A Prediction Model of Merger & Acquisitions in the US Telecommunications Industry

-A Case Study of a Recent M&A in Wireless Communications Sector

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Abstract-The “1997 Merger Guidelines” articulates the analytical framework that Department of Justice (DoJ) and Federal Trade Commission (FTC) use to review merger and acquisition cases. To better apply the guidelines to the M&A cases in telecommunication industry, the authorities and merging companies in telecommunications industry have a need to translate the provisions of the general guidelines to the specific situation of the telecom sector. Based on the telecommunication M&A cases between 1996 and 2009, this paper develops a model to assess the predictability of prospective M&A outcome from the DoJ/FTC review process. The model could be a good leading indicator for the potential merging companies and the decision makers in M&A reviews. The model while integrates the M&A criteria based on the M&A circumstances in telecommunication industry, it does not eliminate the need for exercise of judgment from the evaluation of mergers under the antitrust laws. A recent Merger case between Cisco and Starent Networks is evaluated as a case study.

Keywords-Merger and Acquisition, Horizontal Merger Guidelines, HHI, Antitrust Laws, Telecommunications, Market Concentration, Neural Networks.

I. BACKGROUND INTRODUCTION

The recent decades have witnessed a positive transformation in the enforcement of merger and acquisition laws since the issuance of Horizontal Merger Guidelines (HMG) by Department of Justice (DoJ) and Federal Trade Commission (FTC) in 1982. In particular, the guidelines have played a remarkable role in regulating the many complex merger cases in U.S. telecommunications industry following the passage of the Telecommunications Act of 1996, in which the policy of deregulation, to some degree, interacts closely with merger regulations defined in HMG to create and maintain a competitive domestic telecommunications market. Merger analysis generally does not apply in markets or sectors that are regulated. Hence policy shift to competition, such as deregulation of enhanced services in 1980, long distance service in 1984, and local exchange in 1996, actually advanced the role of HMG in regulating the mergers in the U.S. telecommunications market. In addition, Shelanski in Reference [1] discusses a trend away from industry specific regulation of telecommunications, that is, regulation by Federal Communications Commission (FCC) and the States towards governance of that sector through general competition laws, i.e. the HMG by DoJ and FTC. His analysis also stresses the important standing of HMG in the investigation process of the M&A cases in telecommunication industry.

When FCC was created in 1934, the telecom industry was a regulated monopoly and FCC and local PUCs (Public Service Commission) oversaw the operation of the Bell System regulating rates and services for consumers and ensuring adequate return to share owners. Furthermore, the Bell System commitment not to buy independent companies as agreed to in the Consent Decree of 1914 remained in effect. The breakdown of the Bell System in 1984 and the push for deregulation of the industry with the 1996 Communications Act changed this stable paradigm and the role of FCC. Deregulation has narrowed FCC’s oversight role in regulating the industry.

Although enforcement of antitrust laws in the case of M&A is the responsibility of DoJ/FTC, congress has given specific power to FCC in Sections 214 and 310 of the
Communications Act to review M&A of communications companies as this involves transfer of licenses which requires FCC approval. The FCC approval creates a unique situation for M&A in the telecom industry compared to other industries. In reviewing a M&A from the antitrust point of view, if DoJ/FTC find no objections, FCC could still deny the merger considering its public interest framework. FCC and DoJ/FTC have developed a process of coordinating their reviews to avoid contradictions and to ensure an efficient and equitable process.

II. LITERATURE OVERVIEW

A number of researchers have conducted empirical analysis of the M&A cases in US telecommunications industry after 1996 Communication Act. Park et al. (2002) investigated how market participants react to the M&As involving telecommunications companies. Their analysis indicates disappointment of the market to those M&A’s. It also indicates that a cross-border, rather than a domestic M&A deal, is the main driver of the negative market reaction. They concluded that in telecom industry the value creation or synergy through an M&A deal is not warranted even though it can increase the size of the firm and the potential for productivity gain. Wilcox et al. (2001) studied the after-merger performance in terms of firm sizes. The study uses event analysis to examine 44 M&A events involving 89 partners in the telecommunications industry. The results suggest that while overall these events weight positively on market value, M&As involving near-diversification and larger firms tend to experience greater valuation effects. Shelanski (2002) studied the role of FCC in merger review and discussed the possibility of eliminating sector-specific regulation of FCC for telecommunications mergers. Brennan (2008) examined the definition of market in the deregulation policy. A question discussed is whether forbearance from regulation will lead to an increase in prices. Forbearance in telecommunications highlights market definition questions regarding gross vs. marginal substitutes, dynamic efficiencies, and service bundling.

