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Determinants of European telecommunication operators systematic risk

Olivier Chalmeau

Abstract

This article studies the determinants of systematic risk for a panel of European telecommunication incumbent operators. The systematic risk (the beta coefficient) is estimated with the capital asset pricing model using different econometric methods (OLS, ML GARCH and Kalman Filter).

Previous empirical literature has identified accounting variables as being determinants of systematic risk. These control variables serve as a basis to study the impact of regulation and competition on risk. The Polynomics regulatory index is used for regulation and Herfindahl-Hirschman Indexes for competition.

The overall index of regulation doesn't have a clear impact on risk. However, sub-indexes indicating quantity regulation is associated with higher risk. By quantity, we mean regulatory constraints such as Universal service obligation or coverage obligation for mobile networks. In contrast, access regulation decreases the risk. The impact of the competition's intensity is different for the mobile and fixed markets. Results for mobile competition are not significant whereas more intense fixed competition is associated with less risk.

These results are consistent with the interpretation that regulation and competition have reduced the investment of the sector. It is also consistent with the observation that competition has taken place on services rather than on infrastructures.

1 Introduction

The aim of this paper is to analyze the determinants of systematic risk[1] for European Telecommunication Operators (ETO). A focus is made on sector specific determinants such as the intensity of regulation and competition.

The systematic risk is the key parameter of the cost of capital. The cost of capital being the minimum remuneration required by investors for a given level of systematic risk. In other words, a higher risk implies a higher remuneration of the capital. The study of the determinant of systematic risk is of a particular importance for the telecommunication sector for three reasons.

The first one is that the sector has important investment needs. Indeed, the telecommunication industry is very capital intensive and has high technical progress rate (Koh and Magee, 2006).

The second reason is that the sector is regulated on various aspects. One of the major concerns of the regulator, is to promote competition without deterring investment. If the regulator makes a decision which increases the risk of the sector, it will increase the cost of capital and it may reduce the investment if profits are not sufficient. Thus, there is a concern to allow enough profit in order to provide a sufficient remuneration to investors.

A third reason (closely linked to the second) is that, when setting a regulated price, regulators must estimate the weighted average cost of capital (WACC)[2]. For this purpose, they need to know the value of systematic risk. Unfortunately, this estimation is not straightforward and errors can be made when a regulator sets the appropriate WACC. It is impossible to know the true theoretical value of the WACC for two main reasons. Indeed various estimation methods exist, but they lead to different values. Even if efforts are made to homogenize practices to set the WACC, some discretion remains (IRG, 2007).

But beyond problems of measurement, the main concern comes from a potential forecast error. For instance, if the regulatory WACC is updated every year, it must be set taking into account the sector (risk) evolution for the coming year. Thus regulatory WACC must be forward looking. Unfortunately historical estimations are not necessarily good estimations of the future cost of capital.

[1]Portfolio theory makes a distinction between systematic risk and specific risk. Systematic risk, is the volatility that comes from the co-variation of a firm return with the entire market returns. Systematic risk, also called market risk is important since contrary to the specific risk it can't be diversified through a portfolio composition.

[2]The WACC takes into account the cost of equity capital and also the remuneration of debt holders. The cost is thus weighted between equity and debt.

Therefore, it appears fundamental to understand the main determinants of systematic risk in the telecommunication sector. Beyond traditional determinants of risk, regulation is certainly a key determinant because it modifies market outcomes. The impact of regulation on risk is complex and difficult to measure.

Until now, two sorts of empirical studies have been done[3]. One uses the event-study methodology which focuses on the short term impact and on very specific issues (events). Other methods try to link the regime of regulation[4] to risk. These studies deal with structural and long-term effects. However, the work of Gaggero (2007, 2012) shows that we cannot observe any effect when taking into account various countries and sectors. Only Grout and Zalewska (2006) succeeded in linking regulatory regime to risk because they take advantage of a clear case when the regulatory regime of the United kingdom was supposed to change.

The present study attempts to link regulation to systematic risk by focusing on the telecommunication sector. It allows taking more precise variables that may describe the regulatory framework more accurately than inter-sector comparison. For this purpose, the study considers a panel of 15 European telecommunication incumbents for a period going from 1997 to 2012. It completes an event study also focusing on European telecommunication operators (Chalmeau, 2012). The study is based on annual data thus taking into account more long-term and structural impacts of regulation.

