DOI: 10.1007/s10272-011-0370-y

Antonin Arlandis* and Edmond Baranes**

Interactions Between Network Operators, Content Producers and Internet Intermediaries: Empirical Implications of Network Neutrality

Economically the net neutrality debate focuses on the question whether services of different quality should be subject to price discrimination. The debate strongly affects the interaction between the players that are involved in the provision of online content. The authors analyse this interaction and find important synergies between suppliers along the value chain. The revenues of all players depend on investment in networks which determines the quality of content. The benefits of policies that support net neutrality are unequally distributed among the different players. This might explain diverging policy approaches in the USA and Europe.

The issue of network neutrality, which has been a contentious issue for several years in the United States, is starting to gain attention in Europe. This time-lag is mainly due to transatlantic differences with regard to specific regulatory policies and market features. Net neutrality refers to the restriction on network owners regarding price discriminating amongst Internet applications (such as search, e-commerce and content) in order to manage their traffic and block access to certain networks.

A significant issue lies in the strong complementarities that exist between broadband roll-out, content that is available to customers and the emergence of Internet intermediaries. In Europe, this trend has produced a wide gap between the process of value creation and its distribution among the different layers of the ICT sector. To understand this easily, it may be convenient to analyse the ICT sector as an ecosystem.

Content producers and Internet intermediaries such as search engines or e-commerce firms make use of telecommunications and cable networks to provide their services online. All these players belong to the ICT sector, which can be considered an ecosystem where different firms interact within a common environment. The layer model developed by Lombard[1] can be applied here to analyse the main dynamics and the major past and upcoming evolutions of this ecosystem. The layer model is also used by Fransman[2] to describe the relationships at work within the frame of ICT industries. Firms are classified on the basis of their core business and main activity. Four groups of players are identified: technology providers (Layer 1), network operators (Layer 2), Internet intermediaries (Layer 3) and content providers (Layer 4).

The networked elements are produced in the first layer of activity. These include telecommunications switches and transmission systems manufactured by firms like Alcatel Lucent and Cisco; fixed and mobile phones produced by firms such as Apple, LG, Nokia and Motorola; and electronic devices connected to networks such as PCs produced by Acer, Apple, Dell, Sony and Toshiba.

Some of these elements are strung together in the second layer by network operators. Network operators include telecommunications operators such as AT&T, BT Group, Deutsche Telecom, France Telecom, Telecom Italia, Telefonica and Verizon; cable TV operators such as Cox Communications, Ono, Time Warner Cable and Virgin Media; and satellite operators such as BSkyB and DirecTV.

The third layer features intermediation platforms, including search engines such as Google and Yahoo, electronic commerce firms such as Amazon and eBay, and firms developing social networks such as Facebook and Twitter. These firms are based on two-sided business models

* Coe-Rexecode, Paris, France.
** University of Montpellier, France.

1 D. Lombard: Le Village Numérique Mondial, 2008, Odile Jacob.
2 M. Fransman: The New ICT Ecosystem: Implication for Europe, Kokoro 2007.

and make use of access networks developed by network operators to provide their online services. Search engines enable interactions between consumers and advertisers and derive their revenues from advertisers only, while electronic commerce firms cater to both the sellers and the buyers.

The content production industry is embodied in the fourth layer. Content relates to the material downloaded or viewed by end users, such as textual information, music and movies. Content can be produced either by national broadcast channels like Antena 3, Canal +, CBS, and TF1 or by media and entertainment conglomerates like Time Warner and Walt Disney.

The ICT sector analysis, as a set of cross-relationships between various layers and the specific business models applied by firms and operators along the vertical chain, allows understanding of the disconnection between the creation and distribution of value. While broadband operators invest to attract customers, Internet intermediaries, using a two-sided business model, benefit from rent extraction by taking advantage of network neutrality.

