Society of Actuaries' Research Project
Health Plan Provider Network Risk

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Introduction and Executive Summary

On the website www.economist.com, risk is defined as follows:

"The chance of things not turning out as expected. Risk taking lies at the heart of capitalism and is responsible for a large part of the growth of an economy. In general, economists assume that people are willing to be exposed to increased risks only if, on average, they can expect to earn higher returns than if they had less exposure to risk. How much higher these expected returns need to be depends partly on the probability of an undesirable outcome and partly on whether the risk taker is risk averse, risk neutral or risk seeking."

What is the nature of provider network risk to a health plan? As described above, risk relates to the probability of unexpected events occurring. Risk is usually considered from the standpoint of quantifying the likelihood of negative events occurring (unexpected positive events or levels may also occur, but are not the focus of risk management). With regard to provider networks, there are two primary potential negative events that affect the contracting health plan:

1. Physician groups or hospitals leave the health plan's network voluntarily. For instance, they might seek out better contractual terms.
2. Physician groups or hospitals leave the network involuntarily, because they are no longer financially viable.

In any health plan, some provider turnover is to be expected. Extraordinary turnover, however, can cause a myriad of problems for a health plan, including a loss of discounts, member dissatisfaction and potentially bad publicity and the loss of market share. In this paper and supporting Excel workbook, we provide a framework for estimating the financial impact of network risk, and a sample model for calculating that risk in specific situations.

Negative provider network events are affected by the specific characteristics of the network providers themselves, of the health plan, and of the specific market(s) in which the plan is operating. The important determining characteristics are those that define the competitive position of the health plan and the network providers, such as reimbursement levels and market alternatives, from both the health plan and provider standpoint.

Excessive provider termination rates can have a domino effect leading to pricing, market share, and solvency implications for a health plan. In this report, we will focus on the first "domino", i.e., the impact of network turnover on negotiated provider discounts. Examination of the factors that affect network risk can help health plans understand the inherent riskiness of their own provider networks, and can suggest important ways in which health plans might be able to mitigate this risk.

To our knowledge, very little public research has been done in the field of health plan provider network risk, and hence there is a paucity of publicly available data with which to construct an actuarial model of this risk. By necessity, then, the starting values and assumptions in our model are based largely on professional actuarial judgment. The goal of this model is to establish a thought framework, with gaps filled in by future researchers. Future development of this subject could include a deep study of historic network provider withdrawals in various markets in order to better understand the various characteristics that affected these occurrences, and the resulting impacts on health plan claim cost levels in those markets. However, provider network reimbursement rates are considered highly proprietary by most health plans, and so publicly available data may always be scarce. This will likely always be a challenge for researchers in this area.

The model that accompanies this report measures network risk in terms of the payment level discounts lost when providers leave the network. Discounts are measured relative to prevailing billed charges in the area. For example, say discounts are 10% in a particular market, i.e., the health plan pays providers at 90% of their full payment rate. If a health plan lost all of their network providers, and hence lost all of the payment discounts, then it would end up paying as much as 11% more in claims cost in that market, all other things being equal. While this is an extreme example and would normally be an unlikely occurrence, it provides an upper bound and a context for considering the financial impact of losing network providers.

In the process of building our model, we defined three scenarios and calibrated and tested the model under those scenarios. We defined three hypothetical networks in terms of their characteristics, covering a reasonable range of possible risk levels – described as high, average, and low risk within this report and the model. We estimated provider turnover and additional claim cost for networks with these characteristics without using the model. We then calibrated our model so that when networks with these characteristics were entered, the results would be reasonable and consistent with our estimates of provider turnover and cost.

Therefore, the results for these scenarios are illustrative from the standpoint of how the model performs, but it is important to note that the results were defined during the process of developing the model, not by the model itself.

The median and 95th percentile loss in claims and associated provider turnover rates for the low risk, average risk, and high risk networks are as follows.

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Output	High	Average	Low
Median Percent Cost as % of In-Network	1.75%	0.30%	0.19%
95%tile Percent Cost as % of In-Network	5.49%	0.86%	0.65%
Proportion of Providers that Withdraw	22.63%	7.81%	2.59%
Std. Dev. Proportion Withdraw	7.49%	4.20%	2.34%
Proportion Providers Financially Fail	1.25%	0.70%	0.55%
Std. Dev. Proportion Fail	14.73%	1.94%	1.62%

The results above show that, for example, for a "high risk" network (as we define it here), the median value for the claims cost impact of provider turnover is 1.75% of total in-network claims. In addition, there is a 5% probability that the cost of provider turnover will exceed 5.49% of in-network claims.

Note that the model we have created only measures the impact of provider termination rates on provider reimbursement levels. We have made no attempt to model how higher provider payment rates will, in turn, affect a health plan though decreased premium rate competitiveness and loss of market share. Also, the model does not quantify any factors associated with the network other than provider turnover. We do not model the other ways in which a provider network impacts the operations and marketing of a health plan (such as the impact of network reputation on marketability). Other impacts of the network turnover rate, such as the ability of the network to serve members under conditions of rapid growth, are also not quantified with this model. These other questions are relevant to the topic of network risk, and should be addressed in future studies.