These studies are focused on the effect of the M&A Guidelines. Other studies (van Kranenburg, 2008; Wu, et al., 2008; Whally et al., 2004; Coloma, 2007) have looked at M&A cases involving different countries or geographical markets. These types of studies are focused on certain markets to analyze the after-merger performance or highlight the diversity of after-M&A market. Our paper is aimed at quantifying the provisions of the 1997 guidelines and applying a quantitative modeling to the M&A’s in the US telecommunications market.

III. MERGER AND ACQUISITION AND GROWTH OF MARKET POWER

The incentive for a merger is the potential financial gains. Although there are many possible sources of the financial gains from a merger, the guidelines are focused on Market Power as the potential source of financial gains under the antitrust laws. In the analytical frame of the guidelines, there are five primary assessment conditions to determine whether to challenge a horizontal merger. Hence the unifying theme of the guidelines is that a merger should not be permitted to create or enhance market power that could harm consumer through sustained price increases.

Samuelson in his Microeconomics book [12] defines market power, the ability of a firm to influence or control the market price of a good or service. A common measure of market power in the guidelines is market concentration which is quantitatively measured by Herfindahl-Hirschman Index (HHI). HHI is calculated by "summing the squares of the percentage market shares of all participants in the market." Market power exists when a firm or a group of affiliated suppliers has over 40% of the market share in a given market1.

In the US telecommunication market, policy makers and market regulators such as FCC, DoJ, and FTC are concerned with telecommunication service providers and equipment vendors having excessive market power. The significant changes in the regulations over a century impacted the market power under different market models. Table 1 highlights the changes of regulatory policy on telecommunication market in the United States and the rest of the world over the past century. The trend in regulation of telecommunication industry has been to loosen the regulation and encourage competition in both

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1 Some countries such as UK, Italy, and China set it 50%, Germany sets it 33%, and France set a range of 40%-50%. 

The deregulation policy has driven the telecommunication market from monopoly towards perfect competition. This transition is consistent with the US merger laws which define the paradigm that competition is greater when more sellers compete with each other.

From DoJ/FTC and FCC perspectives, effective competition in the telecommunication market is essential to the success of the deregulation policy. But how does the market power and M&A interact? Figure 1 and 2 explains the creation of market power and mutual impacts between M&A and market power. In Figure 1, several factors contribute to market power including economic factors, technology factors and market factors. In telecommunication industry and other technology intensive industries, the technology factor such as the patent rights plays a special role in the creation of market power. However the technology factor is not the primary driving force considered by the merging companies. Before a merger, the two merging companies may consider such primary factors as scale economy, absolute cost advantage, and increased market share. Those factors related to financial gains may boost the merging company’s market share through the merger. This fact can be explained by the theme of the guidelines that authorities shall weigh the financial gains through the merger in approving the merger. That is, DoJ/FTC may challenge a merger if the market power may be potentially enhanced through the merger. A threshold for assessment is if the current market share is over 40%.

![Fig 1. Drivers of market power](image1.png)

![Fig 2. Interaction of M&A and market power](image2.png)

IV. APPLICATION OF ANTITRUST LAWS

The antitrust laws give DoJ/FTC special power to review M&A cases and block those that could potentially harm consumer by reducing competition in the market. In the case of Telecom Mergers as we discussed earlier, FCC also has a unique responsibility to review such mergers. The government responsibility in reviewing a telecommunication merger is then shared between FTC, FCC and DoJ based on their unique roles. Hence FTC/DoJ conduct their assessment of the merger against the antitrust laws. Their findings then become input to the FCC evaluation. FCC also gets input from the PUCs and other
interested parties in addition to its own evaluation in granting or rejection the proposed merger using the broad aim of the Communications Act.