The study will be conducted in two steps. The first one consists of the estimation of the risk parameters. For this purpose, we will rely on the Capital Asset Pricing Model (CAPM) since it is the reference within the European regulatory framework. Financial accounting variables which are traditionally used to explain firm systematic risk, serve as a set of control variables to check for the effect of regulation. We take advantage of a recent Index released by Polynomics to test the impact of regulation (Zenhaeusern et al., 2012). As regulation of the sector aims at increasing competition, we test also the impact of Herfindahl-Hirschmann index on risk.

The paper is organized as follows. Section 2 reviews the literature on regulation and systematic risk. Section 3 presents the methods and estimation results of systematic risk. Section 4 presents the explanatory variables used in the analysis. Section 5 analyses the empirical finding. Finally the last section concludes.

[3]We will come back in detail on these studies in the literature review section.

[4]For example Price Cap or Rate-of-return

2 Literature review

The European regulation of the telecommunication sector deals with various aspects such as price, quality of service, rules for investment and entry regulation. However, the theoretical literature has mainly focused on the effect of price regulation.

The Peltzman (1976) model has become a reference with the well-known **Buffering Effect**. The model is based on Stigler (1971) who argues that regulation results from a conflict between different groups of interest. In this framework, the regulator seeks the political support of consumers and firms. It leads to a trade-off between the interest of consumers (high consumer surplus - low price) with the interest of firms (high profit - high price). The maximization of political support leads to an equilibrium that is between the interests of the different parties. The model predicts that if a shock affects negatively (positively) firms profit, the regulator compensates this effect by increasing (lowering) the price. This redistribution implies that a cost shock will not be borne only by the firm but shared with consumers. Thus Regulated firms have less risk than unregulated ones because regulators buffer shocks.

Empirical studies have confirmed that the presence of regulation reduces systematic risk (Binder and Norton, 1999; Norton, 1985). The deregulation of the American telecommunication sector confirms the existence of the buffering effect for AT&T systematic risk (Chen and Merville, 1986).

Besides the comparison with non-regulated sector, different **regulatory regimes** are also known to influence systematic risk. The regulatory regime refers to the system used to set price. Generally, we differentiate between two families of regulation being cost-based-regulation (eg. Rate-of-return) and incentive-based-regulation (eg. Price Cap). On one hand, cost based regulation takes into account the entire profit function, it guarantees a return whatever the economic conditions are. On the other hand, incentive schemes take into account only the price, thus firms subject to those regulatory regimes have to face demand or cost shocks[5].

Therefore, the closer the regime is to incentive scheme, the higher will be the risk whereas cost-based regime protects firms from shocks and then induces less risk. This theoretical relation is confirmed by Grout and Zalewska (2006). These authors take advantage of a period when the UK government have considered changing the price cap regime for a profit sharing regime[6]. The study shows that systematic risk decreased from the announcement to the abandon of the reform.

[5]Indeed intermediate regime exists such as price-caps with cost pass-through.

[6]A regime characterized by a target profit. If the profit is higher than expected, the gains are shared with

Alexander et al. (1999) classify the regulatory regime applied in 19 countries from 1990 until 1995. Their results support the idea that incentive schemes induce more risk than cost-based schemes. However their analysis lacks of control variables. Thus the observed differences may result from non-observed factors. Recent articles confirm that this result is not robust to the introduction of control variables and to more rigorous econometric analysis (Gaggero, 2007, 2012). This relative lack of empirical evidence may be the sign that the type of regulation is too simplistic to describe the regulatory framework of one country.

Another way to study the interaction between regulation and risk is to focus on a particular regulatory decision. The "event study methodology" has been used to look at the impact on firm risk and returns (Binder, 1985). It allows measuring the impact of every kind of regulatory intervention. Many studies have focused on the UK (Buckland and Fraser, 2001b,a; Paleari and Redondi, 2005). Notably, these studies found that a decrease in the regulated price increases the systematic risk. This effect is particularly important when the decrease is not anticipated. It confirms that regulatory opportunism is source of risk. Paleari and Redondi (2005) argues that a stricter regulation (lower price) should necessarily lead to more risk. The water and electricity industries confirm their model.

However, Antoniou and Pescetto (1997) found that the risk of British telecom decreased with the announcements of lower prices. The authors' interpretation is that lower price deters entry of competitors. Another interpretation is that the decrease was lower than expected. Thus when the price is unveiled risk decreased.

A previous event study on European operator confirms this positive relation between risk and price (Chalmeau, 2012). This results is notably based on an event that took place on july 12th 2012. The European commissioner Neelie Kroes announced that access charge should stabilize to 9 euros. Neelie kroes said that the access charge should stabilize in order to allow operators to invest in next generation networks. But, these potential investments are important risk factors.