Research Team

The research team consisted of consultants and researchers at Milliman, Inc. The primary researchers were Ross Winkelman, FSA, MAAA, Jill Van Den Bos, MA, and Craig Johns, PhD with significant support from Jonathan Shreve, FSA, MAAA, Aree Bly, FSA, MAAA, Syed Mehmud, Ksenia Whittal, and Paul Sakhrani. Thomas D. Snook, FSA, MAAA peer reviewed our work.

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Methodology

The Health Plan Provider Network Risk model we have developed is designed to estimate the impact of provider network terminations on the total claims cost for a health plan in a single market. In the model, the network-related events that have an immediate impact on claims cost are split into two categories: 1) voluntary provider (physician and hospital) turnover, and 2) involuntary provider turnover. Voluntary turnover is defined as providers deciding to leave the network primarily due to financial payment issues, whereas involuntary turnover is defined as providers leaving the network due to their own financial/business failure.

In our model, the claim cost impact is a function of a given set of network and health plan parameters (input items). Changing these parameters changes the "risk level" of the network. Our model measures risk level in terms of the median and 95th percentile impact on claims costs. One can say then that this output provides a measurement of the risk level of a provider network in the situation described by the model input variables.

The risk level of a provider network derives from two key components: the probability distribution function for providers leaving the network, and the cost per unit of provider turnover (the latter depending primarily upon the discount level). Our model measures the first item as a function of a set of network and health plan characteristics (each of these characteristics is defined in further detail later in the report):

<u>Network:</u>

- Network providers' reimbursement relative to their costs
- % Network Owned (versus rented)
- Network care management
- Network care quality
- % of Metropolitan Statistical Area (MSA) covered by Network
- % of Network that is Center of Excellence Provider
- Provider business management
- # separate physician contracts in network
- # separate hospitals/system contracts in network
- # physicians in a single contract as % total physician network
- Largest hospital in network (beds) as % total beds
- Hospital Reimbursement relative to competitor health plans
- Physician Reimbursement relative to competitor health plans

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<u>Market:</u>
Number of health plans in market
% Urban

<u>Health Plan:</u>
Health plan market penetration
In network percent of utilization
% of Enrollee's that are Medicare / MedSupp
% of network providers capitated

In addition, the model defines the function to determine the cost per percentage point of provider turnover as a function of the provider concentration, the termination rate, and the discount level.

Methodology for Quantifying Network Risk

We have created a framework for quantifying the risk profile of networks. The first part of this framework is the structure for describing the network. The second part of this framework is quantifying the risk of the network given its characteristics. To quantify the risk of the overall network, it is important to look at the network as a collection of smaller networks at the MSA level (assuming the health plan operates in more than one MSA).

The total impact of network turnover in a given market is equal to the number or percentage of providers that leave the network, multiplied by the cost for each provider or percentage point of providers that leave the network. In our model, we create a probability distribution for provider loss based on network characteristics, and the cost per provider leaving is a function of the same network characteristics and the proportion of providers that leave (i.e. each point on the provider leaving probability distribution).

We have assigned relative weights and risk scores to the characteristic categories described later in the report based on judgment. The weights and risk scores are combined in the model to create a probability distribution for voluntary or business failure turnover given the profile of the network. A user defined weighted sum is calibrated based on the user's assumed low, medium and high risk network characteristics, and then transformed into a probability using a logistic transformation.

These event probabilities are then translated into total claim costs to the health plan. We assumed that the least cost is zero and the highest cost is the total network discount percentage multiplied by the total claims in that market. The probability of provider turnover is fit to these endpoints using a concave upward curve.

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The three key steps of model development are described in more detail below:

Step 1 – For each of the two modes of withdrawal, we define a probability model for the percent of the network that leave in a given year. The mean and variance are functions of network characteristics. Correlation between the two network loss proportions is added to the model. The correlation structure we have defined assumes that networks with higher than average withdrawal rates are slightly more likely to have higher than average losses due to financial failure.

Step 2 - Cost functions for the two withdrawal types are defined.

Step3 - The distribution of the total loss is computed using a delta-method approximation for the mean and variance of the total cost functions.

The probability model for the two network losses relies on the mean and variance as a function of network characteristics. The mean value in percent leaving the network is modeled using a logistic transformation of a weighted sum of network characteristics X_i

$$M_j = \sum w_{ij} X_i$$

where the weights, w_{ij} are fixed but different for provider withdrawal (j=1) and provider financial failure (j=2). The mean value for the distribution is given by

$$\mu_j = \frac{\exp(M_j)}{1+\exp(M_j)}.$$

Likewise, a model for the variance in the percent leaving the network uses a weighted sum of network characteristics

$$S_j = \sum v_{ij} X_i$$

again with different weights v_{ij} for the two types of loss and using the logistic transformation to ensure that values are in a sensible range.

$$\sigma_j^2 = \frac{\exp(S_j)}{1+\exp(S_j)}.$$

The weights (w_{ij} , v_{ij}) are not all positive in the sums above and can be roughly interpreted as slope coefficients in that the sign of a weight coefficient, w_{ij} determines the direction of the change in the mean corresponding to a unit increase in characteristic X_i (all other things being equal).

