

## MVNOs in the West and the East: Will MVNO be a Western thing?

### Abstract

The purpose of this study is to examine cross-national data in order to identify possible factors related to the observable patterns of MVNO penetration. For this purpose, a mobile market structure was analyzed through the analysis of important economic factors related to the penetration of MVNOs. MVNOs have gained popularity in the Western markets, but have a dismal track record in non-Western regions. In comparing the different regions, this study analyzes how the MVNO market has changed and what opportunities and/or threats network operators and potential MVNO entrants are likely to face. This study conducts an economic assessment of market structure and environment for different countries' MVNO penetration. The data on market structure is analyzed by means of cluster/factor analysis techniques in order to group countries according to their market environments. Then, structural equation modeling is used to investigate the relations of MVNO penetration and independent variables. The results show that the MVNO penetration significantly relates to market structure and performance. These results also imply the appropriate policy to promote MVNO diffusion.

*Keywords:* mobile virtual network operator, vertical integration, market structure

### 1. Introduction

When Virgin Mobile retreated its operation from Singapore in early 2003, the company cited “weak economic and market conditions” in the country as the reason behind the failure of the business (Communications Today, 2002). The Virgin Mobile's decision to exit the Asian market is ensued with the recent failures of Mobile Virtual Network Operators (MVNOs) in Asian countries, such as Taiwan, Hong Kong, and Malaysia. As the Asian MVNO market development is not as visible as in Europe, the failures left some questions as to what market conditions MVNOs would be able to succeed. A cross-national study could shed light on the question as to whether the observable differences are the outcome of a specific set of factors. This research investigates the set of factors influencing MVNO penetration in order to answer following questions:

RQ1: Under what market conditions do MVNOs succeed or fail?

RQ2: What are the factors affecting the penetration of MVNOs in the world markets?

When looking at the emerging MVNO phenomenon, there may be two approaches: (1) from the perspective of the MVNO itself in which the features for its sustainable business development are researched; (2) from the perspective of the overall mobile market and industry in which the relation of MVNOs to the market should be analyzed. The present study is taking the second approach in order to analyze MVNO from a broader perspective by comparing two groups (total 67 countries): one group for the West (28 countries of EU and the 23 countries of America) and the other group for the East (16 Asian countries). After collecting data on market and industry from these groups, cluster and factor analysis are used to summarize patterns of market structure in the telecommunications industry for these cases. Each factor is characterized by a set of coefficients expressing its correlations with the observed variables. The variables are assigned to the factor in which they are most loaded. As a result, the market structure indicators are split into disjoint sets with each indicator associated with a single factor. The estimated factor loadings applied to the country-specific market structure indicators make it possible to score countries according to each of the factors, so that rankings of countries can be obtained in terms of factor-specific scores. It is standard practice to retain a number of the factors which cumulatively explain a substantial part of the overall covariance. A multivariate regression model is developed to evaluate the effects of market variables on the MVNO penetration.

The findings of this study show that the MVNO penetration significantly relates to market structure and industry performance. In Asia, mobile operators have predominantly maintained high vertical market integration strategies where they control or own the spectrum, base stations, connecting

networks, systems infrastructure, customer service operations, pricing, packaging, billing, branding and points of sale. In contrast, European and North American mobile service is becoming a commodity and network operators are more open to outsourcing parts of the value chain. Operators in these regions increasingly view MVNOs as efficient indirect sales channels that can decrease the focus on price because of strong brand loyalty, lower subscriber acquisition costs by tapping existing customer bases and increase average revenue per user via differentiated content and services. This study concludes that the impact of MVNO will be significant and its' penetration will be depend on the roles of MVNE (Mobile Virtual Network Enablers), which together will change the structure and the dynamics of telecom markets.

## **2. Definition and evolution of MVNOs**

Since its origination in Europe in 2000, there are currently approximately 200 operational MVNOs world-wide with various models and concepts. Regulatory bodies around the world have adopted various definitions and different forms of regulatory intervention depending on the extent to which an MVNO relies on the facilities of a mobile network operator. The ITU (2001) defines an MVNO as a carrier providing users with mobile services without its own government-issued license for bandwidth. Ulset (2002) defines it as an organization providing customers with mobile phone services without owning any airtime. Similarly, Ovum (2005) defines an MVNO as a carrier with the following characteristics: provides customers with a mobile service, has an independent mobile network code, issues independent SIM cards, directly operates a mobile communications switch including a home location register and does not own its own bandwidth. There is no specific definition of MVNOs, but generally the term MVNO can be defined as an organization that is more or less independent from its host in terms of technology and service. Definitions of MVNOs vary, but the present study defines them in a broad, functional sense. This broad definition allows this study to grasp the dynamics of the MVNO market which provides flexibility to potential MVNOs to establish business models according to their financial capability. This in turn increases the level of competition which results in lower prices and innovative service offerings that benefit mobile users.

Although there have been many studies conducted, few studies have attempted to look at the MVNO effects and market structure from a comparative perspective. Most of empirical studies on MVNOs are limited to single country's case. The focus on a single country was partly related to the lack of internationally comparable data on market structures. A study by Boylaud and Nicoletti (2001) provides an example of how different market structures can be compared across countries. In addition, many previous studies (Noam, 2003a; Kiiski, 2003; Jang, 2003; Lehr, 2002) help to conceptualize notion of market structure and link it to MVNOs.

## **3. The relation of MVNOs and market structure**

The MVNO is a new player in the telecom value chain which used to be comprised of operators, service providers, application providers, and content providers. With competition and deregulation, virtual network operators squeeze between operators and customers. In the past, telecommunications network operators used to oversee many functions themselves including strict control over physical networks, and a good deal of control over services, content, marketing and billing. This "walled garden" approach resulted in a limited number of services and content offerings. The vertical integration of operators began to disintegrate because of the telecommunication market's downturn, the burden of high infrastructure costs such as Universal Mobile Telecommunications System licenses and 3G (3<sup>rd</sup> generation wireless network) implementations resulting in a lower Average Revenue per Unit (ARPU), and increasing churn in saturated markets. The telecommunications market has changed considerably recently with less vertical integration, a greater degree of outsourcing, and the abolition of monopolies with easier entry of new players into the field. Such vertical disintegration has encompassed not only new telecommunications operators, but also content, service and application providers as well as new equipment providers from the information technology field (Lehr, 2001). Traditionally, as Duchesneau (1975) finds in the energy industry and more recently exemplified by the AT&T failure, the treatment of

vertical integration has presented substantial problems at both the industrial and governmental policy-making levels. Just as in the energy industry, where vertical integration seems to discourage competitive markets, telecommunications follows suit (Economides, 1996). With the emergence of MVNOs, a question arises as to why certain markets continue to integrate while others start to disintegrate.