This event suggests that the effect of regulation on risk may be indirect. For instance, if a regulator makes a decision which increases the cost of investing in next generation networks, then, if the increase is sufficiently high, it may not be interesting enough to make this investment. In this case, instead of observing an increase of risk, we observe a decrease, not because the cost of capital is lower but because investment have not been made. In the case of the discourse of Neelie Kroes the aim was to foster investment which is potentially risky. We can call this a potential investment effect.

consumers. If on the contrary, the profit is lower losses are also shared.

Finally, as one of regulation purposes[7] is to enhance competition, we wonder how competition intensity impacts risk ? Panattoni (2009) reviews the literature linking intensity of competition to risk. She finds opposing conclusions both on theoretical and empirical field. Basically, competition may have positive, negative or no effect on risk.

In the telecommunication industry, the impact of competition will depend on its nature. Service-based competition leads to lower risk than infrastructure based competition because infrastructure based competition implies higher operating leverage[8]. The empirical investigation below will help to see what matters.

3 Systematic risk estimation

Systematic risk must be estimated because its value cannot be observed directly. If various estimation models co-exist, we made the choice of the Capital Asset Pricing Model (CAPM). Indeed, it has become the reference model for regulators, consultants and is the most used model by academics (IRG, 2007; Weber and Schaeffler, 2012).

The CAPM links the expected return of the firm i , $E[R_i]$, with market returns R_M :

$$E[R_i] = R_f + \beta_i (R_M - R_f)$$

Where R_f is the return of a risk free asset (risk free rate). The coefficient β_i, provides an estimation of the systematic risk.

The CAPM beta is generally estimated through ordinary least square (OLS) regressions. Other methods have been developed to take into account some shortcomings of the simple OLS regression. We pick up three other estimation methods : ML GARCH(1,1), Kalman filter and Kalman filter using GARCH (1,1) errors. For details on the kalman filter estimation see Antoniou and Pescetto (1997), Buckland and Fraser (2001b) or Chalmeau (2012). The kalman filter estimation using GARCH (1,1) errors is equivalent to Paleari and Redondi (2005).

These different kinds of estimations are used to check for the robustness of the results presented in relation to the methods of estimation.

[7] If not the principal in the European framework.

[8] Operating leverage being the importance of fixed cost relatively to variable costs. Higher operating leverage increases the sensibility of revenues to shocks.

For brevity's sake, all estimations will not be presented. Indeed the analysis or the conclusion do not differ for the different estimation technics[9]. The most common method of estimation is the OLS regression. Results that are displayed below (Table 1), present betas generated by this method.

Table 1: Descriptive Statistics of Beta OLS

Year	Mean	Median	Max	Min	Std. Dev	Obs.
1997	0,78	0,74	1,35	0,22	0,33	10
1998	0,88	0,90	1,25	0,21	0,29	11
1999	1,03	0,85	1,61	0,57	0,41	11
2000	1,48	1,49	2,44	0,26	0,62	13
2001	1,05	0,94	1,96	0,25	0,50	14
2002	0,91	0,94	2,05	0,16	0,48	14
2003	0,71	0,68	1,21	0,15	0,34	14
2004	0,84	0,72	1,41	0,42	0,29	14
2005	0,70	0,68	1,12	0,25	0,24	15
2006	0,66	0,69	1,04	0,18	0,28	16
2007	0,58	0,66	0,89	0,01	0,25	16
2008	0,64	0,67	0,91	0,16	0,19	16
2009	0,52	0,47	1,03	0,07	0,28	16
2010	0,68	0,60	1,09	0,21	0,27	16
2011	0,69	0,71	1,05	0,23	0,25	16
2012	0,71	0,65	1,32	0,02	0,37	16

The dataset is composed of 16 European incumbents operators (EIO) for a period going from 1997 to 2012[10]. The choice to focus on incumbents is grounded on the availability and structure of data. Indeed, to be included in our sample, an operator must be publicly traded on a daily basis.

One other concern, when dealing with systematic risk, is that operators are nowadays diversified in other countries and sometimes belong to conglomerates. Then in order to see the impact of regulation and market conditions on risk, an operators risk must reflect substantially the condition on its main market. This is the case of European incumbent operators, which still have an important part of their business in their historical market. This is however one major drawback of this study since we are not able to differentiate risk by country. This can be an issue for country specific variable like regulation. This is however

[9]Significant differences will be brought to the attention of the reader.

[10]See the list of operators in the appendix.

not an issue for firm specific[11] variables which captures the evolution of every market where operators are present.