The cost function for withdrawal is given by

$$C_{i1} = d\,\frac{2}{3} Y_i^{\frac{3}{2}}$$

where Y_i is the percent of network in the i-th MSA leaving due to withdrawal. For financial failure, the cost function is

$$C_{i2} = d\left(\frac{1}{2} Z_i + \frac{1}{3} Z_i^{\frac{3}{2}}\right)$$

where *d* is the discount factor for the network and Z_i is the percent of network in i-th MSA leaving the network due to financial failure.

The distribution of $T_i = C_{i1} + C_{i2}$ is approximated using a mathematical technique based on Taylor series approximation theory and assuming a Beta distribution for the sum.

Central to the question of network risk is the characteristic of diversification. The more diversified an organization is, the lower their relative risk. The easiest example to consider is a local HMO compared to a national MCO. It is less likely that the local HMO will experience an adverse event in its sole market than the national MCO, because the national MCO is exposed in multiple markets. However, adverse events in the local HMO's market will have a potentially catastrophic impact to the HMO. Therefore, all other things being equal, a national MCO can tolerate a higher level of risk in any given MSA than a local HMO.

The formula we propose to calculate the expected total network risk, T^*, is the block of business weighted average of estimates across all MSAs:

$$E(T^*) = \sum_{i=1}^{N} p_i E(T_i)$$

where i = 1, … N is an index for the MSAs, p_i is the proportion of total business associated with the MSA and E() is the expectation operator. The estimate of the variance for the total assumes independence between MSAs and is given by

$$\sigma^2(T^*) = \sum_{i=1}^{N} \sigma^2(T_i) p_i^2 .$$

The central limit theorem applies so that for a moderate number of MSAs (at least 20), the normal distribution can be used to effectively estimate the distribution of the sum T^*. Monte Carlo simulation is recommended in situations where the normal distribution is not a good approximation.

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For example, assume that a health plan was in 20 MSAs, whose mean and variances are defined in the following table:

	Cost Distribution		Proportion of Total
MSA #	**Mean**	**Variance**	**Business**
1	0.10%	0.10%	9%
2	1.20%	0.60%	8%
3	0.30%	0.21%	8%
4	0.30%	0.24%	7%
5	0.10%	0.11%	6%
6	0.30%	0.12%	6%
7	0.30%	0.60%	6%
8	0.50%	0.50%	5%
9	0.80%	0.64%	5%
10	0.30%	0.12%	5%
11	0.25%	0.15%	5%
12	0.27%	0.08%	5%
13	0.34%	0.31%	4%
14	0.19%	0.21%	4%
15	0.67%	0.34%	4%
16	0.15%	0.30%	4%
17	0.24%	0.05%	3%
18	0.28%	0.14%	3%
19	0.23%	0.16%	2%
20	0.56%	0.50%	1%
Mean		0.38%	
Variance		0.02%	
Std Deviation		1.27%	
95th Percentile		2.46%	

The results at the bottom of the table above show that the mean network turnover cost is 0.38%, while the 95th percentile cost is 2.46%. It is important to note how much lower the variance of the combined distribution is compared to any of the individual variances. Also, the less variation there is in the proportion of total business in each MSA, the lower the standard deviation and confidence intervals.

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Describing and Scoring the Network

The structure we use includes characteristics that the user inputs for a given network. The target network is intended to describe a network within a single Metropolitan Statistical Area (MSA). These characteristics are grouped by type, including provider/network characteristics, market characteristics, and health plan characteristics. The following table lists the network characteristics included in the model:

<u>Network:</u>

- Network providers' reimbursement relative to their costs
- % Network Owned (versus rented)
- Network care management
- Network care quality
- % of MSA covered by Network
- % of Network that is Center of Excellence Provider
- Provider business management
- # separate physician contracts in network
- # separate hospitals/system contracts in network
- # physicians in a single contract as % total physician network
- Largest hospital in network (beds) as % total beds
- Hospital Reimbursement relative to competitor health plans
- Physician Reimbursement relative to competitor health plans

<u>Market:</u>

- Number of health plans in market
- % Urban

<u>Health Plan:</u>

- Health plan market penetration
- In network percent of utilization
- % of Enrollee's that are Medicare / MedSupp
- % of network providers capitated

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Many of the characteristics are defined relative to overall market values (for example, number of health plans in market, number of hospitals, etc.). Where possible, we have included known market values based on external sources. The following market / state values are included in the model and keyed on which MSA the user selects:

1. Number of health plans in the market
2. Percentage of network providers in market that are capitated
3. Number of separate hospital systems in the market

Network Characteristics

Network providers' reimbursement relative to their costs – This characteristic describes the extent to which network providers are receiving contracted rates that provide adequate margin for them to remain financially viable. This is scored as a percentage, calculated as total reimbursement divided by total fixed and variable costs.

Percent of network owned (versus rented) – This is the percentage of providers in the network that are employed directly by the health plan.

Network care management – This characteristic describes the level of healthcare utilization management demonstrated by network providers. This is scored on a scale ranging from 1 for unmanaged to 10 for well or optimally managed.

Network care quality – This characteristic describes the perceived level of healthcare quality demonstrated by providers in the network. A reputation for high quality is a scored on a scale from 1 for lowest quality to 10 for highest quality.

Percentage of MSA covered by the network – This is the percentage of the reasonable possible health plan coverage area where providers are located.