Among the provisions of the Acts, FCC is focused principally on, on the basis of Section 214 and 310 of Communications Act, whether a merger can serve the public interest in terms of a certificate of public convenience and necessity or at least a balance between public benefits and public harms. DoJ/FTC, in light of Section 7 of Clayton Act, shall prohibit mergers, acquisitions and joint ventures which reduces or eliminates competition, or creates monopoly. From DoJ/FTC perspective any merger that creates or enhances market power or facilities exercise of market power in order to maintain profitably and prices above competitive levels for a significant period of time shall be prevented. As a summary on merger review, the key focus of FCC is public interest while that of DoJ/FTC is market power.

The 1997 HMG outlines the latest enforcement policies on horizontal M&As. The analytical framework and standards set in the guidelines help both DoJ/FTC in reviewing and estimating the merger cases and evaluating the acceptability of the merger in advance. However, a question is how to translate the provisions of general guidelines to the specific situation of the telecom sector. The authors developed a telecommunication sector specific quantitative model for the provisions of the 1997 HMG. The HMG guidelines consist of 5 correlative criteria: market concentration, potential adverse competitive effects of mergers, entry analysis, business efficiencies, and potential financial failures, each of which contains several specific conditions. The proposed model incorporates these considerations and is solely focused on market power. First, we will discuss the five key criteria and present the model.

A. Market concentration

The market concentration is measured on five different market dimensions to determine whether a merger may create or enhance market power of the merging companies.

1. Telecommunications product/service market

A telecommunication product/service market is defined as a telecommunication product/service or group of products/services which are produced or provided to consumer at-large. The telecommunication carriers, telecommunication equipment manufacturers, and end consumers are the stakeholders in such a market and their interactions can create or enhance the market power of the merging companies. Specific markets for the telecommunications products/services are:

- Service market of telecommunication carriers and end consumers. The telecommunication carriers provide basic or enhanced telecommunication services to end consumers. The scope of this type of market is anywhere that the telecommunication service can be served by carriers and used by end consumers.
- Service market of telecommunication equipment manufacturers and carriers. In this type of market, the services and solutions are provided by the
telecommunication vendors to ensure the successful rolling out and operation of their products for the buyers, i.e. telecommunication carriers.

- **Product market of telecommunication equipment manufacturers and carriers.** The premise of a telecommunication carrier to initiate its business is to construct its physical infrastructure which consists of the products provided by the telecommunication equipment vendors. This type of product market delineates the scope in which certain telecommunication products from a vendor are rolled out by its buyers. The telecommunication products in this product market normally belong to the carrier grade equipments.

- **Product market of telecommunication carrier/equipment manufacturer and end consumer.** This type of product market deals with the customer premised products produced by the equipment manufacturers and sold to end consumers or sold to telecommunication carriers who resell the products to end consumers.

DoJ/FTC apply a test to measure the concentration of the telecommunication product/service market: whether the set of firms in that market could institute a “small but significant non-transitory increase in price”. To quantify this test in telecommunication product/service market, DoJ/FTC, in most contexts, will use a price increase of 5% lasting for the foreseeable future.

2. **Telecommunication geographical market**

A telecommunication geographical market is a region in which the firms produce or sell their products or services. DoJ/FTC also impose the same price increase test for the telecommunication geographical market.

3. **Participants in the relevant telecommunication market**

A relevant market is a group of products/services and a geographic area that is no bigger than necessary to satisfy the price increase test. DoJ/FTC identify the competitive significance prior to the merger of the firms that currently produce or sell in that relevant market.

4. **Telecommunication market share**

Market share is calculated for all participated firms in either dollar terms through measurement of sales, shipments or production, or in physical terms through measurement of sales, shipments, production, capacity, or reserves.

5. **Post merger HHI**

The four criteria above depict the prior merger situation while the post merger HHI is an indicator to measure post merger market concentration, which is a function of the number of firms in a telecommunication market and their respective market shares. The HHI is calculated by summing the squares of the individual market shares of all the participants. A significant increase in the HHI index after the merger is a major concern in allowing the merger to go through.

B. **Potential adverse competitive effects of mergers**

A merger may lessen competition and harm consumers through enabling the remaining firms selling in the relevant market more likely, successfully, and completely to engage in coordinated interaction, which consists of those actions by a group of firms that are profitable for each of them only as a result of the accommodating reactions of the others. Some market factors which may result in the potential adverse competitive effects of mergers are considered below:

1. **Conducive coordination**

A merger may reduce competition, resulting in more effective coordination among the remaining firms through tacit collusion. FTC investigates the extent to which post merger market conditions are conductive to coordination, in which the coordinated action could result in sustained price increase. The most significant coordinated action is represented by transactions with competitive competitors and pricing or marketing practices typically employed by firms in the market.

