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PREDICTION OF THE 1996 SUPERBOWL AN APPLICATION OF THE AHP WITH FEEDBACK (THE SUPERMATRIX APPROACH)

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Abstract: This paper develops a refined benefit/cost model using the supermatrix approach of the AHP to predict the outcome of the playoffs and the Super Bowl of the 1995-1996 season.

Introduction

In October 1995, we undertook the task of predicting (Saaty and Vargas, 1991)[1] the outcome of the 1996 Super Bowl. At that time the Miami Dolphins, who had the best statistical record of all the teams in the NFL, appeared to be destined to win the Super Bowl. Soon after, their fortunes went on the decline, but we continued predicting other likely winners using the same model. The variations in our forecasting the winner of the Super Bowl from week to week, made us ask how we could change the model to do better. Soon we learned two lessons. The first lesson was that our model developed a priority for each team from their statistical past performance and from our interpretation of their abilities, independently from who their opponents were in the past or might be in the future. In addition, we forecast the Super Bowl winner at any time, without relating it to the week by week winners. In other words, we looked at the end without considering how we might predict the progress of the outcome from week to week. Needless to say, our predictions were in error which became more apparent when we applied the same approach to predict the week by week outcomes of the playoffs. We asked ourselves where we could modify our understanding to better capture the realities of the situation and make correct predictions.

Some Observations

Two things had to be considered. The first was how to incorporate the performance of a team relative to which other teams it plays, thus, bringing dependence considerations into the model. The second was that one no longer could predict the distant future without having to go through the intervening weeks of competition as they affected various point counts and also intangible factors such as the mental attitude and the physical fitness of each team. In other words, one cannot predict who is going to be in the Super Bowl in October with any reasonable degree of certainty. One may be able to automate the process so that week to week encounters can be used to modify judgments applied to predict subsequent performance, and also the final outcome. One needs to introduce chance occurrences into the model in a sufficiently realistic way as to make it practical to continue predictions from week to week. There is some doubt as to whether including chance would dilute the accuracy of the model to such an extent as to negate its validity. In football, an incapacitated quarterback can change substantially the prospects of a team. The likelihood of such an event is difficult to account for in any model for prediction.

The First Model

Our first approach looked at a "generic" model that included all of the team alternatives using absolute

measurement. That is to say each team's abilities are decomposed into a network of factors that interact to varying degrees with each other. First we identified a set of factors for which we had to judge its importance in relation to winning the game. Examples of such factors include: running game, quarterback ability, weather, coaching ability, home field advantage, and so on, listing nearly 50 factors. These factors were then clustered according to whether they fall into offense, defense, external factors, internal factors, and experience. We first compared the cluster's importance to win a game, and then compared the factors in each cluster and synthesized the results to produce the overall priorities to judge the teams. No team could affect these priorities of the criteria because their importance was established in the abstract. We then constructed an absolute scale of intensities under each of the criteria. There were two kinds of intensities: those representing the spread of our judgments under an intangible criterion, and those determined by the spread of statistics under the tangible criteria. We then judged the teams' standing in terms of these intensities. As the statistics varied from week to week, the team's numeric standing varied accordingly, without regard to who that team's opponent was or will be. This approach did not work, and we learned our lesson prior to the playoffs. We decided to separate our model into two models, one representing the strengths (benefits) and the other the weaknesses (costs) of that team.

The Revised Feedback Model of Strengths and Weaknesses[2]

We began our prediction of the playoffs with the teams paired off officially, and thereafter followed our prediction of the winners that determine who would have to play whom. In developing the priorities for the model, we had to prioritize the criteria and clusters of our model with both teams included, and we did this twice, once for the strengths (benefits), and once for the weaknesses (costs) of the two teams. While the different criteria and clusters remained the same, their relative importance changed depending on the importance that we felt they had in the specific match. That is to say that we felt that Passing would have more importance in the Green Bay-Dallas game (pass oriented teams) than in the Indianapolis-Pittsburgh game (running oriented). We then took a macro look at the competition by consolidating some of the criteria into a smaller set so that each set only had a few criteria to whose comparisons we applied experienced judgment. We ranked the teams using absolute measurement with intensities assigned to the intangible criteria. Instead of a statistical spread of intensities, we also used a judgmental spread for the consolidated tangible criteria, and in this manner, obtained a number for each team's strengths and another for its weaknesses and took their ratio. These numbers only indicated the relative comparison of the two teams with no validity to comparing a team of a pair with another team of another pair.

Our model predicted the wildcard games and the subsequent playoff games through the Super Bowl correctly except for one game between Indianapolis and Kansas City. The latter team had the higher score, but their kicker unluckily had a very, very bad day and they lost. We had no way to account in our forecast for this kicker aberration in advance. In another game, the priorities of the two teams differed by 0.004 (the San Francisco-Green Bay game). Although the ever so slightly larger priority went to San Francisco, they lost. Such errors can probably never be fully eliminated.

We must confess that in this particular playoff competition, we did not have instances where a very good team played a very poor team. In that case, it would have been easier to check correlation with actual scores. We believe that our approach can be adapted to deal with chance occurrences by including a third model of risks and perhaps a fourth of opportunities as one might do with an AHP application to a business problem.