Percentage of the network that is Center of Excellence provider – A "Center of "Excellence" provider is one affiliated with a high-profile, highly desirable healthcare clinic or hospital. Examples of Centers of Excellence would include the Mayo Clinic, or John's Hopkins medical center. This characteristic reflects the percentage of the network that can be described as a Center of Excellence affiliate.

Provider business management – This characteristic is an assessment of the financial/business management capabilities of network providers. This refers to the providers' ability run a business well, and ultimately remain a viable/solvent business entity. This is scored on a scale ranging from 1 for unmanaged to 10 for a well-managed business.

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Number of separate physician contracts in network – This characteristic, scored as the actual number of provider contracts, represents the spread of network risk among more or fewer entities.

Number of separate hospital/system contracts in network – This is parallel to the prior characteristic, using actual number of hospital contracts.

Number of physicians in a single contract as a percentage of total physicians in the network – This characteristic quantifies the largest group of physicians in a single contract, representing the largest number of physicians that could potentially leave the network all at once.

Largest hospital in network (beds) as percentage of total network beds – This is parallel to the prior characteristics using hospital beds to assess the largest number of units that could leave the network all at once.

Physician Reimbursement relative to competitor health plans - This characteristic measures the competitive position of the health plan's reimbursements to its network physicians compared to its competitors' reimbursement rates. This is a percentage, derived by dividing health plan negotiated rates by the assumed rates of other health plans in the market.

Hospital Reimbursement relative to competitor health plans – This characteristic measures the competitive position of the health plan's reimbursements to its network hospitals compared to its competitors' reimbursement rates, parallel to the above characteristic for physicians.

Market Characteristics

Number of health plans in market – This characteristic, which is simply the number of health plans that provide care in the target market, defines the competitiveness of the market from the health plan's standpoint.

Percentage urban – This characteristic represents the percentage of the total market that is in an urban area.

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Health Plan Characteristics

Health plan market penetration – This characteristic represents the total number of health plan enrollees out of the total possible enrollee population in the market.

In-network percent of utilization – This is the percentage of utilization that health plan enrollees experience using the contracted network providers.

Percentage of enrollees that are Medicare Risk/ MedSupp – This is the percentage of the health plan enrollees that are eligible for Medicare. This characteristic is intended to measure the proportion of health plan enrollees that are more change-resistant.

Percentage of network providers that are capitated – This characteristic measures the proportion of network providers that are paid on a capitated basis.

Assessing the Impact of Characteristics on the Percent Provider Turnover

We assume most provider turnover will be from providers voluntarily leaving the network rather than from providers experiencing business failure, in a ratio of 10 to 1.

We used quasi logistic regression to relate network characteristics to the events that define network risk. Two events, provider withdrawal and provider failure, are modeled as the dependent variables using a series of network characteristics as the independent variables. For each dependent variable, there are two regression equations using the network characteristics: one equation models the proportion of network providers that will experience the event (the mean), and the other equation models the variability in the experience of that event (the standard deviation). In all, there are four regression equations using the same network characteristics as independent variables.

The regression weights for each of the four equations were derived by ranking the impact of each characteristic on the independent variable on a scale from zero (no influence) to 100 (perfect correlation) and assigning a direction of influence (positive or negative). For example, for the equation predicting the proportion of providers that will withdraw from the network (mean), we ranked physician reimbursement compared to that of other area health plans to be the most influential characteristic (rank of 60). We assigned a negative direction of influence for that characteristic, implying that the higher the comparative reimbursement level the lower the proportion of providers that are expected to withdraw.

For the equations to predict the variability in the dependent event, we ranked characteristics high if we estimated that they would impact the spread in the distribution of the percentage of providers leaving. Characteristics thought to result in larger numbers

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of providers leaving at a time were ranked higher for these equations. Note that these equations have fewer characteristics deemed important.

To create the regression coefficients (the "weights") from the ranking and direction of influence, we used a simple algorithm as described in the following equation:

Rank/Sum(All Ranks)*If(Negative Direction,-1,1).

The sum of the individual products of the normalized characteristic scores and the coefficients is used in an estimate of the mean percentage of providers likely to leave in a year given the characteristics.

To progress from the weighted scores to the estimates of probability and standard deviation, we used a logistic transformation. The logistic transformation is a useful map from the real numbers onto the interval (0,1). We use the logistic transformation to map regression type weighted sums onto values that represent probabilities. A score, S, is found by a formula that mimics linear regression:

$$S = \sum_{i=1}^{k} \beta_i z_i \,.$$

A score is transformed to a probability using the logistic transformation

$$\frac{e^{a+bS}}{1+e^{a+bS}}$$

where constants for location, *a*, and scale, *b*, are chosen so that results are reasonably consistent with a priori estimates – calibration metrics. Values of *a* and *b* are chosen by trial and error, attempting to match outputs of the model with expected results of special trial cases.

The score function uses values of characteristics, denoted by x_i, transformed to standardized values using the formula:

$$z_i = \frac{(x_i - \mu_i)}{\sigma_i} \,.$$

The relative rankings of observations for characteristics, z_i, provides a natural scale on which to compare characteristics. The score function above also uses coefficients, β_i, that depend on positive weights w_i and v_i which are either +1 or -1, depending on the direction of influence that a characteristic is assumed to have on provider turnover. The weights are estimates of relative importance of a characteristic compared to other characteristics. The coefficients are found by the following formula:

$$\beta_i = \frac{v_i w_i}{\sum w_i} \,.$$

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To estimate the probability of an event, the following steps are taken.