The MVNO model is a catalyst to such vertical disintegration process in telecommunications industry. This creates the situation where many major players separate from the mobile network operators seeking to access the value chain at all levels. Unlike other simple resellers of telecommunications services, MVNOs add value such as brand appeal, distribution channels, and other affinities to the resale of mobile services. In addition, unlike simple resellers, who often have little relationships with others, MVNOs typically have close and tight relationships with other players in the value chain. Effective MVNOs have sufficient agreements with existing operators to provide a good service coverage area; and some well-diversified MVNOs can offer a product mix that incumbent mobile operators cannot match.

Many researches have shown that the level of vertical integration is negatively related to competition and positively related to concentration (Hodendorn, 2005). The introduction of competition in telecom market was followed by a decrease in market concentration with new players entering into markets, and a sharp drop in prices. Along with competition, liberalization has brought new players in fixed and mobile markets. Market liberalization is a tool of promoting competition by opening the market to new entrants backed by private capital. Liberalization and vertical integration are often linked. Liberalization is the opening of a monopolistic market to competitive provision of facilities and services (Melody, 1999). As the new players develop new and niche services, market becomes more and more segmented. For most telecom players who are concerned with decreasing ARPU due to segmented market and customers, the MVNO business is another way to increase ARPU from a stagnant customer base, with potential and peril similar to broadband. MVNO can increase ARPU by providing content-based ARPU and keeping their subscribers satisfied. As Noam (2002) shows, all these variables are closely related and the present study is to examine each variable in relation to MVNO penetration.

#### **4. Summarizing market structure for empirical analysis**

##### *4.1. The choice of indicators*

For the purpose of evaluating the correlations of market structure and MVNO penetration, it is useful to focus on a limited set of indicators that capture the main relationship between MVNOs and market structure. In general, this study adopts the indicators of market structure identified by the OECD study (2004; 2001), which are also used by scholarly research; the degree of vertical integration (Krafft, 2003), the degree of liberalization (Sappington & Weisman, 1996), the degree of concentration (Noam, 2003a), and the degree of segmentation. OECD (2004) investigates the linkages between regulation, and telecom market structure/performance for 23 OECD countries. In the study, market structure was measured with the indicators of vertical integration, concentration, and segmentation, and market performance was measured with competition and liberalization. This study adds ARPU as a market performance measure since the FCC commonly uses the ARPU measure when assessing mobile market performance (2005).

In addition to these indicators, the features of the pricing scheme, the governance mechanisms, and regulatory institutions can have important effects on performance. However, price regulation, governance and institutional change are all qualitative in nature and are difficult to convert to into quantitative variables. In addition, such data are not sufficiently available over long enough time periods and across countries to be useful. The current regulatory environment associated with mobile telecommunications could be included, but it is characterized by a relatively low cross-country similarity of both price regulation and regulatory institutions that can be used in an empirical analysis. These dimensions of regulation and governance were therefore ignored in the analysis. The focus thus became two main issues: market structure and its performance. The FCC (2005) uses four variables when assessing mobile telecommunication markets; (1) market structure; (2) carrier conduct; (3) consumer behavior; and (4) market performance. Because of difficulty in collecting and turning the qualitative data

on carrier conduct and consumer behavior into useful quantitative data, these variables are excluded. The following indicators of the market environment were chosen:

- the degree of liberalization is calculated as a percentage of the number of regulations where no restrictions have been attached to both market access and national treatment for a specific services sub-sector and mode of supply out of total possible commitments. Calculations have been done by the GATT Trade Unit based on the methodology developed by Hoekman (1995). This methodology is in line with the method used in telecom sector by Gual and Trillas (2004) who measure the liberalization policies through the degree to which market opening or deregulation policies are asymmetric or biased in favour of entrants.

H1: The degree of liberalization of telecom market is related to the MVNOs penetration.

- the degree of vertical integration in the telecommunications industry, as measured by the percentage value-added services in the market which is widely used to be the most suitable indicator (Haller, 1997, p 319). According to Choi and Shin (1992), vertical integration illustrates how much an entity has created value on its own through its operating activities. Haller (1997) measures the degree of vertical integration by looking at the ratio of value added to total output. Similarly Perry (1989) argues that a firm can be defined as vertically integrated if it encompasses two single production processes in which either: (1) the entire output of the "upstream" process is employed as all the quantity of one intermediate input into the "downstream" process, or (2) the entire quantity of one intermediate input into the "downstream" process is obtained from part or all of the output of the "upstream" process. The present study applies the measure of firm's vertical integration to the market's vertical integration. The figures of all firm's measure of vertical integration can be averaged by the number of telecom operators in the market. If a market were completely integrated, producing the entire product, the ratio would be one. At the other extreme, if a market were vertically disintegrated, producing most of the materials from different suppliers, this ratio moves towards zero (Levinstein, 2002). Total output is the value of production and added value is the firm's values added.

*Vertical Integration = (Added value / Total output) / the number of telecom operators;*

*(0 < VI ≤ 1; 0 = low vertical integration; 1 = high vertical integration)*

H2: The degree of vertical integration is related to the MVNOs penetration

- the degree of market segmentation as measured by the Market Segmentation Index (Lang Research, 2001; Informa Research, 2005). Market segmentation method involves identifying and describing subgroups of the market. First, factor and cluster analysis profile customers and classified into segments. Based on survey responses, customers are grouped or segmented according to similar preferences or needs. Then, the Market Segmentation Index is computed by dividing the incidence of each market segment in a particular market by the incidence of each market segment in the total market. A score of 1.0 means that market segment is the same as the total market in a market sample. Index values above 1.0 indicate that the market segment is over-represented in a given sample of the overall market while index values below 1.0 indicate that the market segment is under-represented relative to the overall market in that sample. An index value of 1.2 means that market segment is 20 % more likely to be found within the particular sample than in the general population.

H3: The degree of market segmentation is related to the MVNOs penetration

- the degree of mobile market performance as measured by average ARPU. Although there are other indicators of performance like CPGA (cost per gross acquisition), CCPU (cash cost per user), and churn, these data are hard to collect. Despite much criticism on its flaws, ARPU is widely used to measure market performance. Since 1980s, ITU has defined telecommunication performance

indicators and ARPU has been major indicator for the performance (ITU, 2000). ARPU is calculated by dividing billable services-derived revenues for a given period by the average number of billable subscribers for that period.