2. **Unilateral effects**

The concern here is if the merged entity could affect market prices through unilateral actions of its own. Conditions that may lead to such effects include:

- **Heterogeneity of products.** This can be explained by a question that whether the products produced by the merging firms are more similar to each other than those by rivals. Reaching terms of coordination may be impeded by product heterogeneity. Differences in vertical integration or the production of another product through the merger tend to be
used together with the relevant product.

- **Capacities of firms.** When the merging firms have similar production facilities and the combined capacity after the merger could be reduced to reduce supply and cause price increases. Such action is likely when the merged company has a market share of at least 35% \(^2\)\([13]\), it may be profitable to suppress production and raise prices.

C. **Ease of entry**

A merger in telecommunication market is unlikely to create market power if the market entry is so easy that the merged firms could not profitably raise and maintain higher prices. The extent of ease of entry can be measured by three factors as defined below.

1. **Timeliness**

   Is entry easy enough such that new entrants can enter the market in a timely manner in response to price increases by the merged entity? FTC generally considers timely only those entry alternatives that can be achieved within two years from initial planning to significant market impact. In other words, if a significant market impact requires two years or longer, entry will not deter or counteract the competitive effect.

2. **Likelihood**

   Would the entry be profitable and hence a likely response to price increase? An entry alternative by other firms is likely if it would be profitable at premerger prices, and if such prices could be secured by the entrant.

3. **Sufficiency**

   Would the entry be sufficient to return market prices to premerger levels? A sufficient market after the merger is still profitable to attract new entrants to come in.

D. **Efficiency gains**

Competitions stimulate firms to achieve efficiencies internally. FTC considers efficiencies likely to be achieved with the merger. The merging firms must substantiate efficiency claims, so that DoJ/FTC can verify that by reasonable means. DoJ/FTC will not challenge a merger if recognizable efficiencies are of a character and magnitude such that the merger is not likely to be anticompetitive in any relevant market.

1. **Efficiencies to enhance the merged firm’s ability and incentive to compete**

   The efficiencies generated through merger can enhance the competition of the merged firms with other suppliers, which results in lower prices, improved quality, and enhanced services.

2. **Innovation**

   The telecommunication industry is subjects to rapid technological changes. The effect of competitive actions in the short term may not be reflected in an instant snapshot. A static mean to evaluate a merger may conclude that the merger causes market power in a telecommunication product/geographic market, but that dynamic approach may lead to an opposite conclusion. Hence dynamic efficiencies may reduce net harms if a merger would increase innovative activities to reduce costs or develop new products by the merging firms.

3. **Product/service bundles**

   Convergence is a popular term in telecommunication industry. The combination of services such as voice, data, and video provided by telecommunication carriers are greatly beneficial to end consumers. However, this combination of services may harm the interest of the other telecommunication carriers. Product/service bundles and innovation are two telecom sector specific conditions in the model other than the conditions defined in the guidelines by DoJ/FTC.

E. **Potential failures**

A merger is unlikely to create or enhance market power or facilitate its exercise if one or both merging firms would not be able to meet their financial obligations, reorganize successfully, or make successful good-faith effort to elicit reasonable acquisition offers for their assets.

5.2 **Model Formulation And Estimation**

In this section, we present 2 alternative model formulation using: Neural Networks and Logistic Regression.

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5.2.1 Neural Network Approach

A. A quick review of neural networks

Feed-forward neural networks provide a flexible way to generalize linear regression functions. The multi-layer neural network consists of a number of interconnected units. Each unit in the network is interconnected with all nodes in the preceding and following layers. The units are organized into layers where each node transforms the inputs received from other units. The adjacent layers are fully interconnected.

The input layer serves as an entry for the vector of data (or feature) presented to the network. In this layer, each node corresponds to one element of the feature vector. The input units provide a ‘fan out’ and distribute the inputs to the hidden units in the second layer. These units sum their inputs, add a constant (the “bias”) and take a fixed function \( \phi_h \) of the result. The output units are of the same form, but with output function \( \phi_o \). Hence

\[
Y_k = \phi_o \left[ \sum_i W_{ih} \phi_h \left( \sum_j W_{jh} X_j \right) + \alpha_k \right]
\] (1)

The activation function \( \phi_h \) of the hidden layer units is a sigmoid tangent, like the logistic function with an asymptotic behavior.

\[
l(z) = \frac{\exp(z)}{1 + \exp(z)}
\] (2)

The output unit, in this case, is a logistic unit. The output layer represents the output data. In our case, there is only one node in the output layer to predict the case is passed or rejected.