1. Set up model parameters for the characteristics. These preliminary steps have already been done by Milliman to provide default values, but may be modified to reflect individual user perspective.
    a. Characteristic means (μ_i or reference location): These means need not be true average values, but rather a comparison point from which to judge.
    b. Characteristic standard deviations (σ_i or reference scale): The standard deviation likewise gives a scale by which to judge the relative importance of differences of individual input values compared with the means.
    c. Relative Weights (w_i): input the relative importance that each characteristic should have in the score function. Weights should be between 0 and 100. Large weights correspond with high influence.
    d. Positive/Negative Influence (v_i): Input the direction of influence that a characteristic has on the variable of interest (average percent of providers experiencing voluntary turnover, standard deviation of the same; average percent of providers experiencing business failure, standard deviation of the same).
2. Calibrate the model. These preliminary steps have also been done by Milliman to provide default values, but may be modified to reflect individual user perspective. Also note that if changes were made in Step 1 above, these calibration steps must be performed.
    a. Input values of the characteristics for three types of network; low risk, average risk, and high risk. (Cells highlighted blue in Calibration worksheet.)
    b. For each of the three cases, input an approximate expected value for the median and 95th percentile levels of the distributions of Proportion Providers Leaving Network and Proportion of Providers with Financial Failure. (Cells highlighted blue in Calibration worksheet.)
    c. Change values in Location and Scale parameters (cells with red-text) until the new probabilities and standard deviations approximate the input values (cells highlighted brown).
3. Use the model.
    a. Input values of characteristics of the network of interest into the Inputs and Results worksheet (cells highlighted yellow).
    b. Results are immediately displayed.
    c. A graph of the distribution of Total Cost as % of In Network Claims is available in the Cost Distribution worksheet.

The logistic equations above are used to estimate, using plan characteristics, mean and standard deviations of two variables:

1. Proportion of Providers that Withdraw (W) is normally distributed with mean and standard deviation estimated from the process above, denoted as: μ_W and σ_W.
2. Proportion of Providers that Financially Fail (F) is normally distributed with mean and standard deviation estimated from the process above, denoted as: μ_F and σ_F.
3. Providers are assumed to fail or withdraw independently.

Final Impact Measure

The final risk measure we use is the percent of claims dollars lost as a result of network turnover. The average discount that the health plan has negotiated for the network is the maximum expected impact on claims in that market. We assume that provider turnover can have a minimum of no claims impact, and a maximum of the average negotiated discount since, if needed, members can obtain care outside the network at market billed rates. We assumed that the loss of all network providers would result in all services being obtained at prevailing charges, and no provider turnover results in all services being obtained at the negotiated discount rate.

We scaled between these endpoints using a concave upward curve, which implies that as a higher percent of network providers leave, the cost in claims increases steeply at first, and levels out as the percent of network providers leaving approaches 100%. This reflects our assumption that the impact of providers leaving the network increases quickly at first, but levels off at a high level of impact after a certain point; the "damage" is already mostly done as the percentage of providers leaving the network gets large. We used the square root function to estimate this relationship.

To assemble the cost impact measures, we used the following relationships with the provider turnover measures.

1. Costs associated with withdrawals are represented by $C_W = d\frac{2}{3}W^{\frac{3}{2}}$, where d is the average discount level. This formula is the integrated value of the square-root function from 0 to W times the discount rate.
2. Costs associated with financial failure are $C_F = d(\frac{1}{2}F + \frac{1}{3}F^{\frac{3}{2}})$. This formula is the integral of ½ the sum of the discount rate and the square-root function above.

These cost functions have desirable characteristics, but can be modified as necessary.

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From the above assumptions, and assuming independent normal distributions for the two proportions, (normal distributions may be replaced by beta distributions in the future) an approximate distribution of the Total Cost sum can be found. Median and 95th percentiles of the approximate distribution are calculated in the Total Cost Distribution worksheet and returned in the Inputs & Results worksheet.

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Results

The median and 95th percentile loss in claims and associated provider turnover rates for low risk, average risk, and high risk markets are as follows.

Output	**High**	**Average**	**Low**
Median Percent Cost as % of In-Network	1.75%	0.30%	0.19%
95%tile Percent Cost as % of In-Network	5.49%	0.86%	0.65%
Proportion of Providers that Withdraw	22.63%	7.81%	2.59%
Std. Dev. Proportion Withdraw	7.49%	4.20%	2.34%
Proportion Providers Financially Fail	1.25%	0.70%	0.55%
Std. Dev. Proportion Fail	14.73%	1.94%	1.62%

We used these ratings to calibrate the model and they can be maintained as default values for future users.

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Discussion and Recommendations for Further Study

The output provided by this model shows the probability of voluntary and business failure turnover, as well as the associated cost to the health plan given the level of turnover and the total claims volume in the market rated. Rating several networks and comparing results will show estimated relative risks of several network choices given their user ratings. This method could also be used to help decide which network a health plan should rent, whether to build a new network or rent an existing network, contract with a single large network at lower prices or individual providers at higher prices. While this model does not assess all relevant variables that might enter into these decisions, its use could provide some useful insight.