H4: The degree of mobile market performance is associated with the MVNOs penetration

- the degree of competition in the mobile telecommunications industry, as compiled from International Telecom Union and the World Bank (Standard Data) to construct a competition index variable. This competition variable is assigned a value of zero if the telecommunication sector is served by a national monopoly operator, a value of one if the sector has more than one operator in either the fixed-line or the mobile market segment, and a value of two if the sector has more than one operator in both fixed-line and mobile market segments. This method is used by Li and Xu (2004) for measuring competition in the telecom sector around the world.

H5: The degree of competition is related to the MVNOs penetration.

- the degree of concentration in the wireless telecommunications industry, as measured by HHI (Herfindahl-Hirschman Index)

$$HHI = 10,000 [\Sigma(S_i)^2 ] = 10,000 [(S_1)^2 + (S_2)^2 + (S_3)^2 + \dots + (S_n)^2 ]$$

n = number of firms participating in an industry;  $S_i$  = each firm's market share  
i = firm in a given industry.

H6: The degree of concentration is related to MVNOs penetration.

#### 4. 2. Multivariate regression analysis

Multivariate regression analysis is used to determine the relative importance of each MVNO market share within a group. The structural equation can be derived from the above variables in a reduced form to explain MVNO penetration as follows:

*MVNO penetration = f (concentration, competition, vertical integration, liberalization, performance, and segmentation)*

In this study, a multivariate regression method is used to estimate model parameters. Factor analysis and cluster analysis methods were used in mapping the structure of the observations and relations between possible measures for the independent variables. Based on the theoretical model above, following empirical model is formulated:

$$MVNOP = CONS + \beta_1 * COMP + \beta_2 * LIB + \beta_3 * ARPU + \beta_4 * SEG + \beta_5 * COMP + \beta_6 VER + \epsilon \quad (8)$$

with

MVNOD - MVNO penetration ; CONS - intercept (constant) ; CONP - concentration (HHI); LIB – liberalization ; ARPU - Average revenue per unit; SEG – segmentation; COMP - competition; VER - vertical integration;  $\epsilon$  - random error term.

The dependent variable was defined as the total MVNO market share in a country as percentage of the total wireless market (the number of MVNO subscribers as percentages of the total mobile subscribers; Table 1e). Data was collected (Table 1) on a period between 2003 and 2005.

< Table 1 here >

### 4.3. Cluster analysis and factor analysis

Based on the data above, a cluster analysis was used to categorize and group mobile markets according to market structure and performance. Cluster analysis is used to investigate the similarity of the countries based on the country scores on each of the estimated factors. Starting from the values taken by the scores in each country, this technique progressively groups countries in clusters of increasing size based on (multi-dimensional) pair-wise comparisons. At each step in the clustering process, an index of inter-group similarity measuring the distance between the clusters being joined is calculated. It is standard practice to stop the clustering procedure (i.e., select the relevant number of clusters) when the distance between clusters becomes sizeable.

Using cluster analysis, several groups of countries could be identified based on their experience with MVNOs over the period analyzed, the most vertical being Hong Kong and Singapore, and the most horizontal, layered or open (horizontally diversified or consolidated) being the UK, Denmark, Netherlands, Norway, Sweden, and U.S.. Country clusters based on market conditions are as follow:

- Vertical structure (23 countries): Most Asian countries, Mexico, etc.
- Horizontal structure (24 countries): Most of the EU, North America, Japan, Australia.
- Mixture (20 countries): New Zealand, etc.

After the groupings of countries were created through cluster analysis, a factor analysis was carried out to evaluate the underlying commitment factors and to reduce number of variables in order to avoid multi-collinearity (Table 2). Factor analysis is a statistical technique aimed at finding the minimum number of latent variables that explain the maximum amount of the overall covariance of the observed variables. The factors, which are linear combinations of the observed variables, can be interpreted in economic terms such as market structure, openness, and dependency. Each factor is characterized by a set of coefficients expressing its correlation with the observed variables and the variables are assigned to the factor in which they are most loaded (Table 3). As a result, the market structure indicators are split into disjoint sets, each of which is associated with one factor. The estimated factor loadings applied to the country-specific market structure indicators make it possible to “score” countries according to each of the factors, so that rankings of countries can be obtained in terms of factor-specific scores. It is standard practice to retain a number of factors which cumulatively explain a substantial part of the overall covariance.

<Table 2 here>

<Table 3 here>

## 5. Empirical model and analysis results

Overall, the empirical results allow the identification of important factors that influence the observable pattern of MVNO penetration (Table 4). Four hypotheses were confirmed while two hypotheses were rejected (H4 & H6). Four main factors are found to best describe the cross-country variance in the set of indicators of MVNO and market structure.

<Table 4 here>

Table estimation results summarize the estimated effects of market structure on MVNO penetration for the selected model specifications (i.e., those that were not rejected by the tests). Overall, the market structure indicators performed quite well, significantly improving the fit of the regressions. By looking at the indicators most closely associated with each of the factors, a straightforward economic interpretation can be made: the first factor (associated with vertical integration of the mobile market) shows that the degree of vertical integration is significantly associated with MVNO penetration; the proliferation of vertically integrated mobile operators reduces the MVNO market share. The second (associated with segmentation in telecom services) expresses the positive significant relationship with the

MVNO penetration; the third factor (associated with mobile market competition) shows the positive relation that higher competition is related to higher MVNO penetration; and the fourth (associated with liberalization) factor accounts for the positive relation with the process of the MVNO penetration. The concentration factor has the negative relation with the MVNO penetration, but the relation is not statistically significant. While ARPU does not show a statistically significant result either, ARPU shows an interesting insight. The ARPU of MVNO, show breakdown by region shows that North American has increased ARPU since 2000 indicating higher-end segments coming online through emphasis on post-paid MVNOs such as ESPN and Disney. The ARPU of EU MVNO has declined implying growth in the low-end segments and intense competition. The ARPU of Asia is relatively stable indicating a slight offset by data revenues from data-only operators.

A principal components method with a varimax rotation of the 6 variables reveals 5 underlying factors with eigenvalues of greater than one. These 5 factors explained 75.9% of the variability in the eleven variables. Model 1 does not account for the vertical integration variable and model 2 does not include the competition variable. Model 3 has a better overall explanatory capacity, but the variables of competition and liberalization are not significant. Model 4 does not include the dependency variable, but is generally acceptable. Model 5 drops four variables and shows the lowest explanatory power. There are some recurrent observations from these models. Vertical integration and segmentation are most statistically significant factors. The effect of these two variables is also relatively robust.