To our knowledge, there have been few net neutrality law cases. In the United States, in most cases in which a network operator attempted to block consumers from accessing a service through the Internet, the Federal Communications Commission (FCC) acted to compel the carrier to put an end to that practice. In 2005, Vonage stated that Madison River Telephone Co., a small American telephone company, was preventing its DSL customers from accessing Vonage's VoIP service in order to protect Madison River's conventional telephone service from competition. The FCC responded by preventing Madison River from blocking access to Vonage.[3] In 2007, several Comcast customers noticed that the company had slowed their access to peer-to-peer sites, which allow Internet users to share files directly with each other. This was in violation of the net neutrality principle. Several advocacy groups complained to the FCC, and Comcast stopped the practice. The FCC then ordered Comcast to disclose details of its change of heart. Comcast complied but then challenged the commission's authority to issue the order at all. The case went to court. Finally, on April 2010, the District of Columbia Court of Appeals ruled that the FCC had no authority to regulate how network operators manage traffic to their customers.[4]

The tricky point is that welfare depends on how social surplus is distributed amongst the different layers involved, according to their geographical location. Considering Internet intermediaries are overwhelmingly American, European broadband operators do not derive the full benefits of their investments because of network neutrality, and this can have a negative impact on the welfare of European countries.

Our study aims to analyse the relationships among broadband penetration, network operators' investments, competition among network operators, and layer revenues, mainly those of content providers and Internet intermediaries. Our econometric estimations suggest the Internet penetration rate is positively associated with content producers' and Internet intermediaries' revenues. We also find a positive relationship between network operators' investments and content producers' revenues. Furthermore, our analysis suggests that increased competition among network operators had a positive impact on Internet intermediaries' revenues.

The paper is organised as follows: a short overview of the recent literature on the economics of network neutrality will be followed by an econometric analysis and a review of the regression model for estimation and the most relevant results. Finally, we provide some concluding remarks and policy implications for European industry.

Related Literature

A large strand of literature has recently developed on network neutrality. Most of the papers discuss the legal issues of network neutrality and the expected consequences of its abolition. Economic analysis in this field is less developed, although some recent theoretical research has been made in the field of two-sided market models.

Economides and Tåg[5] model the Internet broadband market as a two-sided platform in which broadband consumers are on one side and content producers on the other. In this framework, they discuss the benefits of net neutrality regulation in both monopolistic and competitive settings. Their results show that when access is monopolised, network neutrality regulation (which imposes zero fees "on the opposite side" of the market) generally increases industry surplus compared to the fully private optimum at which the monopoly platform imposes positive fees on content and application producers. In the same manner, Economides and Tåg find that imposing network neutrality in a duopoly setting increases total surplus compared

3 R. Atkinson: Network Neutrality: History Will Repeat Itself, in: Communications and Strategies, 2008, No. 68, pp. 67-88.

4 The Economist: Comcast v the FCC: Raze the mystery house, 10 April 2010.

5 N. Economides, J. Tåg: Net Neutrality on the Internet: A Two-sided Market Analysis, NET Institute Working Paper No. 07-14, 2007.

to a situation in which competitive platforms charge a positive fee to content producers. Without network neutrality regulation, platforms set a lower subscription fee, as they have an incentive to attract more consumers and generate revenue by charging content producers, resulting in an increase in consumers' surplus. This positive impact is offset by the negative effect on content provision. Ultimately, network neutrality increases welfare, which does not depend on platform competition anyway.

While Economides and Tåg[6] model network neutrality assuming zero fees for content producers, Hermalin and Katz[7] consider network neutrality a situation in which the broadband platform produces a single access quality (non-discriminatory access quality). They assume both traditional markets and two-sided markets where platform providers offer services making a connection between consumers and Internet application providers. Consumers are heterogeneous with regard to the quality of content, and Internet application providers purchase network services of varying qualities from the broadband platform. Network neutrality functions as a product-line restriction, and as a direct effect of this, low-valuation application providers get ruled out of the market. Their results show that network neutrality regulation by product restriction may hinder both consumers' surplus and social welfare. They also examine a duopoly model and find that welfare is likely to decrease under net neutrality.

Choi and Kim[8] analyse the effects of network neutrality regulation on investment incentives for network providers and content producers as well as their implications for social welfare. They define network neutrality as non-discriminatory in the delivery of content through networks. The model they develop is based on the queuing theory developed in operations research to take clear account of bandwidth scarcity and the need for rationing as the main causes of the network neutrality regulation debate. In this setting, they show that network providers' decision on discriminating across content depends on a potential trade-off between access fees and the revenue from the trade of the first priority. Concerning the network providers' investment incentives, their results show that the growth in capacity affects the sale price of the priority right under the discriminatory regime. They conclude that as the relative merit of the first priority becomes relatively small for higher level capacity, the network's incentives to invest under discrimination may be smaller than that under network neutrality regulation in which such rent extraction effects do not exist. Finally, the welfare effects of network neutrality regulation are ambiguous and depend largely on how capacity expansion affects the need to acquire the priority right and thus the ability to extract rent from content producers.