Other important questions regarding network risk have not been addressed directly in this fairly circumscribed model. These questions surround the strategic value of a network. This can be indirectly assessed by rating different networks and comparing the resulting expected turnover rates and costs to the health plan. Issues not tied to these outcomes, such as long-term strategic value of a network, are outside the scope of this model.

For this analysis, our model inputs are illustrative only. They reflect our best professional judgment based on our experience, and are not based on research or published data. The user should see the value of the model as a tool to quantify various factors which influence provider withdrawal. The determination of good input assumptions and further calibration of the model is an area for further research.

The following list presents other areas where we believe additional study would be most beneficial in terms of furthering the analysis (most of the items relate to obtaining actual data).

1. Actual data on provider turnover
2. Detailed discount data by market
3. Actual data on reimbursement arrangements
4. Use of the model in specific circumstances and constructive comments on the results compared to expectations and the judgment of those using the model (i.e. battle test the model)

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Appendix A Example

The following hypothetical example shows how a sample network would be evaluated using the network risk model.

Scenario Description. Assume a large health plan is considering entering what is, for it, a new market in Laredo, Texas. To determine the profitability of doing so, health plan decision-makers want to assess the needed level of provider reimbursement to balance between competitive advantage and minimizing the "flight risk" that these arrangements would create with providers in the network.

The competitive environment in the Laredo market is as follows. One other health plan is present in the market (which is mostly rural). As such, providers in the other health plan's network are highly compensated (180% RBRVS) for commercial business. Since the area is somewhat distant from competition, there are few providers to choose from to assemble a panel. The local hospital is relatively small, and complicated cases would need to be sent 100 miles away to the larger hospitals near Corpus Christi.

Scoring the Network. To begin, the user must enter all the required characteristics for their health plan and the market. In this case, the characteristics are entered based on assumptions about what Health Plan ABC will be able to accomplish.

Society of Actuaries' Research Project - Health Care Provider Network Risk Model

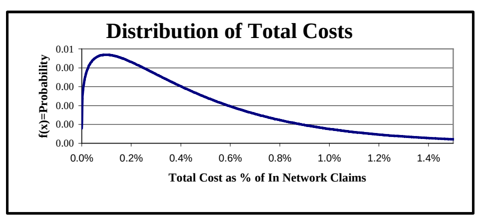
INPUTS

Global:		Value	
Health Plan Name		HP ABC	
Annual Premium		500,000,000	
Loss Ratio		80.0%	
% of Claim Cost In-Net		90.0%	
Average discount level		10.0%	
MSA		Laredo, TX / Las Cruces, NM / Las Vegas, NV--AZ	
Market:		**Value**	**Benchmark / MSA**
No. HPs in market	# HPs	1	1
% Urban	%	20%	
Health Plan:			
Health plan market penetration	%	50%	
In network percent of utilization	%	90%	
% of Enrollee's that are Medicare	%	20%	
% of network providers capitated	%	26%	26.0%

Network Characteristics:	Input Format	Value	Benchmark / MSA
Network providers reimbursement relative to their costs	%	125%	
% Network Owned (versus rented)	%	15%	
Network care management	rating (1=unmgd, 10= well mgd)	4	
Network care quality	rating (1= low, 10 = high)	7	
% of MSA covered by Network	%	65%	
% of Network that is Center of Excellence Provider	%	15%	
Provider business management	rating (1=unmanaged, 10= well mgd)	7	
# separate physician contracts in network	#	11	
# separate hospitals/system contracts in network	#	3	3
# physicians in a single contract as % total phys network	%	25%	
Largest hospital in network (beds) as % total beds	%	40%	
Hospital Reimbursement relative to competitor HPs	%	95%	
Physician Reimbursement relative to competitor HPs	%	95%	

RESULTS

Median Percent Cost as % of In-Network	0.34%	Median Total Dollar Impact	$ 1,216,592
95%tile Percent Cost as % of In-Network	1.13%	Loss Ratio Impact	0.27%
Proportion of Providers that Withdraw	4.71%	*Other Results*	*0.00%*
Std. Dev. Proportion Withdraw	4.57%	*Other Results*	*0.00%*
Proportion Providers Financially Fail	0.57%	*Other Results*	*0.00%*
Std. Dev. Proportion Fail	2.41%	*Other Results*	*0.00%*



Having no experience in this market, the user is choosing to use the benchmark suggested values where available. Since the area is somewhat isolated, the in-network utilization percentage is expected to be high and the health plan expects to achieve 50% market

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penetration. Network providers are accustomed to receiving a generous fee schedule, but Health Plan ABC hopes to reimburse at a slightly lower level than its competitor due to the competitor's recent high-profile lawsuits. The target hospital network would include all three hospitals, one of which is a very large teaching hospital that is closer to Corpus Christi. The target physician network is expected to include a large multi-specialty physician group that is located in Laredo.

If assumptions all pan out, the total cost of provider turnover in this market is expected to be low at 0.34%. The proportion of providers expected to withdraw annually is 4.71%, and the proportion expected to fail is 0.57%. The confidence intervals around the values are large relative to the mean values.

Sensitivity Testing. Using the same situation, health plan decision-makers want to test what are the worst likely results of entering this market assuming the above scenario is the expected "most likely" scenario.

For this high risk scenario, the characteristics were entered as follows.