Dividing the sample into the two groups (vertical and horizontal) identified by the cluster analysis showed more insights (Table 5). The interpretation of the cluster analysis between the groups is that MVNO penetration among the groups correlates strongly with market structural factors (e.g., concentration, segmentation, liberalization, and vertical integration) and to a lesser extent with performance indicators (e.g., competition, ARPU).

The statistical analysis shows that the liberalization factor present in the horizontal group had a positive and significant impact on the MVNO penetration. This can be explained by the EU's Access Directive (2002) which helped to correct vertical integration in communications services and facilitated MVNO launches. The EU's Access Directive (2002) contains requirements that vertically integrated network operators must impose accounting separation and initiate transfer pricing arrangements where they control access to essential input facilities that are used by their competitors in a retail market. In contrast, the liberalization factor for the vertical group was detrimental to MVNO penetration, although the effect also was not statistically significant.

<Table 5 here>

Model runs at the level of country sub-groups show that the overall pattern is particularly visible in the horizontal group of countries. In this group, competition is correlated positively with MVNO penetration (with no significance) and concentration does not exhibit a significant effect. Within the countries in the vertical group, competition has the opposite effect and is negatively related to MVNO penetration.

Concentration (measured by HHI) shows a positive effect, but not statistically significant on MVNO penetration. This finding contradicts the widely held belief by several previous studies (e.g., Noam, 2003b). The HHI of the U.S. is more effective than Europe. The U.S.'s HHI is 1,377 compared to that of Europe. Market concentration is low by international standards in the U.S. and the MVNO penetration therefore has been largely unaffected by market concentration. Concentration also is not a significant factor in Asia. For example, Hong Kong's HHI is low (1,936), which is an effective HHI figure. The HHI figures of the Asian countries contribute to the insignificant result of competition and concentration. As the competition variable shows, Hong Kong and Singapore are two of the world's most competitive mobile markets. The implication is that the Asian markets in general are small scale markets, and therefore the incentive to innovate may be lower than in large markets. As shown in the EU and U.S. mobile markets, larger firms innovate more. The largest operators in Hong Kong and Singapore have relatively small market shares. Hong Kong and Singapore are the two of the most fragmented world markets; and less fragmented markets, such as the EU and the U.S. have much higher MVNO penetration. An explanation may be that fragmented or segmented submarkets in smaller overall markets obviate inter-operator collaboration on application development (Godfrey & Kam, 2004). As the ITU report

(2004) shows, Hong Kong has a more fragmented market sector than any other country and no mobile operator there accounts for more than 30% of the market. This segmented market produces a low HHI in Hong Kong. As to the HHI variable itself, the HHI may not be a good measure in such a small market (Farrell & Shapiro, 1990; Demsetz, 1974). A more appropriate one may be Gans' new measurement of HHI when it applies vertical structure, namely "vertical HHI" (Gans, 2005).

The market segmentation variable shows different results across groups. The segmentations in EU and North America show significant correlation with the MVNO market share. This result reflects the current U.S.'s MVNE proliferation. An MVNE does not have a relationship with end-user customers. Instead, MVNEs provide infrastructure and services to enable MVNOs to offer services and have a relationship with end-user customers. MVNEs enable infrastructure and related services ranging from network element provisioning, administration, operation support systems, and business support systems by providing the intermediation between MVNOs that do not want to have any control over network elements and those that want complete control. As of 2006, there are more than 39 MVNE's in the world and 80 percent of them are located in the Western countries and there is no MVNE in Asian countries (Pyramid Research, 2006). MVNEs accelerate markets to be segmented by allowing MVNOs to provide various segments such as prepaid, high-end, data-focused players, etc.

Interestingly, this segmentation variable shows a significant correlation with vertical integration variable. This can be explained that the fact that the European MVNE's provide the telecom operators with a relationship to manage through a single, trusted interface for different MVNOs (Kristensson, 2001). In other words, MVNE's provide a bundled platform for MVNOs. These equate to turnkey type solutions that typically include automated interfaces to a carrier's provisioning system, real-time or near-real-time usage, gateways for Short Message Service and content, as well as the usual telco back-office systems and services. MVNE's take such forms as Application Service Providers, billing companies, content providers, hardware manufacturers, and Internet or media companies.

The highly vertical-integrated markets of Asia in general have both been not favorable to the MVNO model. The fact that the MVNO model has had difficulty establishing itself in such segmented market environment suggests that the intensity of the facilities-based competition creates limited opportunities for them to be economically viable, even with a differentiated strategy in the face of aggressive price competition. Hong Kong's MVNOs lease network services from facilities-based providers, and compete on the basis of retail service differentiation. Yet, because of the already fragmented sector in these markets, MVNOs have not been effective in focusing on niche markets that can be served at lower cost with a focused marketing strategy. MVNOs in Hong Kong have therefore become vertically integrated service providers who contribute to and enhance the vertical market structure.

As pertaining to market performance, the ARPU variable shows no significant correlation although it does show a positive relation. The insignificance of ARPU implies that the main challenge prospective MVNOs will face is not necessarily a low ARPU, but other ones such as a niche market. In other words, regardless of mobile operators are making or losing profit, they are seeking new markets. As Jost (2004) predicts, MVNOs can potentially survive on \$5 ARPU, but that the MVNO model in general must find a way to survive from the cost side of the business. The positive relation implies that MVNOs are active in markets where they deal with low margin subscribers. The undesirable role of MVNOs in this scenario winds up as protecting the host carrier from absorbing undesirable financial costs such as those related to volatile prepaid churn, high capital investment, and consumer fraud. All of these can accompany an MVNO that targets low-value subscribers. The positive correlation further suggests that MVNOs must find a niche among incumbent carriers who are willing to lease capacity since most operators are unlikely to open their networks.

The estimation results of liberalization show that liberalization is a somewhat significant factor (Table 4a). It is interesting to note that the Asian markets' liberalization also significantly contributes to the MVNO penetration (Table 5) despite the low penetration in general. Since market liberalization in EU huge number of competing MVNO is operating and in Asian markets, under pressure of regulations and entrepreneurs, the process of MVNO development just started. This can be interpreted that several Asian countries like Japan, Malaysia, and India are making positive efforts to facilitate MVNO by establishing guidelines require network operators leasing or open to MVNOs.

Overall, the empirical analysis does show key drivers of MVNO penetration, but it also provides implications that several constellations of factors may exist that can be conducive to MVNO penetration.

The active operation of MVNEs supports the analyses of segmentization, vertical integration, concentration, and liberalization. This point needs to be further examined by using panel regression.

