structure is defined by the number of operators and their market share asymmetry. This latter is measured as the difference between an operator's market share and the average market share. Investment is measured as the logarithm of capital expenditures, excluding licence fees. We account for the adjustment costs of investment by estimating a dynamic econometric model that links investment to its lagged values. The econometric model is derived from a Salop model with vertical differentiation. Vertical differentiation stems from investment that either lowers marginal costs or increases quality, two key features of investment in mobile networks. The theoretical model predicts that investment in mobile networks depends on the number of

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* Corresponding author at: Orange, 78 rue Olivier de Serres, 75505, Paris Cedex 15, France.
E-mail addresses: francois.jeanjean@orange.com (F. Jeanjean), gvivienh@gmail.com (G.V. Houngbonon).

[1] See the report by the OECD which highlights a positive relationship between the number of mobile operators and investment in quality (OECD, 2014), and the report by the Centre on Regulation in Europe which suggests a negative relationship between the number of mobile operators and investment (Genakos et al., 2015).

[2] See Schumpeter (1942) and Arrow (1962) for earlier analyses of the link between competition and innovation.

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operators and their asymmetry in terms of quality. More specifically, in symmetric markets, investment per operator falls with the number of operators, and this effect tends to be larger for lower-quality operators.

In accordance with the predictions of the theoretical model, we formulate a dynamic panel econometric model that links investment to the number of operators, market share asymmetry and the lagged values of investment, controlling for operator fixed effects, market characteristics and year fixed effects. The identification of the parameters relies on the Arellano–Bond estimator, a two-step system generalised method of moments estimator. We use 3-to-5 years lagged values of investment as instruments, ensuring that there is no serial correlation. We also use political ideology, mobile termination rates and population size as instruments for the number of mobile operators, market share asymmetry and market size, respectively.

Consistently with the predictions of the theoretical model, we find that investment per operator falls with the number of operators. This negative effect is larger for operators that lose market share more than the average. The industry investment tends to rise in the short run, but eventually falls in the long run due to significant adjustment costs of investment in the mobile industry. The magnitude of the long run effect amplifies the short run effect by a factor of up to 5. These findings are robust to market characteristics such as market size, consumers' income, competition from fixed lines, cash flow and retail prices.

This paper is amongst the first to show that market structure has significant effects on investment in the mobile industry. Theoretical papers such as Vives (2008) and Schmutzler (2013) find that investment in cost-reducing technologies tends to decrease with the number of firms. Boone (2000) emphasizes the role of cost efficiency gap between firms in determining how competition affects their investment incentives. Few empirical papers provide evidence for these theoretical propositions. The findings of this paper lend support to these theoretical predictions. Sacco and Schmutzler (2011) show that the relationship between competition and investment can be U-shaped. Our findings suggest a monotone effect of market structure on investment in symmetric markets. However, this relationship strongly depends on asymmetry. Beneito et al. (2015) test the effect of competitive pressure, measured by the degree of product differentiation and market size, on investment in a free entry setting, thus excluding the analysis of the effect of market structure. Consistent with their results, we also find a positive effect of market size on investment per operator.

The remaining of the paper is organised as follows. Section 2 presents the theoretical model. Section 3 outlines the empirical framework, and in particular the data, econometric model and estimation strategy. Section 4 reports and discusses the results while Section 5 concludes.

2. Theoretical background

In this section, we start by summarising the relevant findings from Vives (2008) in symmetric markets and Schmutzler (2013) in asymmetric markets. Then we focus on how market structure affects investment in the mobile industry using a Salop model with vertical differentiation as this provides a good representation of the mobile market. Salop's model is an extension of the Hotelling model often used to describe telecommunication markets characterised by price competition with horizontal and vertical differentiation (Laffont et al., 1998). The Hotelling model represents a duopoly and the Salop model extends to a more general oligopolistic market structure. In particular, it can be used to compare market outcomes when the number of firms changes. Moreover, the predictions of this theoretical model will be useful in specifying our econometric model.

Vives (2008) shows that, in a symmetric market, the number of firms impacts investment and output in the same way. He shows that, generally, an increasing number of firms decreases both production and investment in each firm. This may occur when the growth of the total market size does not compensate for the decline in per-firm market share. According to Vives, the decrease in market share, called demand effect, is a direct consequence of the rise in the number of firms, while the growth of market size is an indirect outcome (price-pressure effect). The rise in the number of firms tends to reduce prices and thus increase consumer participation and market size. In the case where the market is close to full coverage, the demand of the industry is weakly sensitive to price or market structure changes. In this case, the price-pressure effect is weak and the demand effect would likely dominate. Therefore, an increase in the number of firms has a negative impact on investment.

In our model, we assume that the market is fully covered in order to limit the price-pressure effect. This is consistent with the mobile industry where, in most countries, the penetration rate is sufficiently high such that we can expect the demand effect to dominate.[3] In the empirical model, we control for the growth of market size.

Schmutzler (2013) shows that in asymmetric markets, smaller firms are more sensitive to changes in market structure. We also verify this in both the theoretical and empirical models.

2.1. Settings of the model

All operators are located equidistantly around a circle where consumers are uniformly distributed. It is assumed that product space is totally homogeneous, thus the location of operators does not matter. The perimeter of the circle and the density of consumers are equal to unity and consumers move around the circle with a transportation cost equal to t to purchase one unit of the good from one of the operators.

We consider a restricted entry regime where the number of operators, $N > 1$, is exogenously determined by regulation. The distance between two operators is $1/N$. We also assume that the gross consumer surplus s of each operator is high enough such that the market is fully covered. The demand for operator i's variety is q_i and the demand of the industry is $Q = \sum_{i=1}^{N} q_i$, where $q_i = Q\sigma_i$. Q is a constant since the market is fully covered and σ_i is the market share of operator i. We normalise $Q = 1$ and consider the following two-stage game:

In the first stage, operators choose their investment z, which determines the level of quality of their variety. For operator i, we define the level of quality as $d_i = s_i - c_i$, where c_i represents the constant marginal cost of production and s_i is the gross surplus of purchasing from that operator ($c_i \leq s_i$). This definition reflects the fact that higher quality may result from higher consumer surplus or lower marginal cost of production. In order to choose the quality d_i, operator i invests an amount $z_i(d_i)$ increasing and convex with d_i and incurs a sunk fixed cost F to enter the market.

In the second stage, operators compete in price and operator i sets price p_i. The game is solved by backward induction.

The utility of a customer located at a distance x from operator i to purchase from that operator is: $U_i = s_i - tx - p_i$, and the utility from purchasing from operator $i+1$ is: $U_{i+1} = s_{i+1} - t(\frac{1}{N} - x) - p_{i+1}$. An indifferent consumer between operators i and $i+1$ is located at:

$$x = \frac{1}{2N} + \frac{(s_i - p_i) - (s_{i+1} - p_{i+1})}{2t}$$

[3] Worldwide subscription penetration rate in 2015 is close to 100% and user penetration rate is over 65%. (Worldwide cellular user forecast 2015–2020, Strategy Analytics).