The approximation results are non-constructive, and in practice the weights have to be chosen to minimize some fitting criterion, for example, least squares

\[
E = \sum_p \left[ t^p - y^p \right]^2
\] (3)

where \( t^p \) is the target and \( y^p \) the output for the pth example pattern.

B. The architecture of neural networks for the model

The best neural network architecture can only be determined via couples of experiments varying different parameters. In this case, several tests have been performed by changing the number of units in hidden layers. As discussed in Section 4.1, the model of merger and acquisition consists of five portions, each of which contains several telecom sector specific conditions that are converted from the universal conditions for a merger case evaluation. The five portions are represented by five neural units in the input layer.

The number of hidden units and hidden layers cannot be obtained by any formulas. In general, the number of hidden nodes should be large enough to ensure a sufficient number of degrees of freedom for the network function and small enough to minimize the problem of loss in generalization ability of the network.

To obtain an optimal architecture of the neural network, the number of hidden nodes has been varied between 1 and 10. Each structure has been trained with different weight initializations by the method of 10-fold cross validation. The results shown in Table 2 illustrate that the variation of the number of units has a slight effect on classification accuracy. Considering such conditions as average rate, the three layer network shown in Figure 3 is selected, in which the input layer contains 5 inputs neural units, the hidden layer contains 3 hidden neural units, and at last the output layer contains 1 output unit. The following section will illustrate the training process in detail.

<table>
<thead>
<tr>
<th>Architecture</th>
<th>Number of weights</th>
<th>Average error</th>
<th>Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,1,1</td>
<td>8</td>
<td>0.2831057</td>
<td>0.18578217</td>
</tr>
<tr>
<td>5,2,1</td>
<td>15</td>
<td>0.2491862</td>
<td>0.12052515</td>
</tr>
<tr>
<td>5,3,1</td>
<td>22</td>
<td>0.2359203</td>
<td>0.12802414</td>
</tr>
<tr>
<td>5,4,1</td>
<td>29</td>
<td>0.2768077</td>
<td>0.15754129</td>
</tr>
<tr>
<td>5,5,1</td>
<td>36</td>
<td>0.2721695</td>
<td>0.16482062</td>
</tr>
<tr>
<td>5,6,1</td>
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<td>0.09620046</td>
</tr>
<tr>
<td>5,7,1</td>
<td>50</td>
<td>0.2659427</td>
<td>0.13637915</td>
</tr>
<tr>
<td>5,8,1</td>
<td>57</td>
<td>0.2545212</td>
<td>0.11258727</td>
</tr>
</tbody>
</table>
Fig 3. Neural networks for the model

C. Principal component analysis to obtain five inputs

Five portions in the model are represented by the five neurons in the input layer. But each portion is determined by several telecom sector specific conditions which are converted from the universal conditions for a merger case estimation.

Thus a principal component analysis is necessary to extract the major entropy from those telecom sector specific conditions. The five new components after the adjustment, representing the five portions of the model, will be input into the five neurons in the input layer.

Principal component analysis is performed to five portions of the model respectively. The Table 3 illustrates the result of the principal component analysis for the model. The first two components in every portion contribute no less than 70% of the cumulative proportion. Thus the adoption of first two primary components to represent each portion is acceptable.