## **6. Tripartite description of MVNO: America, EU, and Asia**

The comparative analyses imply that the MVNO models may be effective in Western countries but have a limitation applying to global markets. Based on the findings here, the EU markets can be characterized as one of the most competitive, liberal, and the least vertically integrated market and therefore highly segmented among the markets. The liberalized market of EU allows MVNOs more freely negotiate with HNO (Host Network Operator, i.e., Sprint). A large number of MVNE in EU and U.S. implies highly segmented market, which facilitate the negotiation between MVNO and HNO. MVNEs such as Visage Mobile provide back-office services and facilitate the interface between the brand and the carrier. Essentially, MVNEs handle operations so the brand partner can focus on customer acquisition and content. The emergence and proliferation of MVNEs relates to the fact that the mobile businesses in Western have based on content and branding, while Asian mobile markets are still driven mainly by handsets and price.

In addition, the liberalized markets of EU seem to expedite MVNO penetration in consolidated and integrated applications instead of segmented services. The European MVNO providers differentiate product and price, establish good distribution channels, and target specific customer segments. While not as evolved as the European MVNO market, the North American markets has matured to the point where success is determined by traditional business competency including factors such as brand strength, marketing, sales, distribution, and perceived value by the consumers. In particular, MVNOs have been making significant headway in North America. MVNOs in the U.S. and Canada are primarily targeting niche markets and many such markets remain untapped or underserved. As shown by the regression, the U.S. market seems to be more segmented than that of EU, and thus MVNOs are focusing on niche segments. For example, Virgin Mobile U.S. offers to the youth market, while Movida is focused on Hispanics population in the U.S.

It appears that the growth of MNVO in U.S. is related to the growing trend toward specialization in market segmentation by operators. As operators better define the segments that they serve most profitably, operators will be better able to drop off their less profitable and more difficult segments to groups that are more efficient at serving these segments. These fundamental shifts in market structure are opening up the U.S. market to MVNO entry by the region's key service brands: banks, distributors, and retailers. Each of these groups has created unique relationships with specific consumers and corporate segments that may well set the stage for an expansion into mobile services. Reflecting the high segmented market, a large number of MVNO in the U.S. started as data centric MVNOs (e.g., ESPN, 7-11 and Movado) as opposed to enterprise MVNOs. In the U.S., MNVOs are a route by which HNOs can use mobile services to attract new customers and grow faster without compromising their mass market appeal.

While EU started ahead of U.S., the MVNO in North America has many similarities to the EU MVNO. Both EU and the U.S. have a overall Prepaid Focus, both have caused overall price deflation, both have used data to boost revenues, both are looking to take advantage of 3G to differentiate and increase revenues, and both have used MVNO to develop underserved market segments to address with a targeted MVNO offer.

As to Latin America, however, a situation is quite different from North America. Although the Latin American mobile landscape presents many of the obstacles affecting the U.S. mobile market, such as low ARPU and increasingly saturated markets, the Latin American region has its own set of problems, such as regulatory constraints and lack of spectrum capacity. In addition, key factors of MVNOs such as competition, performance, liberal market, and niche market do not exist with enough momentum to make MVNOs a reality. These factors will limit the number of viable brand-based MVNOs, as the potential addressable market may not justify the investments. However, since 2003 many of these obstacles have been largely removed or substantially lowered by the growing implementation of 2.5G technologies and the resulting increase in network capacity. Furthermore, recent plan of auctions for W-CDMA spectra for 3G services are creating a shift in regulatory initiatives that will force new license owners to open up their networks to MVNOs.

In Asia, the MVNO market development is not as visible as in Western markets (Table 1b and 1c). As shown in this study, market and industry performance create the challenges for MVNOs. In addition, maybe more importantly, Asian regulators are reluctant to force operators to open up to MVNOs, and operators even more so. The regulators have promoted facilities-based competition and the operators who fear of customer base cannibalization seem to influence the regulations and market of MVNO. The regulators' intervention may be in line with the discrepancy between the Asian's high liberalization and low MVNO penetration (Table 5). The liberalization indicators in Asian countries may be the result of policy-based liberalization, which is different from market-based liberalization of Western countries. Under the policy-based liberalization, the markets are artificially changing toward liberal markets but liberalized markets are most effective in markets where there is effective competition (Wu, 2003). Although overall Asian markets are apparently liberalized by the governments' intervention, Asian markets still seem to be not open enough to embrace the MVNO, and the MVNO does not appear to stabilize in the markets without effective competition. It is ironic that SK Telecom, Korea's biggest mobile operator, is running MVNO business in U.S. in the name of Helio, which has been successful in targeting niche tech-savvy young adults seeking multiplayer gaming. SK Telecom obviously does not want open their walled garden vertical market, but takes advantage of the liberalized and segmented U.S. market. These all the peculiar features in Asian operators imply that the Asian factors and indicators should be interpreted with special care because of peculiar market structure and industry culture. In this light, the Asian markets will likely force the "Asianization" of the current MVNO models being implemented in other regions of the world. The emerging market MVNO model cannot be similar to the MVNO model used in mature markets. The MVNO diffusion in Asia will come at a much slower pace and through diverse processes because governments are more cautious in their approach due to political costs.

The tripartite comparisons imply that MVNOs tend to be more prosperous in developed, mature, and thus dynamic markets like the Western markets than emerging and young markets like Asia and Latin America. In fact, MVNO tends to follow an economy of scale and it is a number game; the rich get richer, the poor get poorer. The findings of this study imply that a certain level of penetration before the MVNO model becomes feasible. The emergence of MVNO poses opportunities for established markets and threats for new markets. While the Asian markets see the MVNO as threats of losing customer control and price deflation in the market, the Western markets turn such possible threats to opportunities by reselling excess network capacity and by creating new market segments. To increase MVNO penetration, Asian governments are now putting their efforts to liberalize, disintegrate, deregulate, and privatize their markets to create an environment fostering a rich diversity of MVNOs, which Western countries have built over the long time. Asian regulators seem to realize the benefits of MVNO's as a means of encouraging competition, which would ultimately lead to greater choice and lower prices. The regulators should evaluate the market and make policy recommendations for MVNO based on competitive prices and keeping the market viable and profitable.

## **7. Conclusion: Future Convergence Value Era**

The emergence of MVNOs has revealed two main industry structures in the mobile telecommunications industry: a horizontally layered (either diversified or consolidated), market-driven structure with a modular product architecture, and a vertically integrated, "walled-garden" structure with an integrated product architecture. As shown previously, MVNO services are much more successful in Western than in Asian countries. One major reason for this difference in success is the differences in the industry structures between the markets in both areas. Because of the complexity of MVNO services, a horizontal-layered structure seems to be more effective and successful. This finding provides future carriers and potential MVNOs with a framework to determine if the MVNO model is right for their respective business.