Total return indexes (including dividends) are taken from Datastream. Our risk free rate proxy is the Deutsch government bond. Market returns are proxied by the Euro-Stoxx 600 total return index. All these variables are taken from Datastream and allow us to compute beta coefficient for our sample. Table 1 shows the descriptive statistics of our estimation of risk.

We can observe the effect of the dot-com bubble with highest beta in 2000. It is also during this year that we observe a greater variability of the beta between operators. There is then a downward trend until 2009. Since 2009, risk tends to increase again. These trends are particularly pronounced for the five big operators: British Telecom, Deutsch Telekom, Orange, Telecom Italia and Telefonica.

4 Determinants of systematic risk

4.1 Accounting variables

To study the impact of regulation on risk, we need a set of control variables to make sure that we do not misinterpret the real effect of regulation and competition.

A large literature which began in the 70's, has linked CAPM beta with accounting variables. These financial variables have been extensively used as determinants of CAPM beta in numerous studies. We will not refer to all the work that has been done in that area but we can probably cite the first and most known studies from Beaver et al. (1970) and Logue and Merville (1972). This literature identifies the main financial determinants as being liquidity, financial leverage, operating efficiency, profitability, growth, and firm size.

These variables serve to analyze the determinants of the beta but also as a set of control variables in order to check for the effect of regulation and competition.

Liquidity appears to be a determinant of systematic risk. However, the sign of the effect is not determined. In one hand, a high liquidity is an indicator of firm ability to meet its cash requirement. However Jensen (1986) argues that high liquidity may foster agency problem such as moral hazard. Thus liquidity may increase or decrease risk. Liquidity is measured by the quick ratio[12].

[11] Accounting variables are described below.

[12] It is the ratio of current assets minus inventories over current liabilities.

Maybe the most well-known determinant of the beta is the **Financial Leverage** also known as capital structure. High financial leverage implies a risk of bankruptcy and worsens profit sensitivity to change of revenue.

However, thanks to the work of Spiegel and Spulber (1994) we know also that financial leverage acts as a strategic variable in regulated sectors. In this theoretical framework, regulated firms use debt to protect themselves from regulatory opportunism. Indeed, by emitting more debt, firms increase the threat of financial distress, which forces the regulator to increase price. By lowering regulatory opportunism, debt allows firms to invest more. This theory was empirically confirmed for European telecommunication incumbents (Cambini and Rondi, 2009)

Thus, the impact of debt on risk in regulated sectors is not necessarily positive since it reduces regulatory opportunism. But as it allows firms to invest more, the risk is not necessarily reduced. The ratio of total debts to current asset will be used for the leverage variable.

Higher **operating efficiency** is expected to lower risk since it indicates the ability of a firm to generate revenues for a given level of assets. Therefore, efficiency is measured by the ratio of revenue to total assets.

The **profitability** of the firm should reduce systematic risk because it protects the firm from financial instability. Return on assets, which is the ratio between net income to assets, will be used as a proxy to profitability.

The expected relation between **firm size** and risk, is negative. As big firms are more marketable, they enjoy economies of scale and have lower probability of financial distress. The size proxy is the natural logarithm of revenues. Total assets can be used but don't lead to very different results.

Growth measured by change in earnings before interest and tax is also known to play a role by enhancing the confidence of investors in the firm's capacity to make profit.

All these accounting variables are collected from the Worldscope[13] database.

4.2 Regulation and competition variables

Since the main purpose of the study is to test the interaction between risk and regulation we need variables that describe the regulatory framework of the sector. The Polynomics Regulation Index 2012 was precisely designed to fulfill this purpose (Zenhaeuserna and Schneiderb,

[13]Part of Datastream.

2012). It provides a highly detailed measurement of regulation intensity for a set of 32 countries from 1997 to 2010. It is an update to the "Plaut Economics Regulation Index". These indexes have already been used by academics to study the impact of regulation on investment or financial leverage (Bacache et al., 2012; Cambini and Rondi, 2011; Grajek and Röller, 2012).

The index consists in a set of questions dealing with various aspects of the fixed and mobile telecommunication regulation. The overall index (RDI 24) is the average of all indicators that varies between 0 and 1. A higher index value indicates a more intense regulation.

The overall index can be decomposed in sub-indexes depending on the aspect of regulation we want to study. We will use the overall index (RDI 24) and four sub-indexes to check for potential heterogeneous effects. The overall index may have no effect on risk because it mixes aspects of regulation which have different expected impacts.