Society of Actuaries' Research Project - Health Care Provider Network Risk Model

INPUTS

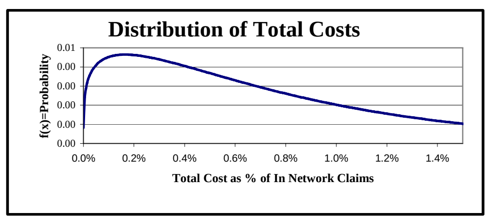
Global:	**Value**
Health Plan Name	HP ABC
Annual Premium	500,000,000
Loss Ratio	80.0%
% of Claim Cost In-Net	80.0%
Average discount level	10.0%
MSA	Laredo, TX (Las Cruces, NM; Las Vegas, NV--AZ)

Market:		**Value**	**Benchmark / MSA**
No. HPs in market	# HPs	1	1
% Urban	%	20%	
Health Plan:			
Health plan market penetration	%	25%	
In network percent of utilization	%	75%	
% of Enrollee's that are Medicare	%	20%	
% of network providers capitated	%	40%	26.0%

Network Characteristics:	**Input Format**	**Value**	**Benchmark / MSA**
Network providers reimbursement relative to their costs	%	110%	
% Network Owned (versus rented)	%	25%	
Network care management	rating (1=unmgd, 10= well mgd)	2	
Network care quality	rating (1= low, 10 = high)	5	
% of MSA covered by Network	%	60%	
% of Network that is Center of Excellence Provider	%	15%	
Provider business management	rating (1=unmanaged, 10= well mgd)	6	
# separate physician contracts in network	#	11	
# separate hospitals/system contracts in network	#	2	3
# physicians in a single contract as % total phys network	%	35%	
Largest hospital in network (beds) as % total beds	%	55%	
Hospital Reimbursement relative to competitor HPs	%	95%	
Physician Reimbursement relative to competitor HPs	%	95%	

RESULTS

Median Percent Cost as % of In-Network	0.58%	Median Total Dollar Impact	$ 1,871,313
95%tile Percent Cost as % of In-Network	1.95%	Loss Ratio Impact	0.47%
Proportion of Providers that Withdraw	6.92%	*Other Results*	*0.00%*
Std. Dev. Proportion Withdraw	5.79%	*Other Results*	*0.00%*
Proportion Providers Financially Fail	0.80%	*Other Results*	*0.00%*
Std. Dev. Proportion Fail	4.23%	*Other Results*	*0.00%*



This scenario assumes lower health plan penetration, a lower percentage of utilization in-network, more network providers are capitated, network providers are getting less reimbursement in relation to their expenses, care management and quality are lower, there is a hospital with a larger proportion of the total beds, and a physician contract with a larger proportion of the total physician network.

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In this situation, the total cost of provider turnover in this market is expected to be 0.58%. The proportion of providers expected to withdraw annually is 6.92%, and the proportion expected to fail is 0.8%. The confidence intervals around the values are again large relative to the mean values.

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Appendix B Model Instructions

The model is built in Microsoft Excel. The model workbook contains six sheets, which are discussed below. Note that the spreadsheet is protected (without a password) so that the user does not inadvertently change any cells other than those designated as input cells. For the user who wants to make other changes, the protection can be turned off by clicking on Tools, Protection, Unprotect Workbook.

Inputs & Results. This sheet allows the user to score the target network with respect to the model characteristics in the box labeled Inputs, and view the results for the target network in the box labeled Results and the accompanying graph. The user can, if desired, use only this sheet in the model.

The first section of inputs, entitled Global allows the user to input descriptive features about the health plan, and the market in which the target network is being assessed. Note that the model will assess the network risk level for a single market at a time, so that large health plans that operate in multiple markets will need to model the risk for one market at a time. We define a market to be a single MSA or rural area.

Inputs are entered in the yellow cells. These inputs include the health plan name, annual premium for the market being evaluated, loss ratio, percent of claims in the market that are in-network, the average negotiated provider discount in the market, and the MSA for the market in question which is selected in the drop-down menu provided.

The other three sections of inputs, Market, Health Plan, and Network Characteristics, contain individual characteristics that define the competitive position of the network being scored based on features about the market in which the network operates, the health plan with which it contracts, and the network itself. Each section lists the characteristics, followed by the format in which the score should be entered, a yellow cell where the score is entered, and in some cases a benchmark based on the MSA selected in the Global section. The model provides benchmark values for the number of health plans operating in the market, the percentage of physicians in the market that are capitated, and the number of hospitals/hospital systems operating in the market. For the number of health plans, the user will probably want to use the benchmark value. For the other two, the benchmarks simply provide information for the user's reference.

The Results box presents four measures of the riskiness of the target network in terms related to claims dollars. Cells E28 and E29 present the median and 95th percentile total estimated cost of turnover for the target network, respectively. These estimates are given as a percentage of total in-network claims dollars. Cell J28 presents an estimate of the median in-network cost in dollars. Cell J29 presents the estimated impact of the network risk on the loss ratio.

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Cells E30 through E33 present the direct results of the four regression equations: the expected proportion of providers that withdraw from the network, the standard deviation of the proportion of providers that withdraw from the network, the expected proportion of providers that financially fail, and the standard deviation of the proportion of providers financially fail.

To the right of the Results box is a graph showing the distribution of expected total cost of the target network as a percentage of in-network claims.