Similar to Choi and Kim[9], Cheng et al.[10] develop a game theoretical model to highlight the winners and losers of abolishing network neutrality and to analyse broadband providers' incentives to expand capacity. In a duopoly setting on content provision, they assume that content producers can avoid congestion by paying network providers for preferential access. They find that content producers are left worse off when network neutrality is abolished and consumer surplus either does not change or is higher in the short run. In the short run, social welfare increases when one content producer pays for preferential treatment but remains unchanged when both content producers pay. Finally, they find that broadband providers' incentive to invest in capacity is generally higher under neutrality regulation because the network owner incurs a loss from the content producer's side without net neutrality.

There are few empirical studies that test the effects of network neutrality on welfare and its impacts on a network's incentives to invest. This is particularly true for European countries. A recent contribution by Hausladen and Wallsten[11] addresses this lack of empirical analysis of the effect of neutrality regulation in Europe and countries other than the United States. In particular, they explore net neutrality in the UK, France, Denmark, the Netherlands, Germany, Sweden, South Korea and Japan. Because net neutrality is another type of mandatory network sharing and because unbundling is a key component in Europe, they use a dataset to test empirically the effect of unbundling on investment in fibre to the home. They find a significant negative correlation between the number of unbundled DSL connections per capita and the number of fibre connections. Therefore, countries that rely more on unbundled lines to provide broadband access exhibit less investment by incumbents in fibre than countries that rely less on unbundled lines and more on facility-based entry.

6 Ibid.

7 B.E. Hermalin, M.L. Katz: The Economics of Product-Line Restrictions with an Application to the Network Neutrality Debate, AEI-Brookings Joint Center Woking Paper No. 07-02, 2007, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1003391.

8 J.P. Choi, B.C. Kim: Net Neutrality and Investments Incentives, Net Institute Working Paper, No. 08-03, 2008.

9 Ibid.

10 H.K. Cheng, S. Bandyopadhyay, H. Guo: The Debate on Net Neutrality: A Policy Perspective, Working Paper, 2008, http://net.educause.edu/ir/library/pdf/CSD4854.pdf.

11 S. Hausladen, S. Wallsten: Net Neutrality, Unbundling, and their effects on International Investment in Next-Generation Networks, in: Review of Network Economics, Vol. 8, 2009, Issue 1, March 2009.

The current study will provide an empirical analysis of network neutrality regulation, taking into account how value is created in the ICT sector and how it is distributed among operators and firms and among different geographical locations. Our results emphasise the importance of the Internet as a main driver of economic growth and highlight the major impact that the network neutrality debate will have on innovation and investment incentives for various layers, especially from a European perspective.

Data Analysis and Econometric Analysis

This section empirically investigates the relationship between network operators and content producers as well as the relationship between network operators and Internet intermediaries. Four equations are estimated. The first one models the impact of the Internet penetration rate, competition among network operators and real GDP per capita on content producers' revenues. The second equation captures the effect of network operators' investments, competition between network operators and GDP per capita on content producers' revenues. The third one examines the impact of the Internet penetration rate, competition among network operators and GDP per capita on Internet intermediaries' revenues. Finally, the last equation analyses the impact of network operators' investments, competition among network operators and GDP per capita on Internet intermediaries' revenues.

Data

To address the economic relationship between content producers and network operators, we consider a panel of seven countries: Japan, the United States, the United Kingdom, Italy, France, Spain and Germany. We then consider a panel of five countries (Japan, the United Kingdom, Italy, France and the United States) to analyse the relationship between Internet intermediaries and network operators.[12]

We gathered data related to general and sectoral economic variables from different sources. We compute content producers' real revenues and Internet intermediaries' real revenues in each country. Content producers' revenues and Internet intermediaries' revenues are obtained from the Thomson Financial database. Content producers' and Internet intermediaries' revenues are given by the sum of firms' revenues in Layers 3 and 4 of the Layer Model. Index prices used to deflate revenues are from the OECD database. We also compute the Herfindahl-Hirschmann indexes, or HHI, which measure the degree of competition among network operators for the Internet access market. Operators' market shares used to calculate Herfindahl-Hirschmann indexes come from Informa and the Telecom Media database[13], as well as Internet penetration rates. We then calculate network operators' real capital expenditures for fixed networks, which represent network operators' investments in fixed networks. Capital expenditures for fixed networks are obtained from the IDATE database. Real GDP per capita figures are from the OECD database. All data gathered cover the period 2001-2008, with the exception of network operators' real capital expenditures, which cover the period 2003-2008. Table 1 defines the variables used in this study and presents some summary statistics.