Since, we are dealing with the impact of regulation on risk, we use a slightly different decomposition than the four sub-indexes proposed by the authors. Our four sub-indexes are called: Price, Quantity, Access, and Entry.

Sub-index **Price** (questions 4 to 7) is composed of questions that indicates the type of price regulation applied. Questions 4 and 5 refer to the design of price regulation, where lower values indicate more incentives-based regulation with zero being the absence of regulation. According to the buffering effect, this index should be negatively correlated with systematic risk. Question 6 which deals with the value of regulated WACC. The index is decreasing with regulated WACC, higher WACC being the sign of less regulation. Indirectly, a higher WACC implies higher access charge. In that sense one could expect an increase of risk. However, as highlighted in the literature review section the relation between systematic risk and regulated price is not necessarily positive. Then we keep question 6 in the Price index. We expect a negative relationship between sub-index price and risk.

Sub-index **Quantity** (question 9 to 12 & 28 to 29) refers to constraints applied to operators like the obligation to provide some services (Universal Service Obligation and coverage obligation with 3G). These constraints should increase systematic risk since they force operators to invest in not necessarily profitable areas. Question 28 (radiation limits) and 29 (possibility for the regulator to issue significant fines) are included and constitute potential constraints that should have the same positive impact on risk.

Sub-index **Access** (question 13 to 20) indicates the degree of infrastructure that incumbents have to share with their competitors. The expected impact of this variable is unknown. It fosters competition on the retail market and thus may increase risk. However it is more

likely to observe a negative effect since access regulation can slow-down deployment of entrant infrastructures.

Sub-index **Entry** (question 21 to 24) concerns the number of actors on the mobile market and then is a measure of competition.

As mentioned before, we want to check for the impact of competition on systematic risk. Competition variables are taken from the WBIS and WCIS database. To check for the effect of competition on risk, we use the Herfindahl-Hirschman Index (HHI[14]) both for fixed and mobile retail markets. This index value takes value 1 when the industry is a monopoly. Lower values indicate a more intense competition.

Before analysing the result, we check for potential multicolinearity problems. In the appendix, pair-wise correlations among the variables are presented. Correlations are sufficiently low not to worry about multicolinearity as being an issue.

5 Results

Table 2: Effect of competition on systematic risk

Dependent variable : Beta						
Variables	POLS	FE1	FE2	FE	RE1	RE2
HHI Fix	0,694***	0,997***	0,109	0,364*	1,019***	0,45**
HHI Mob	0,275	1,266**	-0,11	-1,072*	0,654	0,162
Liquidity	-0,126	0,076	-0,024	0,128*	0,038	-0,099
Leverage	0,004**	-0,003	0,005***	0,003*	-0,001	0,004***
Efficiency	-0,948***	-1,355***	-0,595***	-0,614**	-1,159***	-0,851***
Profitability	0,002	-0,002	0,001	0	-0,001	0,002
Size	0,055***	0,142	0,059***	0,198*	0,054	0,056***
Growth	-0,025	-0,021	-0,031**	-0,024**	-0,019	-0,027*
Constant	-0,107	-1,562	-0,116	-2,31	-0,056	-0,097
R2	0,27	0,61	0,52	0,76	0,33	0,23

Dependent variable is estimated through OLS. The period of estimation goes from 1997 to 2010 and includes 186 observations. POLS stands for pooled least square, FEI for countries fixed effect, FE2 for time fixed effects, FE for two-way fixed effects, RE1 for country random effect and RE2 for time random effect. * indicates statistically significant at 10 %, ** at 5 % and *** at 1 %

[14]This index is the sum of the squares of market shares.

For practical reasons, the effects of regulation and competition are tested separately. Indeed, regulation index are available from 1997 to 2010 whereas market shares for the fixed market are available from 2000 to 2012. Results are presented for various specifications: pooled ols (POLS), country fixed effects (FE1), time fixed effects (FE2), two-way fixed effects (FE), country random effects (RE1) and time random effects (RE2). The panel is unbalanced because some operators are not quoted for the entire sample period[15].

Before analysing the results of competition and regulation, we first review the impact of control variables. For this model Hausman and redundant fixed effects tests lead to keep the two-way fixed effects (FE) specification.

Efficiency and Growth have the negative expected impact. Surprisingly, Size has a positive effect on risk. As operators of the sample are rather big incumbents operators, it may explain this result. Finally, liquidity and profitability don't seem to play a significant role.

Despite the specificity of debt in a context of regulation, leverage still impacts risk positively as in non-regulated industries. However, the effect is reduced. An increase of the debt ratio of 10% only leads to a change of beta on the second digit. This result is consistent with the model of Spiegel and Spulber since the regulator sets the price to protect the incumbent from bankruptcy. The impact is still positive, as investment increases with debt, but reduced.