The Asian industrial framework is optimized for traditional mobile voice services. It does not allow MVNOs to develop their business models in ways that have turned to be popular in Western Europe. In other words, MVNO services are more successful in markets where virtual operators take intermediary and aggregating roles in order to offer a true end-to-end mobile service. The incumbent Asian operators

are not eager to change the market structure. It seems that MVNOs would have nothing but negative consequences from the consumer's point of view if the market structure changed. In his study on market structure, Economides (1996) leaves open question of whether the horizontal or a vertical industry structure is the better for MVNOs. To be more specific, the open questions would be: Is it more valuable to have a transparent, market-driven industry structure or a vertically integrated structure enabling provision of easy-to-use services? Would this more integrated structure provide a mobile telecommunications market with only one, monopoly-type player. This study partly answers such questions by showing that a horizontally-layered market is better with respect to facilitating MVNO penetration. It is clear, however, that the old vertically integrated telecom business models are no longer viable in an environment where the demand for a whole range of value-added services is strong. Under such a horizontal value chain, vertical integration will be minimized or eventually disappear.

Predicting which MVNO trends will prevail can be a hard question. In the long run, MVNOs, along with MVNEs, are likely to rise and decline in popularity as uncertain market and industry change. One thing is clear, regardless of prevail or fail of MVNOs, their impact will be significant throughout the wireless industry.

## 8. Limitations and future studies

This study used an aggregation model and data was collected for the limited time of 2003-2005. Therefore, it would be helpful for future studies to conduct comparative studies at a less aggregated level, such as using cross-sectional time-series analysis methods. In addition, multivariate regression, as Cava-Ferreruela et al. (2006) indicate, has weak numeric and estimation features. Other sophisticated measures may be accompanied with multivariate regression such as bootstrap re-sampling or stepwise selection techniques. Strong methodological framework will better predict the prospect of MVNO. One question that remains uncertain for MVNOs in East and West alike is the long-term viability of the MVNO. This question relates to how the value chain will develop and where the bottlenecks will remain.

The current study intentionally simplifies and limits the variables in order to grasp the overall understanding of MVNO penetration factors. The limited variables allowed this study to set aside regulations, policy and carrier conduct and behavior as dummy variables. As Economides (1996) contends, the structural differences are caused by the dissimilarities in the national regulations. As the present study excludes national policy from variables, it neglects to note many important aspects: EU regulators are opening up network access in favor of MVNO models and FCC has been generally favorable to MVNO, which are not in the case of non-Western region. In addition, the significant results of the dummy variable imply that there is something more behind the MVNO penetration and market structure. For example, despite the overall similarities between the U.S. and EU, the lower MVNO in the U.S. can be explained by the fact that the U.S. operators are carefully watching MVNO development as they believe that the transition period between 2.5G and 3G will be the most fruitful period for MVNOs. This kind of carrier behaviors will need to be investigated with respect to regulation and policy.

## References

- Boylaud O, & Nicoletti G. (2001). Regulation, market structure and performance in telecommunications. *OECD Economic Studies*, 32, 99-142.
- Cava-Ferreruela, I. & Alabau-Munoz, A. (2006). Broadband policy assessment: A cross-national empirical analysis. *Telecommunications Policy*, article In Press.
- Choi, C. & Shin, H. (1992). A comment on a model of vertical product differentiation. *The Journal of Industrial Economics*, 40 (2), 229-231.
- Demsetz H. (1974). *Two systems of belief about monopoly*. In: H. Goldschmid editor. *Industrial Concentration: The New Learning*, Little Brown: Boston, Massachusetts.
- Duchesneau T. (1975). *Competition in the U.S. energy industry: A report to the energy policy project of the Ford Foundation*. Ford Foundation Press.
- Economides, N. (1996). The economics of networks. *International Journal of Industrial Organization*, 14(2), 675-699.

- Federal Communications Commission (2005). WTB Seeks Comment On CMRS Market Competition, WT Docket No. 05-71, DA 05-487, Released: February 24, 2005. Available [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/DA-05-487A1.doc](http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-05-487A1.doc).
- Farrell, J. & Shapiro, C. (1990). Horizontal Mergers: An Equilibrium Analysis. *American Economic Review*, 80 (1), 107-123.
- Gans, J. S. (2005). Concentration-based merger tests and vertical market structure. *Journal of Economic Literature*, 43(2), 238-256.
- Godfrey, J. & Kam, J. (2004). *What it takes to kick start mobile data: the lessons from Japan and South Korea*. ITU Asia 2004, Online News Service.
- Gual, J. & Trillas, J.F. (2004). Telecommunications policies: determinants and impact. (August 2004). CEPR Discussion Paper No. 4578. Available at Social Science Research Network: <http://ssrn.com/abstract=604468>
- Haller, A. (1997). Die Wertschöpfungsrechnung - Ein Instrument zur Steigerung der Aussagefähigkeit von Unternehmensabschlüssen im internationale Jontext, Poeschel Verlag, Stuttgart.
- Hodendorn, C. (2005). Regulating vertical integration in broadband: Open access versus common carriage. *Review of Network Economics*, 4(1), 19-32.
- Hoekman, B. (1995). Trade laws and institutions: Good practices and the World Trade Organisation, Supplementary paper presented at The Uruguay Round and Developing Economies, a *World Bank Conference*, 26-27 January 1995.
- Informa Research (2005). Informa research services' telecom market segmentation and customer profiling program, 2005. Accessed in March 2006 <http://www.marketrends.com/industry/telecom/telecomproj.htm#5>
- International Telecom Union (2001). *Mobile Virtual Network Operators*, Geneva. Geneva: ITU.
- International Telecom Union (2004). Trends in telecommunication reform: Effective regulation. Geneva: ITU.
- International Telecom Union (2002). *Asia-Pacific Telecommunications Indicators*. Geneva: ITU.
- Jang, B. (2003). Vertical structure and network competition in telecommunications services market. *Information Society Research*, Fall: 81-101.
- Jost, J. (2004). *Can MVNOs succeed in emerging markets?* Pyramid Research.
- Krafft, J. (2003). Vertical structure of the industry and competition: an analysis of the evolution of the info-communications industry. *Telecommunications Policy*, 27(8/9), 625-649.
- Kristensson, S. (2001). *Mobile Virtual Network Operators. Assessing MVNO business opportunities*. School of Business, University of Stockholm, Master of Science Thesis, June 2001.
- Lang Research Inc. (2001). *Travel activities & motivation survey, touring segmentation report*. October 2001, Canadian Tourism Commission.
- Lehr, W. (2002). Vertical integration, Industry Structure, and Internet Telephony. *Internet Telephony* (ed. McKnight, Lehr, and Clark), the MIT Press, 2001.
- Levinstein, M.C. (2002). Vertical integration. In: Mokyr, J. editor. *Oxford Encyclopedia of Economic History*, New York.
- Li, W. & Xu, C. (2000). The impact of privatization and competition in the telecommunications sector around the world. *Journal of Law and Economics*, 48 (October).
- Market Research (2005). *Future of mobile virtual network operator series: Europe, America, Asia Africa 2006*. Market Research Publication Report (Report ID: RFB1188821).
- Melody, W. (1999). Telecom reform. *Telecommunications Policy*, 25, 7 – 34.
- Noam, E. (2003). The effect of deregulation on market concentration: an analysis of the Telecom Act of 1996 and the industry meltdown. *The Columbia Science and Technology Law Review*, 4, 1-12.
- Noam, E. (2003b). Deregulation and market concentration: An analysis of post-1996 consolidations. *Federal Communications Law Journal*, 58, 539-550.
- Noam, E. (2002). *How telecom is becoming a cyclical industry, and what to do about it*. Presentation at Columbia Institute for Tele-Information, Conference on Telecommunications Volatility, April 2002, Columbia University, New York.
- OECD Economics Department Working Papers (2001). OECD Economics Department in its series by Olivier Boylaud and Giuseppe Nicoletti. Regulation, market structure and performance in telecommunications, 2001.