Before turning to our econometric models, we present the evolution of different dependant and explanatory variables.

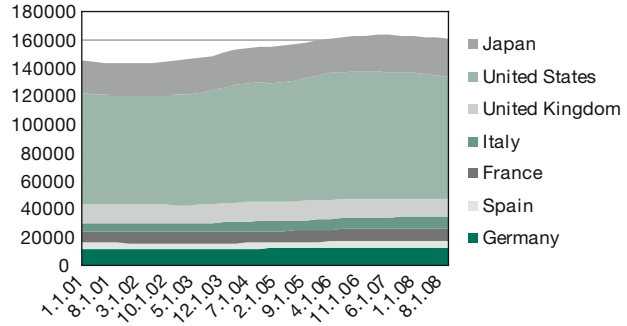
Table 1
Variable Description and Summary Statistics

Variable	Description	Mean	Std. Dev.	Minimum	Maximum
HHIint	Herfindahl-Hirschmann for Internet access market	3571.1	1605.7	1493.5	10000
PENint	Internet access penetration rate	29.7%	20.6%	4%	65.9%
GDP	Real GDP per capita in real 2005 euros	29001.4	4.254.063	25485.5	38788.1
CAPEX	Total fixed capital expenditures of network operators	$3.14*10^{15}$	$6.35*10^{15}$	$2.10*10^{9}$	$1.75*10^{16}$
REVtv	Real total revenues of content producers	$1.64*10^{10}$	$1.95*10^{10}$	$2.95*10^{9}$	$6.76*10^{10}$
REVinter	Real total revenues of Internet intermediaries	$6.49*10^{9}$	$1.31*10^{10}$	491340.1	$5.80*10^{10}$

12 Because there are few Internet intermediaries, we can gather data in only five countries in the second panel.

13 Given the Internet market structure in the United States, where there is mostly a duopolistic competition between cable and telecom operators, we performed special calculations for the Herfindahl-Hirschmann index. Internet HHI in the USA is equal to the sum of the cable market share plus the sum of the telecom market share.

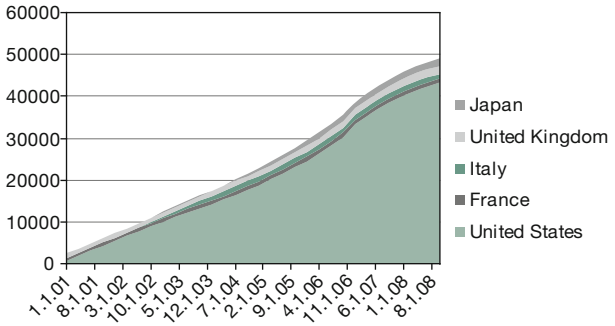
Figure 1
Content Producers' Real Revenues
(in billions of euros)



Note: Data are displayed in constant 2000 euros.

Source: Authors' calculations based on Thomson Financial database.

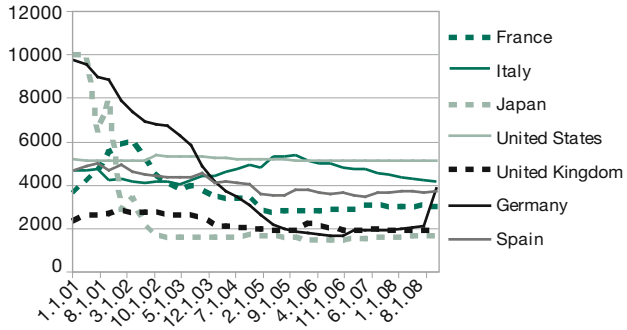
Figure 2
Internet Intermediaries' Real Revenues
(in billions of euros)



Note: Data are displayed in constant 2000 euros.

Source: Authors' calculations based on Thomson Financial database.