The impact of the competition intensity is interesting because it shows different results for fixed and mobile markets. Tests indicate also the two-way fixed effects as being the more reliable.

The fixed competition variable is significant and has a positive coefficient. This result may appear surprising because it implies that higher competition intensity leads to less risk. The within estimator (effect of the evolution of the index) is stronger than the between estimator which is not significant. As the coefficient is also significant when using random effect estimations, we can say that this result is robust.

However, coefficient of the mobile competition variable is not stable to various estimations. It is significant for the two-way fixed effects and for the country fixed estimation but with different signs. Even if we retain the two-way fixed effects model, it would be hazardous to affirm that mobile competition has a negative effect on risk.

How to explain that competition could have contributed to lower risk ? One explanation may be that increasing competition might led to lower investment by incumbents. By relying on past investment rather on new investment, there is less risk. This is particularly the case if competition relies on the incumbent infrastructure.

[15]For this reason, our econometric software, Eviews, doesn't allow to compute two-way random effects.

This interpretation is consistent with the observation of different results for the mobile market. Indeed, the mobile market relies more on infrastructure based competition as the cost to build a network is lower.

Table 3: Effect of regulation sub-indexes on systematic risk

Dependent variable : Beta						
Variables	POLS	FE1	FE2	FE	RE1	RE2
Price reg	-0,467	-0,41	0,662**	0,135	-0,355	-0,049
Quantity reg	0,511***	0,389	0,524***	0,285	0,441*	0,492***
Access reg	-0,469***	-0,834***	0,258	-0,339	-0,674***	-0,195
Entry reg	0,014	0,12	0,099	0,206	0,152	0,064
Liquidity	-0,119	0,039	0	0,058	-0,016	-0,068
Leverage	0,004**	0,004**	0,004**	0,004***	0,004**	0,004***
Efficiency	-1,193***	-1,485***	-0,658***	-0,765***	-1,312***	-0,906***
Profitability	0,003	-0,001	0,001	-0,002	0,001	0,001
Size	0,071***	0,197*	0,078***	0,107	0,084***	0,071***
Growth	-0,033**	-0,031**	-0,035***	-0,028***	-0,03**	-0,033***
Constant	0,302	-1,508	-1,257***	-0,968	0,168	-0,259
R2	0,33	0,56	0,586	0,71	0,32	0,29

Dependent variable is estimated through OLS. The period of estimation goes from 1997 to 2010 and includes 185 observations. POLS stands for pooled least square, FEI for countries fixed effect, FE2 for time fixed effects, FE for two-way fixed effects, RE1 for country random effect and RE2 for time random effect. * indicates statistically significant at 10 %, ** at 5 % and *** at 1 %

The model including the index of regulation doesn't allow to draw clear conclusions since results lead to contradictions. Indeed, the within coefficient is negative (RE1) whereas between coefficient (RE2) is positive. It is also the case for the country random effect and time random effect[16].

If the model was correct, this would mean that the evolution towards more intense regulation leads to a reduction of risk. But the countries where the index is higher, are also the countries where the incumbent risk is higher.

These results are not surprising as the overall index mixes different kind of regulation which have potential differentiated effects. This justifies the use of sub-indexes.

Since sub-indexes are composed of fewer indicators than the overall index, then sub-indexes are frequently constant across years for a given country. The within variability is then lower.

[16]Results of this model are in the appendix, table 7.

Thus the results using time fixed effects may rely on too little variability. As noted in Gaggero studies, random effects lead to more reliable estimates. The Hausman test confirms this insight by indicating random country effects as being the best model.

Sub-index Entry, which measures the number of actors on the mobile market, is clearly not significant. It confirms the results observed for the competition model.

Price sub-index leads also to unclear and mainly not significant results. We cannot conclude about the effect of the regime of price regulation. Here again, the result is consistent with Gaggero. Despite a negative pair-wise correlation between price regulation and betas, a model with control variables does not give significant results.

As expected, imposing regulatory constraints on investments increases risk (Sub-index quantity). The variable Quantity Country is not significant for the country fixed effects and two fixed effects model[17]. However random effect models give significant result.

Finally, access regulation decreases risk. It is also consistent with the interpretation that access regulation has reduce incentives to invest. It is consistent also with the view that access regulation may deter infrastructure-based competition.

6 Conclusion

This article has studied the effect of regulation and competition on systematic risk. It concerns a panel of European telecommunication incumbents from 1997 to 2012.