- OECD (2000). Performance Indicators for Public Telecommunication Operators. Paris. Original OECD report available online at: <http://www.oecd.org/dsti/sti/it/cm/prod/ICCP22.htm>
- Ovum (2005). *Virtual mobile services: Strategies for fixed and mobile operators*, June 30, 2005. Ovum Research & Consultancy, Market Research Report.
- Perry, M. (1989). Vertical Integration: Determinants and Effects. (Eds) R. Schmalensee and R. Willig, *Handbook of Industrial Organization*, Volume I, Chapter 4.
- Pyramid Research (2006). *MVNOs and MVNEs: Analyzing the Viability of Virtual Mobile Players*. February 2006 (ID: PYR1224156) Accessed in August 2006.  
<http://www.marketresearch.com/product/display.asp?productid=1224156>
- Sappington, D. & Weisman, D. (1996). *Designing incentive regulation for the telecommunications industry*. MIT Press, Cambridge, MA.
- Ulset, S. (2002). Mobile virtual network operators: a strategic transaction cost analysis of preliminary experiences. *Telecommunications Policy*, 26(9-10), 537-549.
- Wu, F. (2003). From monopoly to competition: a comparative study of telecommunications policy reform in four Asia countries. *Proceeding of Pacific Telecommunications Council*, January 2003, Manoa, Hawaii.

## Appendices

Table 1a  
Data collected

	HHI	VI	Lib	Segm	ARPU	COM
EU average	3,948	0.23	0.86	0.93	49.91%	0.73
Asian average	2,186	0.32	0.54	0.56	42.54%	0.53
North America average	1,337	0.59	0.34	0.84	28.4%	0.81

- Europe (28): Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Netherlands, Netherlands Antilles, Norway, Poland, Portugal, Russia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom.
- America (23): USA, Canada, Mexico, Caribbean countries, and Latin American countries.
- Asia (16): Hong Kong, Singapore, China, India, Japan, Indonesia, Korea, Malaysia, Myanmar, Mongolia, Philippines, Taiwan, Australia, New Zealand, Thailand, and Vietnam.

Table 1b  
Mobile market

	Number of license holders	Share of largest operator	Share of second largest operator
Denmark	8	39	19
Finland	4	67	30
Sweden	5	43	25
UK	5	32	20
USA	8	27	24
Singapore	3	54	19
Hong Kong	3	34	18

\* EU's weighted average (i.e., HHI is weighted by the countries share of telecom revenue)  
Sources: OECD Communications Outlook, ITU Database, World Mobile Market 1996-2010," OMSYC

Table 1c

MVNO subscribers as percentage of total mobile subscribers in 2004.

Countries	EU	US	Asia
%	5.9%	1.3%	0.01%

Note: Data compiled from Market Research (2005).

Table 1d

MVNO in Europe, America, and Asia

## MVNO in Europe

Austria	3 MVNO relationships – A1 (0), H3G (0), ONE (2), tele.ring (1), T-Mobile (0)
Belgium	29 MVNO relationships - BASE (25, 3 via MVNE Transatel), Mobistar (1), Proximus (1)
Denmark	14 MVNO / SP relationships - H3G (0), Sonofon (3), TDC Mobil (11), Telia Mobil (0)
Estonia	2 MVNO relationships - AS EMT (0), Elisa (1), Tele2 Eesti (0)
Finland	10 MVNO / SP relationships – Elisa (1), Finnet (3), TeliaSonera (3)
France	13 MVNO / SP relationships - Bouygues (3, 2 via MVNEs), Orange (4), SFR (5)
Germany	32 MVNO / SP relationships
Greece	1 MVNO
Hungary	2 MVNO relationships
Ireland	3-4 MVNO relationships
Italy	1 MVNO
Latvia	1 MVNO / SP relationship – LMT (1), Tele2 (0)
Liechtenstein	1 MVNO
Lithuania	2 MVNO / SP relationships - BitSM (2), Omnitel (0), UAB Tele2 (0)
Luxembourg	1 MVNO relationship - LUXGSM (1), Tango AS (0), VOX Mobile (0)
Netherlands, The	24 MVNO / SP relationships - KPN Mobile (5), Orange (2), Telfort (14), T-mobile (0), Vodafone (3), unknown (1) planned / speculations (3)
Netherlands Antilles	1 MVNO relationship
Norway	11 MVNO relationships
Poland	2 MVNO relationships (?)
Portugal	0 MVNO relationships
Russia	2 MVNO relationships
Slovenia	1 MVNO / SP relationship
Spain	2-3 MVNO / SP relationships
Sweden	23 MVNO relationships
Switzerland	3 MVNO / SP relationships
Turkey	0 MVNO
Ukraine	1 MVNO relationship
U.K.	24 MVNO relationships

\*SP: Service provider

## MVNO in America

North America	Canada	7 MVNO relationships - Bell Mobility (1), E-Mobile (1), Microcell (2)
	U.S.	53 MVNO relationships
	Mexico	3 MVNO
Latin & South America	Argentina	3 MVNO
	Brazil	1 MVNO
	Bolivia	2 MVNO (COTAS)
	Puerto Rico	1 MVNO
	Venezuela	2 MVNO

\*Rest of Latin and South America countries do not have MVNO.