Factor Analysis. This sheet develops the four quasi logistic regression equations and their output in terms of the expected proportion of providers leaving the network or failing, and the standard deviations for those proportions. Users need not do anything to this sheet, but can change the development of the regression weights to reflect user judgment regarding the impact of the characteristics on the events if desired.

The input scores for the network characteristics are pulled from the Inputs & Results sheet (column D) and normalizes these scores using estimated averages and standard deviations for each characteristic (columns E and F). Note that these distribution assumptions were not derived from data, but were rather estimated based on the judgment of the model developers. The normalized scores in column G are multiplied by the regression weights for each equation and summed to get the raw scores presented in row 31 for each of the four equations. The raw scores are adjusted in row 32 such that the resulting output is calibrated to the modelers' reasonability criteria (described for sheet Calibration below). The final regression output is shown in the yellow cells in row 33, where the adjusted raw scores above are translated into meaningful output using a logistic transformation as described in the Method section.

For the event of provider withdrawal, the regression equation to estimate the mean percentage of providers leaving the network is developed in columns I, J, and K. Column I shows the importance ranking of each characteristics for this equation, and column J shows the direction of the influence. Column K develops the regression weights (Beta) based on the information in columns I and J. Columns L, M, and N present the parallel information for the regression equation to estimate the standard deviation of the proportion of the providers leaving the network, with column N developing the regression weights (Gamma) for that equation.

The parallel development for the regression equations predicting the mean and standard deviation of the proportion of providers that financially fail is shown in columns O through T.

Calibration. This sheet uses reasonable output targets to calibrate the model such that the regression equations provide results within these parameters. These preliminary steps have also been done by Milliman, but may be modified to reflect individual user perspective. If changes are made to the development of the equations on the Factor Analysis sheet, these calibration steps will need to be redone.

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This sheet presents the model developers' targets for model characteristic scores and regression equation results in blue in columns C through E for provider withdrawal, and columns T through V for provider failure. The calibrating targets for the equations that develop the mean proportions are shown in rows 8 through 30, and the parallel targets for the equations that develop the standard deviations are shown in rows 36 through 58. These targets were developed to be the characteristic scores that one would expect for a low risk, average risk, and high risk network.

The values in blue in columns C through E in rows 66 through 73 present the modelers' estimates of the resulting turnover rates and standard deviations for low, average, and high risk networks.

We used these targets, estimated using our best judgment, to calibrate the output of the regression equations such that results fell within a range deemed to be reasonable.

The first step in the calibration is normalizing the characteristic scores, which is done using the estimated means and standard deviations from the Factor Analysis sheet. This step is shown in columns G through I, and columns X through Z.

The normalized scores are multiplied by the regression weights pulled in from the Factor Analysis sheet in columns L and N, and summed in cells L32 through N32. Cells in row 33 create the parallel probability scores using the target medians for the low, average, and high risk networks. Row 34 uses the calibration location and scale in cells O33 and P33 to realign the raw scores derived from the equations. Row 35 uses the values in row 32 to create the mean percent physicians leaving based on the low, average, and high risk networks. Row 36 reiterates the target percentage of physicians leaving, and row 37 shows the calibrated percentage of physicians leaving the network.

Rows 39 through 45 repeat the sequence for the equation that determines the standard deviation in the percent of providers leaving the network.

To calibrate the equations based on user targets, the user can adjust the values in the Location and Scale parameters (cells with red text) until the new probabilities and standard deviations approximate the input values (rows highlighted in brown are approximately equal to each other). The resulting Location and Scale parameters are used to adjust the raw output from the equations on sheet Factor Analysis to create reasonable output from the equations.

The parallel calibration steps for the provider failure equations are shown in columns R through AG.

Cost Functions. This sheet translates the regression equation output parameters into probability distributions and associated cost distributions. These distributions are shown in graphic form on this sheet. This information is not used elsewhere.

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Columns B and E show the probability distributions of the two events developed from the parameters (mean and standard deviations) that result from the regression equations.

Columns C and F use simple formulas to translate each probability point into a withdrawal cost, stated in terms of a loss in average network discount.

Distribution of Total Cost. This sheet develops the total cost of network turnover as a percentage of total network claims, the graph of which is presented on the Inputs & Results sheet. The table uses a Beta distribution to approximate the distribution of the total cost.

C2 and C3 develop the mode and standard deviation for the combined probability of withdrawal from the network for either voluntary provider withdrawal or provider failure. These values are used to develop the Beta distribution parameters.

Cells H2 and H3 develop the parameters of the Beta distribution. These are based on information pulled from the Inputs & Results sheet including the estimated average network discount and the output means and standard deviations in provider withdrawal that result directly from the regression equations.

Cells H4 and H5 present the estimated mean and standard deviation of the approximated distribution.

Column B shows the points on the x-axis over the desired range of total costs. Column C develops the Beta distribution over the desired range and Column D grosses it up to total 1.0. The probability density function in Column D is graphed to the right, and also in the results section on the Inputs & Results sheet.

Columns G and H are used to collect the 50^{th} and 95^{th} percentiles for output table, which are presented in the final output on the Inputs & Results sheet.

MSA Data. This sheet provides data tables used to fill in the benchmarks on the Inputs & Results sheet.

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