Systematic risk is estimated with the CAPM and various econometric methods. Estimations show that the beta coefficient of incumbents has decreased between 2001 (the dot-com bubble) and 2009. Since 2009, risk has an upward trend.

A set of accounting variables is used as controls to study the impact of regulation and competition on risk. As expected efficiency and growth have an negative impact on risk. Even leverage has the expected positive sign despite the strategic role played by debt in regulated industries. Surprisingly, size is positively associated with risk.

If the overall impact of regulation is not significant, we do observe a negative impact of access regulation on risk. As expected, imposing regulatory constraints like coverage obligation increases risk.

The impact of competition differs for the fixed and mobile markets. No clear conclusions can be drawn for the effect of mobile competition. However, more intense fixed competition is associated with less systematic risk.

[17] Certainly because of too little within variability.

In order to understand these findings, we have to put them in perspective with other evidence concerning investment in the sector. Indeed, if access regulation leads to less investment as shown by Grajek and Röller (2012) it is normal to observe a reduction of risk. Incumbents rely more on their past infrastructure rather than taking risk by constructing new generation infrastructure. We are not able to observe a positive impact of regulation on risk because regulation deters investment.

The effect of fixed competition confirms this interpretation. It is probably because there is more service-based competition rather than infrastructure based competition on the fixed market than competition doesn't have increased risk.

This interpretation implies that regulation influences risk but indirectly. It is also because operators adapt their investment strategy that we observe decreasing risk. Thus low risk is not an indicator that profits are too high. A wrong interpretation would be to decrease regulated prices considering that the cost of capital is low.

Actually, the risk should be higher if the sector was investing more. Indeed, if projects are not made it maybe because they have a too high cost of capital. And their impact cannot be observed.

When setting the WACC, a regulator must take into account the needs for future potential investments rather than historical risk values as reference. It all depends on whether the investment level appears as sufficient.

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7 Appendix

Table 4: List of operators

Operator	Data availability
BELGACOM	2005 - 2012
BRITISH TELECOM	1997 - 2012
DEUTSCH TELEKOM	1997 - 2012
HELLENIC TELECOM	1997 - 2012
KPN KON	1997 - 2012
MAGYAR TELEKOM	1997 - 2012
ORANGE	1997 - 2012
PORTUGAL TELECOM	1997 - 2012
SWISSCOM	1998 - 2012
TDC	1997 - 2012
TELECOM ITALIA	1997 - 2012
TELEFONICA	1997 - 2012
TELEKOM AUSTRIA	2000 - 2012
TELEKOM SLOVENIJE	2006 - 2012
TELENOR	2001 - 2012
TELIA SONERA	2000 - 2012

Table 5: Descriptive statistics for the sub-indexes of regulation

	PRICE		QUANT		ACCESS		ENTRY	
DATE	MEAN	Std. Dev.	MEAN	Std. Dev.	MEAN	Std. Dev.	MEAN	Std. Dev.
1997	0.38	0.051	0.39	0.15	0.19	0.09	0.40	0.10
1998	0.37	0.048	0.4	0.13	0.28	0.11	0.37	0.09
1999	0.47	0.067	0.43	0.18	0.31	0.15	0.35	0.10
2000	0.48	0.067	0.5	0.24	0.40	0.20	0.34	0.10
2001	0.48	0.072	0.59	0.2	0.54	0.24	0.40	0.13
2002	0.48	0.072	0.6	0.2	0.69	0.23	0.41	0.13
2003	0.49	0.075	0.61	0.16	0.69	0.23	0.38	0.14
2004	0.49	0.08	0.6	0.15	0.71	0.22	0.32	0.15
2005	0.55	0.12	0.65	0.12	0.72	0.18	0.31	0.16
2006	0.63	0.086	0.66	0.14	0.75	0.17	0.32	0.14
2007	0.65	0.085	0.64	0.16	0.80	0.12	0.34	0.19
2008	0.63	0.054	0.64	0.16	0.82	0.11	0.34	0.19
2009	0.62	0.081	0.64	0.16	0.80	0.09	0.34	0.21
2010	0.6	0.097	0.64	0.16	0.81	0.09	0.34	0.17