MVNO in Asia

Australia	30 MVNO relationships - H3G (0), Optus (12), Telstra (6), Vodafone (8, 7 via MVNEs)
China	1 MVNO
Hong Kong	6 MVNO
India	2 MVNO
Indonesia	0 MVNO
Japan	8 MVNO
Korea	1 MVNO (operate in U.S.)
Malaysia	2 MVNO
Myanmar	0 MVNO
Mongo	0 MVNO
New Zealand	1 MVNO
Philippines	1 MVNO
Singapore	2 MVNO
Taiwan	2 MVNO
Thailand	0 MVNO
Vietnam	0 MVNO

Table 1e  
MVNO market share

	Mobile subscribers (million)			MVNO subscribers (million)			MVNO market share (%)		
	2003	2004	2005	2003	2004	2005	2003	2004	2005
Asia Pacific	621	733	912	0.9	1.02	1.04	0.1	0.01	0.01
Europe	610	721	878	10.4	11.9	17.1	1.7	1.7	1.9
North America	211	232	245	6.3	9.2	11.3	3	4.4	4.9
Latin America	198	237	247	0.4	0.42	0.44	0.02	0.01	0.01

Table 2  
Results of factor analysis: Rotated factor loadings

Variables/factors	Performance	Structure	Ancillary Regulation
Competition	0.628	0.052	-0.0083
ARPU	0.721	-0.188	0.114
Segmentation	0.023	0.930	0.149
Concentration	-0.129	0.900	-0.033
Vertical integration	-0.093	-0.838	0.199
Liberalization	0.003	-0.254	0.349

\*Factor loadings measure the correlation between the individual indicators and the latent factors. Indicators are assigned to the factor to which they are most correlated. The rotation of factor loadings is a transformation aimed at minimizing the number of indicators that are highly correlated with more than one factor.

Table 3  
Correlation matrix (full model)

	Concentration	Competition	Segmentation	Liberalization	ARPU	Vertical
--	---------------	-------------	--------------	----------------	------	----------

						integration
Concentration	1					
Competition	-0.3923	1				
Segmentation	-0.2328	0.7992	1			
Liberalization	-0.2134	0.5923	0.4283	1		
ARPU	-0.3769	0.5912	0.6913	0.5131	1	
Vertical integration	0.5460	-0.4942	-0.4093	-0.7022	-0.4623	1

Table 4a  
Estimation results

Variables/factors	Model1	Model2	Model3	Model4	Model5
Concentration	0.0078 <i>0,029</i>	0.00688 <i>0.305</i>		-0.01003 <i>-2.566</i>	**0.0382 <i>2.903</i>
Competition	0.0883 <i>-1.349</i>		-0.0232 <i>-2.301</i>	*-0.1372 <i>-1.212</i>	-0.0034 <i>-2.393</i>
Segmentation	**0.27442 <i>3.492</i>	***0.2432 <i>4.203</i>	***0.235 <i>3.999</i>	**0.1578 <i>2.942</i>	
Liberalization	0.0302 <i>0.624</i>	-0.214 <i>-0.992</i>	0.034 <i>1.932</i>	*0.134 <i>2.321</i>	
ARPU	*0.0899 <i>-3.392</i>	0.0603 <i>1.9323</i>	**0.00907 <i>-3.2093</i>		**0.0197 <i>-2.9332</i>
Vertical integration		*-0.183 <i>-2.032</i>	*0.192 <i>0.123</i>	-0.031 <i>3.234</i>	
Constant	-5.934 <i>-1.170</i>	-3.423 <i>-1.153</i>	-7.392 <i>-1.923</i>	-4.923 <i>-0.132</i>	0.323 <i>3.293</i>
Prob>F	***0.0071	**0.0162	***0.0012	***0.0052	**0.0129
R <sup>2</sup>	0.5517	0.5711	0.5417	0.5291	0.323
Adj. R <sup>2</sup>	0.4136	0.4053	0.4793	0.4293	0.203

Note: \*significant at 90% level; \*\* significant at 95% level; \*\*\* significant at 99% level.  
(Dependent variable MVNO market share in 2002-2003, t-statistic is italic)

Table 4b  
Summary measures (multiple regression)

R	R Square	Adjusted R Square	Std. Error of the Estimated
.8061	.8323	.8434	.0054

	Sum of Square	df	Mean Square	F	Sig. (p-value)
Regression	52.613	10	5.261	67.676	.000
Residual	28.454	366	7.774		
Total	81.067	376			

Table 4c

## Regression coefficients

	Unstandardized coefficient (B)	Standard Error	t-value	Sig. (p-value)
Concentration	-.101	.003	-1.321	.000
Competition	.022	.007	3.103	.002
Segmentation	.116	.011	4.507	.010
Liberalization	.180	.078	6.401	.002
ARPU	.103	.007	1.297	.000
Vert. Integration	-.046	.021	-10.874	.022
Constant	.873	.082	10.625	.000

Table 5  
Estimation results, country groups

Variables/factors	EU	North America	Asia
Concentration	-0.08752 <i>-1.979</i>	*-0.01003 <i>0.9302</i>	*0.2101 <i>0.210</i>
Competition	*0.19832 <i>2.392</i>	0.1238 <i>1.341</i>	0.09333 <i>1.101</i>
Segmentation	*0.07832 <i>3.232</i>	**0.0932 <i>2.942</i>	*-0.0920
Liberalization	**0.2983 <i>4.344</i>	**0.3903 <i>3.9434</i>	**0.3683 <i>4.233</i>
ARPU	0.0738 <i>5.1323</i>	*0.0423 <i>2.381</i>	0.0128 <i>0.4923</i>
Vertical integration	** -0.1374 <i>4.999</i>	** -0.0393 <i>3.2832</i>	** -2.034 <i>4.213</i>
Constant	**12.3049 <i>4.923</i>	0.3943 <i>2.123</i>	0.984 <i>1.032</i>
Prob>F	***0.0071	**0.0162	***0.0052
R <sup>2</sup>	0.5517	0.5711	0.5291
Adj. R <sup>2</sup>	0.4136	0.4053	0.4293

Note: \*significant at 90% level; \*\* significant at 95% level; \*\*\* significant at 99% level.  
(dependent variable MVNO penetration from 2004 to 2005, t-static in italics)