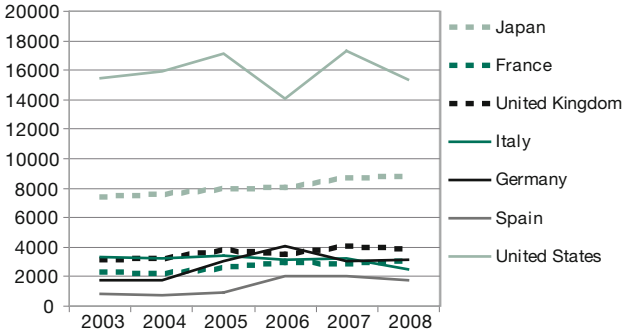
Figure 3
Evolution of Internet Herfindahl-Hirschmann Indexes
(in billions of euros)



Note: Data are displayed in constant 2000 euros.

Source: Authors' calculations based on Informa and Telecom Media database.

Figure 4
Network Operators' Real Capital Expenditures
(in billions of euros)



Note: Data are displayed in constant 2000 euros.

Source: Authors' calculations based on IDATE database.

Figure 1 features the evolution of content producers' real revenues and shows that these revenues have increased slowly between 2001 and 2008. During this period, content producers' revenues have increased by 1.4 per cent on average each year. Content producers' revenues increased from €145,432 billion in the first quarter 2001 to reach €160,303 billion in the fourth quarter 2008. In the fourth quarter 2008, American content producers' revenues were €86,291 billions, which represents 53.8 per cent of the total revenues of the content producers gathered in our panel. Indeed, many content producers and entertainment conglomerates are American companies.

Figure 2 shows that the real revenues of Internet intermedairies increased by 53.76 per cent on average each year between 2001 and 2008. Internet intermediaries' revenues increased from €2,412 billion in the first quarter 2001 to €49,016 billion in the fourth quarter 2008. In the first quarter 2008, American Internet intermediaries' revenues were €43,300 billion, which represents 83.3 per cent of the total revenues of Internet intermediaries gathered in our panel. Indeed, the biggest Internet intermediaries, such as Google, Yahoo, Amazon and eBay, are all American companies.

The evolution of Internet HHIs exhibits a general decreasing trend, indicating that the Internet access market has become more competitive (see Figure 3). Competition intensity in the Internet access market has increased in all countries (i.e. Internet HHI has decreased in all countries). Between 2001 and 2008, Internet HHI decreased by 2.69 per cent on average each year in France, by 22.98 per cent in Japan, and by 0.12 per cent in the United States.

Figure 4 presents real capital expenditures for fixed networks. Real fixed capital expenditures increased by 5.94 per cent each year on average in France. Conversely, real

capital expenditures decreased at an annual rate of 5.19 per cent in Italy.

Finally, the Internet penetration rate has increased in every country on our panel. The United States had an increase in the penetration rate from 17.55 per cent in the first quarter of 2001 to 65.12 per cent in the fourth quarter of 2008.

Econometric Analysis

We now turn to the econometric analysis and consider four panel models. We first consider the relationship between network operators and content producers. The random effects model used to estimate the economic relationship among content producers' real revenues in each country, Internet penetration rate, Internet HHI and real GDP per capita is given by:

$$LREVtv_{it} = \mu + \beta_1 PENint_{it} + \beta_2 LHHIint_{it} + \beta_3 LGDP_{it} + \varepsilon_{it}$$

with

$$\varepsilon_{it} = \alpha_i + u_{it}$$

where i stands for countries and t for time quarters, α_i captures individual effects, $LREVtv_{it}$ is the logarithm of content producers' real revenues in each country, PEN_{it} stands for broadband penetration rate, $LHHIint_{it}$ stands for the logarithm of the Herfindahl-Hirschmann index for the Internet access market in each country and $LGDP_{it}$ measures the logarithm of real GDP per capita in each country. The Hausman statistic is equal to 90.37. Therefore we have to reject the hypothesis of absence of correlation between individual specific effects and explanatory variables and must consider the fixed effects specification. The fixed effects model is given by:

$$LREVtv_{it} = \alpha_0 + \delta_i + \beta_1 LREVtv_{it-1} + \beta_2 LREVtv_{it-2} + \beta_3 PENint_{it} + \beta_4 LHHIint_{it} + \beta_5 LGDP_{it} + u_{it} \quad (1)$$