Table 6: Descriptive statistics for competition intensity

	HHI Mob		HHI Fix	
	Mean	St. Dev.	Mean	St. Dev.
2000	0,412	0,107	0,543	0,262
2001	0,399	0,108	0,497	0,258
2002	0,389	0,0998	0,385	0,113
2003	0,376	0,102	0,369	0,098
2004	0,364	0,108	0,344	0,093
2005	0,358	0,101	0,314	0,1
2006	0,348	0,0961	0,299	0,08
2007	0,339	0,0809	0,289	0,07
2008	0,324	0,0712	0,287	0,067
2009	0,319	0,0689	0,292	0,068
2010	0,321	0,0625	0,287	0,064
2011	0,318	0,0626	0,279	0,067
2012	0,312	0,0625	0,276	0,068

Correlation Matrix

	BETA	LIQ	LEV	EFFI	PROF	SIZE	GROW	RDI	PRICE	QUANT	ACCESS	ENT	HHI F	HHI M
BETA	1.00	-0.17	0.13	-0.42	-0.23	0.19	-0.13	0.01	-0.23	0.15	-0.19	-0.04	0.37	-0.04
QR	-0.17	1.00	-0.30	0.06	0.40	-0.17	0.07	-0.17	0.04	-0.20	-0.28	0.10	-0.02	0.24
LEV	0.13	-0.30	1.00	0.02	-0.09	-0.15	0.08	0.35	0.04	0.44	0.46	-0.34	-0.06	-0.42
EFFI	-0.42	0.06	0.02	1.00	0.44	-0.05	0.04	-0.01	0.09	-0.07	0.13	0.11	-0.32	-0.05
PROF	-0.23	0.40	-0.09	0.44	1.00	-0.03	0.25	-0.15	0.16	-0.19	-0.08	-0.01	-0.12	0.04
SIZE	0.19	-0.17	-0.15	-0.05	-0.03	1.00	-0.03	-0.25	-0.14	-0.28	-0.07	0.04	0.10	-0.15
GROW	-0.13	0.07	0.08	0.04	0.25	-0.03	1.00	0.03	0.04	0.05	0.00	-0.09	-0.06	0.01
RDI	0.01	-0.17	0.35	-0.01	-0.15	-0.25	0.03	1.00	0.44	0.88	0.54	0.06	-0.21	-0.05
PRICE	-0.23	0.04	0.04	0.09	0.16	-0.14	0.04	0.44	1.00	0.15	0.31	-0.12	-0.26	-0.19
QUANT	0.15	-0.20	0.44	-0.07	-0.19	-0.28	0.05	0.88	0.15	1.00	0.32	-0.04	-0.07	-0.05
ACCESS	-0.19	-0.28	0.46	0.13	-0.08	-0.07	0.00	0.54	0.31	0.32	1.00	-0.27	-0.44	-0.54
ENTRY	-0.04	0.10	-0.34	0.11	-0.01	0.04	-0.09	0.06	-0.12	-0.04	-0.27	1.00	0.12	0.46
COMP F	0.37	-0.02	-0.06	-0.32	-0.12	0.10	-0.06	-0.21	-0.26	-0.07	-0.44	0.12	1.00	0.24
COMP M	-0.04	0.24	-0.42	-0.05	0.04	-0.15	0.01	-0.05	-0.19	-0.05	-0.54	0.46	0.24	1.00

LIQ stands for liquidity, LEV for leverage, EFFI for efficiency, PROF for profitability, GROW for growth, RDI for the overall regulatory index, ENT for entry, HHI F for the competition intensity on the fixed market and HHI M for the intensity of competition on the mobile market.

Table 7: Effect of regulation index on systematic risk

Dependent variable : Beta						
Variables	POLS	FE1	FE2	FE	RE1	RE2
RDI 24	-0,326	-1,074**	1,451***	0,504	-0,82***	0,4
Liquidity	-0,132	0,022	-0,015	0,054	-0,034	-0,084
Leverage	0,003**	0,001	0,004***	0,004**	0,002	0,004***
Efficiency	-1,326***	-1,514***	-0,645***	-0,706***	-1,387***	-0,99***
Profitability	0,001	-0,003	0,001	-0,001	-0,001	0,002
Size	0,051**	0,076	0,074***	0,123	0,053*	0,0586***
Growth	-0,024*	-0,021*	-0,036***	-0,029***	-0,022*	-0,028***
Constant	0,716*	0,84	-1,125***	-1,41	0,979*	-0,029
R2	0,22	0,5	0,58	0,7	0,23	0,25

Dependent variable is estimated through OLS. The period of estimation goes from 1997 to 2010 and includes 185 observations. POLS stands for pooled least square, FEI for countries fixed effect, FE2 for time fixed effects, FE for two-way fixed effects, RE1 for country random effect and RE2 for time random effect. * indicates statistically significant at 10 %, ** at 5 % and *** at 1 %