Since only 5 input units are required in the input layer of neural network, the two principal components should be merged to one variable as the sole input into its corresponding

Table III Principal component analysis for the model

<table>
<thead>
<tr>
<th>Portion 1</th>
<th>Portion 2</th>
<th>Portion 3</th>
<th>Portion 4</th>
<th>Portion 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comp1</td>
<td>Comp2</td>
<td>Comp1</td>
<td>Comp2</td>
<td>Comp1</td>
</tr>
<tr>
<td>Proportion of variance</td>
<td>0.611</td>
<td>0.108</td>
<td>0.359</td>
<td>0.336</td>
</tr>
<tr>
<td>Cumulative proportion</td>
<td>0.611</td>
<td>0.719</td>
<td>0.359</td>
<td>0.695</td>
</tr>
<tr>
<td>Weights</td>
<td>-0.434</td>
<td>0</td>
<td>0.623</td>
<td>0.488</td>
</tr>
<tr>
<td></td>
<td>-0.441</td>
<td>0</td>
<td>0.3</td>
<td>-0.871</td>
</tr>
<tr>
<td></td>
<td>-0.371</td>
<td>0</td>
<td>-0.723</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>-0.478</td>
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<td>N/A</td>
</tr>
<tr>
<td></td>
<td>-0.353</td>
<td>-0.7</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>-0.354</td>
<td>0.706</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

input unit. The Equation 4 describes the algorithm to merge the components to one variable.

\[
\text{Input}_h = \left( \sum_{k} W_{ik} G_i \right) \left( \frac{P_1}{P_1 + P_2} \right) + \left( \sum_{k} W_{ik} G_i \right) \left( \frac{P_2}{P_1 + P_2} \right) \quad (4)
\]

where Input$_h$ (h=1,2,…5) is the input score to each input neural unit; k denotes the number of the conditions in each portion; there are 18 conditions in total in which condition 1 to 6 belong to portion 1 (market concentration); 7 to 9 belong to portion 2 (adverse competitive effect); 10 to 12 belong to portion 3 (entry analysis); 13 to 15 belong to portion 4 (gain efficiencies); and 16 to 18 belong to portion 5 (potential failure). W$_{ik}$ denotes the weight of condition one in component1; G$_i$ denotes the grade of the condition; P1 denotes the proportion of component 1; and P2 denotes the proportion of component 2.

For example the equation to generate the input score for portion 2 is shown in Equation 4.

\[
\text{Input}_2 = (0.623 G_7 + 0.3 G_8 - 0.723 G_9) \left( \frac{0.359}{0.695} \right) + (0.488 G_7 - 0.871 G_8) \left( \frac{0.336}{0.695} \right) \quad (4)
\]
D. Training with Neural networks

Eight samples (10%) out of 77 samples are randomly selected as the testing set. The remaining 69 samples, as the training set, are used to train the model. The 5 variables in each sample are input to the 5 input neural units respectively; the training in the neural network is converged after 150 iterations.

After the training for the 77 samples, the three layer 5-3-1 neural network with 27 weights and 1 linear output unit generates the following algorithms for the model.

\[
\begin{align*}
H_1 &= -9.13 - 4.62I_1 - 0.07I_2 + 1.05I_3 + 4.01I_4 + 5.5I_5 \\
H_2 &= 0.28 - 0.47I_1 - 1.88I_2 - 0.23I_3 + 3.28I_4 + 0.34I_5 \\
H_3 &= 4.26 - 0.29I_1 + 0.84I_2 + 9.05I_3 - 4.41I_4 - 1.46I_5
\end{align*}
\]

(5)

\[
\begin{align*}
H_1' &= \exp(H_1) / [1 + \exp(H_1)] \\
H_2' &= \exp(H_2) / [1 + \exp(H_2)] \\
H_3' &= \exp(H_3) / [1 + \exp(H_3)]
\end{align*}
\]

(6)

Output = -0.41 + 1.51H1' + 3.09H2' - 1.10H3'  \quad (7)

where H1, H2 and H3 describe the process in the hidden layer; Equation 6 is the activation function; the Equation 7 denotes the output model connected to the hidden neural units.

5.2.2 Logistic Regression

Applying logistic regression, the following model is generated.

\[
P = \frac{\exp \left( -1.47916 + 0.05378I_1 - 1.24408I_2 + 0.45737I_3 - 1.45434I_4 + 0.93348I_5 \right)}{1 + \exp \left( -1.47916 + 0.05378I_1 - 1.24408I_2 + 0.45737I_3 - 1.45434I_4 + 0.93348I_5 \right)}
\]

(8)

where \( p \) is the probability of pass. In this model the data shows that the intercept, I4 and I5 are statistically significant in 95% confidence interval.