Lagged variables are introduced to eliminate the remaining autocorrelation of the residuals. The fixed effects model used to estimate the economic relationship among content producers' real revenues, fixed capital expenditures, Internet HHI and GDP per capita is given by:

$$LREVtv_{it} = \alpha_0 + \delta_i + \beta_1 LREVtv_{it-1} + \beta_2 LREVtv_{it-2} + \beta_3 LCAPEX_{it} + \beta_4 LHHIint_{it} + \beta_5 LGDP_{it} + u_{it} \quad (2)$$

The variable $LCAPEX_{it}$ is the logarithm of network operators' real capital expenditures in each country. As the Hausman statistic is equal to 62.82, we reject the hypothesis of an absence of correlation between individual specific effects and explanatory variables. Table 2 reports the equation (1) and (2) estimation results.

Table 2
Equations (1) and (2) Estimation Results

Dependant variable: LREVtv	Within groups estimator (1)		Within groups estimator (2)	
	Coef.	t-stat	Coef.	t-stat
α	15.22	5.89***	14.04	4.27***
LREVtv (-1)	1.54	11.6***	1.47	20.46***
LREVtv (-2)	-0.56	-4.15***	-0.52	-7.4***
LHHIint	-0.01	-0.46	-0.01	-0.58
LCAPEX			0.06	4.53***
PENint	0.11	2.41**		
LGDP	0.76	2.97**	0.75	2.32**
R^2	0.99		0.99	
Durbin-Watson stat.	2.22		2.16	

***, **, *: statistically significant at the 1, 5 and 10% levels respectively.

The results of the equation (1) estimation, reported in Table 2, indicate a negative relationship between the logarithm of the Herfindahl-Hirschmann index for the Internet access market and content producers' revenues. However, the logarithm of the Herfindahl-Hirschmann index is not statistically significant. Furthermore, results show a positive relationship between the Internet penetration rate and content producers' revenues. The rise in Internet penetration has in turn increased content producers' revenues. The point estimate of the elasticity is 0.11, which implies that a one per cent increase in the Internet penetration rate increases content producers' revenues by, on average, 0.11 per cent. We do not consider reverse causality between content producers' revenues and the Internet penetration rate. We argue that content producers' revenues increase because Internet penetration growth and innovation are creating new ways to reach consumers, as opposed to the idea that consumers purchase Internet access to consume television content. Finally, Table 2 displays a positive relationship between GDP per capita and content producers' revenues. The elasticity for real GDP per capita is 0.76. Thus, a one per cent increase in real GDP per capita increases content producers' revenues by, on average, 0.76 per cent.

The estimation of model (2), reported in Table 2, exhibits a negative relationship between the logarithm of Internet HHI and the logarithm of content producers' revenues. However, the logarithm of Internet HHI is not statistically

significant. The estimation of model (2) indicates, in addition, that network operators' fixed capital investments are positively and significantly associated with content producers' revenues. The elasticity for network operators' fixed capital investments equals 0.06. We also find that real GDP per capita is positively associated with content producers' real revenues. The elasticity for real GDP per capita is 0.75.

We now turn to the relationship between network operators and Internet intermediaries. The random effects model used to estimate the economic relationship among Internet intermediaries' real revenues at the country level, penetration rate, Internet HHI and real GDP per capita is given by:

$$LREVinter_{it} = \mu + \beta_1 PENint_{it} + \beta_2 LHHIint_{it} + \beta_3 LGDP_{it} + \varepsilon_{it} \quad (3)$$

with

$$\varepsilon_{it} = \alpha_i + u_{it}$$

$LREVinter_{it}$ is the logarithm of Internet intermediaries' revenues in each country. The Hausman statistic is equal to 11.87. Therefore we accept the hypothesis of an absence of correlation between fixed effects and explanatory variables and must consider random effects specification.

The fixed effects model used to estimate the economic relationship among Internet intermediaries' real revenues in each country, real fixed capital expenditures, Internet HHI and real GDP per capita is given by:

$$LREVinter_{it} = \alpha_0 + \delta_i + \beta_1 LREVinter_{it-1} + \beta_2 LREVinter_{it-2} + \beta_3 LCAPEX_{it} + \beta_4 LHHIint_{it} + \beta_5 LGDP_{it} + u_{it} \quad (4)$$

As the Hausman statistic is equal to 82.06, we reject the hypothesis of an absence of correlation between individual specific effects and explanatory variables and consider the fixed effects specification. Table 3 reports equation (3) and (4) estimation results.

The estimation of equation (3) indicates a negative relationship between the logarithm of HHI for the Internet access market and Internet intermediaries' revenues. Therefore, competition growth has increased Internet intermediaries' revenues. The elasticity for Internet HHI equals -1.94. Furthermore, there is a positive relationship between the broadband penetration rate and Internet intermediaries' revenues: the rise in broadband penetration has increased Internet intermediaries' revenues. The elasticity is 2.59, which implies that a 1 per cent increase in the broadband penetration rate increases Internet intermediaries' revenues, on average, by 2.59 per cent. Note that the elasticity of the broadband penetration rate here is higher than the elasticity of the broadband penetration rate estimated in equation (1). Finally, the estimation of equation (3) exhibits a positive relationship between GDP per capita and Internet intermediaries' revenues. The elasticity for GDP per capita equals 6.56.

Table 3
Equation (3) and (4) Estimation Results

Dependant variable: LREVinter	Between-groups estimator (3)		Within groups estimator (4)	
	Coef.	t-stat	Coef.	t-stat
μ	-31.54	-0.8		
α			4.85	0.53
LREVinter (-1)			1.63	13.05***
LREVinter (-2)			-0.64	-5.64***
LHHIint	-1.94	-4.73***	-0.03	-0.87
PENint	2.59	2.96***		
LCAPEX			0.02	0.79
LGDP	6.56	1.69*	1.67	1.96*
R^2	0.43		0.99	
Durbin-Watson stat.			2.42	

***, **, *: statistically significant at the 1, 5 and 10% levels respectively.

The estimation of equation (4) indicates that the logarithm of HHI for the Internet access market is negative but not significantly associated with Internet intermediaries' real revenues. The logarithm of fixed capital expenditures is also negative but not significantly associated with Internet intermediaries' revenues. Finally, the estimation exhibits a positive relationship between real GDP per capita and Internet intermediaries' revenues. The elasticity for GDP per capita equals 1.57.[14]

Concluding Remarks

This paper examines two economic relationships: the one between network operators and content producers and the one between network operators and Internet intermediaries.

14 The elasticity for GDP per capita estimated in equation (4) is lower than the elasticity for GDP per capita estimated in equation (3) because equation (3) relates to the 2001-2008 period, whereas equation (4) relates to the 2003-2008 period.

The results of the literature on net neutrality depend on how the authors have defined net neutrality. While Economides and Tåg[15] point to synergies between network owners and content producers, Hermalin and Katz[16] find that network neutrality, i.e. non-discrimination in network access quality, can exclude application providers from the market and reduce welfare. The majority of the literature finds that network neutrality increases total industry surplus. This is mainly the result of the two-sided nature of Internet intermediaries' and content producers' business models. According to the literature, the impact of network neutrality regulation on network operators' investment incentives is ambiguous.

In contrast to the literature on net neutrality based on industrial organisation, our econometric analysis takes account of the geographical dimension and draws a distinction between content producers and Internet intermediaries. Our econometric analysis suggests that the Internet penetration rate is positively associated with content producers' revenues and with Internet intermediaries' revenues. We also find a positive relationship between network operators' investments and content producers' revenues. Therefore, these results suggest that synergies are at work amongst network operators and Internet intermediaries and amongst network operators and content producers.

European policies focus on promoting competition. Our econometric analysis suggests that increased competition has a positive impact on Internet intermediaries' revenues. Indeed, competition among network operators has promoted innovation and increased Internet intermediaries' revenues. These results suggest the existence of spillovers created by network operators. However, most of the Internet intermediaries are American firms. The biggest Internet intermediaries like Google, Yahoo, Amazon and eBay are all American companies. Internet intermediaries expect fast growth in revenues, and thus value creation spills out from European industry. Ultimately, Internet intermediaries' expansion yields an economic transfer from Europe and Asia to the United States. Therefore, it is likely that European industries will not benefit from network neutrality unless European firms enter the Internet intermediary business. European policy should thus focus on inducing firms to innovate and invest at the Internet intermediary layer. This can also help network owners financing next generation network investments.

15 N. Economides, J. Tåg, op. cit.
16 B.E. Hermalin, M.L. Katz, op. cit.