We can optimize the logistic regression model with Akaike's information criterion (AIC) algorithm, which results in an improved model:

\[
P = \frac{\exp \left( -1.6113 - 1.1056I_2 - 1.0614I_4 + 0.8833I_5 \right)}{1 + \exp \left( -1.6113 - 1.1056I_2 - 1.0614I_4 + 0.8833I_5 \right)}
\]

(9)

where item I3 and I1, due to low contributions, are removed; the intercept, I4 and I5 are statistically significant in 95% confidence interval.

5.3 Analysis of Training Results with Three Models

Table 4 illustrates the prediction accuracy of three models. The 69 training samples are composed of 39 passed cases and 30 rejected cases while the 8 testing samples consist of 4 passed cases and 4 rejected cases.

In neural network, the training result shows the accuracy of training set is \((23 + 32)/69 = 81.15\%\), much better than the accuracy of training set in logistic model \((17 + 32)/69 = 71.02\%\). Even after the optimization, the accuracy of the improved logistic model is slightly raised to \((18 + 32)/69 = 72.46\%\) only.

To investigate the robustness of three models, we can find the accuracy of training set in three models are declined by \((81.15\% - 75\%)/81.15\% = 7.57\%\) in neural model, \((71.02\% - 62.5\%)/71.02\% = 11.99\%\) in logistic model, and \((72.46\% - 62.5\%)/72.46\% = 13.74\%\) in improved logistic model. The three decline rates show that the neural network model is more robust than the other two models.

Figure 4 displays the receiver operating characteristic (ROC) curves for three models. The area under the curve (AUC) of neural network model is larger than that of the others, representing a better fitting effect and slimmer chance to make type I and II errors.

<table>
<thead>
<tr>
<th>TABLE IV PREDICTED V.S. TRUE VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural network</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>True value (Pass=1)</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>Prediction in training set</td>
</tr>
<tr>
<td>Prediction in testing set</td>
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VI. CASE STUDY OF THE MERGER: CISCO AND STARENT

A good case recently in telecommunications sector for our model to apply is the merger between Cisco and Starent Networks, both of which, through the merger, make an ongoing effort to provide mobile internet products to mobile operators. Since the two organizations in the merger are from the same industry and produce similar products, the potential merger can be identified as a horizontal merger case. As a result, the model developed in Section 5 can be applied to this case to predict the potential decision made by FTC/DoJ.

In this study, three experts from those two companies were invited in October and November 2009 to grade the case followed by the criterion of the model. Most of the items in the model can be objectively scored since their quantitative results could be obtained. However, a few items request the graders to subjectively predict the results and grade those items on the basis of their experience. For example, an item asks the grader to predict the chance of entry for potential firms after one year of the merger. This item is easy to answer for those training cases since the history after the merger has told the truth. But this ongoing case between Cisco and Starent, at least at this moment, is hard to say what may happen after one year. So it’s necessary to test the internal consistency and reliability of the scores from three graders, especially for those “ongoing items”.

After a Cronbach’s Alpha estimation, the internal consistency value is 0.87, the high reliability shows that the items in the model that propose to measure the same construct produce similar grades. Input the grades from those three experts in the training model, the model shows that the results of those three inputs are all passed (1.0). That means the model, with the 81.15% accuracy rate, estimates that this case has a huge chance to be cleared by FTC/DoJ. The result predicted by the model is actually consistent with the final decision made by FTC/DoJ in December 16 2009 (see [14]).

VII. CONCLUSION

In this paper, the provisions of “1997 Merger Guidelines” were first translated to the specific situation of telecommunications sector in the States in order to better adapt the M&A cases in the telecommunication industry to the guidelines. On the basis of the representative M&A cases in telecom industry after 1996, the authors developed a quantitative model to predict the outcome of prospective M&A’s from the DoJ/FTC review process. A recent case of merger between Cisco and Starent was used as a case study to illustrate application of the model.

We recognize that evaluating M&A by DoJ/FTC, while using some objective criteria, also involves other considerations and trade-offs which are not easy to quantify. However, the authors show that application of a model as presented in this paper could be a good leading indicator for the merging companies at the outset and also for the regulators when considering new M&A cases. The model while integrates the M&A criteria based on the M&A circumstances in telecommunication industry, it does not eliminate the need for exercise of judgment from the evaluation of mergers under the antitrust laws.

REFERENCE
[8] H.L. (Hans) van Kranenburg et al. Strategic focus of incumbents in the European telecommunications industry: The cases of BT, Deutsche Telekom and KPN.