The outcome of the playoff games are exhibited in Figures 1a-d:

Figure 1a. Wild Card Games

Team	Benefits	Costs	B/C
Miami vs.	0.701	0.612	1.145

Buffalo	0.745	0.590	1.263
Indianapolis vs.	0.687	0.622	1.105
San Diego	0.660	0.650	1.015
Detroit vs.	0.625	0.636	0.983
Philadelphia	0.695	0.580	1.198
Atlanta vs.	0.590	0.612	0.964
Green Bay	0.785	0.515	1.524

Figure 1b. Second Round

Pittsburgh vs.	0.740	0.581	1.274
Buffalo	0.704	0.605	1.164
Indianapolis vs.	0.695	0.590	1.178
Kansas City	0.750	0.575	1.304
Green Bay vs.	0.755	0.590	1.280
San Francisco	0.751	0.585	1.284
Philadelphia vs.	0.732	0.641	1.142
Dallas	0.759	0.576	1.318

Figure 1c. Divisional Playoffs

Dallas vs.	0.742	0.540	1.370
Green Bay	0.756	0.561	1.350
Pittsburgh vs.	0.699	0.555	1.260
Indianapolis	0.741	0.598	1.240

Figure 1d. The Super Bowl

Dallas vs.	0.761	0.728	1.045
Pittsburgh	0.748	0.735	1.018

Description of the Method

We will illustrate our approach with Benefits and Costs hierarchies that we considered for Green Bay and Dallas in the Divisional Championship game. We had to use the network approach of the AHP to compare the relative merits of each team, given that it will play the other team and we implicitly considered the strengths and weaknesses of the other team while we compared the strengths of a given team. In the one case, we asked which is a greater strength for one team, given the other team (strengths and weaknesses together) as a whole. In the other, we asked which is a greater weakness for that team given the same knowledge as before about the other team. Absolute intensities are then assigned and the two teams ranked on these intensities. The ratio of the two outcomes is then formed and used as an indicator of the relative standing of the two teams in the match. As yet, we have no way to convert these priorities to actual football scores.

The first step in developing our model was to decide which factors affected the outcome of the game.

The first step in developing our model was to decide which factors affected the outcome of the game. Figures 2a and 2b show the clusters and criteria that we used with respect to both Benefits and Costs, respectively. Also shown here (with arrows) are the interactions that we feel are appropriate between the criteria. For instance, in Figure 2a for Benefits, we can see that there is a relationship between Green Bay-Quarterback, and Green Bay-Running. In making judgments, we decided that with respect to Green Bay, Quarterback was Moderately to Strongly More Important than Running Game. This is based on the fact that Green Bay relies more heavily on its Passing Game. This judgment would give us priorities of 0.800 for Passing and 0.200 for Running. We can see in Figure 3, for the local priority supermatrix, that these two values are listed under the column "GREEN BAY" and the rows "QB ability" and "Running". Similar comparisons were made for each interaction shown in Figure 2 and included as columns in Figure 3. The columns of the supermatrix of Figure 3 do not each add up to one. However, they will after weighting each block by the influence of the corresponding cluster. In other words, all entries in the submatrix corresponding to the cluster are multiplied by the single number priority of that cluster.

The cluster weights are shown at the bottom of Figure 3 for the Benefits and the bottom of Figure 5 for the Costs. The Limiting Supermatrix is then shown at the bottom of Figures 4 and 6, with all columns identical.

The values that are given in the Limiting Supermatrices of Figures 4 and 6 yield priorities of the criteria. These priorities are used to weight the intensities on which each of the two teams is rated. The criteria are shown in figures 7 and 8 along with their corresponding intensities and their local priorities which add to one. These weights were obtained by pairwise comparing each of the 3 intensity choices under each criterion. The intensity assigned to each team is designated by a D or a GB for Dallas and Green Bay, respectively and placed above the priority of that intensity. While the intensities and their weights remain the same for each game, each team is ranked individually for each game that is played and the supermatrices would be different. The sum of the weighted intensities give a total benefit and a total cost component for each team. The final outcome is obtained by dividing the total benefit by the total cost. In this matter we obtain the final result for the Green Bay-Dallas playoff game:

	Benefits	Costs	B/C
Dallas vs.	0.742	0.540	1.370
Green Bay	0.756	0.561	1.350

We will now discuss some of the judgments and their justification for the Green Bay-Dallas game.

Further Detail About the Judgments

To help the reader understand in greater detail our judgment process, we give some illustrative examples.

For the Benefits Model:

- With respect to Green Bay, Quarterback is very strongly more important than Running Game. The basis for this is that Green Bay's success is due largely to the performance of its quarterback, Favre, and its team exhibits little excellence in running the football.

- With respect to Green Bay, Playing Beyond Their Means is moderately more important than Coaching Ability to Inspire. Here, we have the idea that the head coach of Green Bay's proven ability to inspire his team is more important for success than the fact that the players exceed expectations.

- With respect to Green Bay, Quarterback is moderately to strongly more important than Home Field Advantage. These two elements are inherently linked because the quarterback for Green Bay has an extremely good record in the cold temperatures of Green Bay. Basically we think that while the cold and friendly confines of Green Bay help the team, the ability of Favre outweighs that factor.

Figure 2a. The Benefits

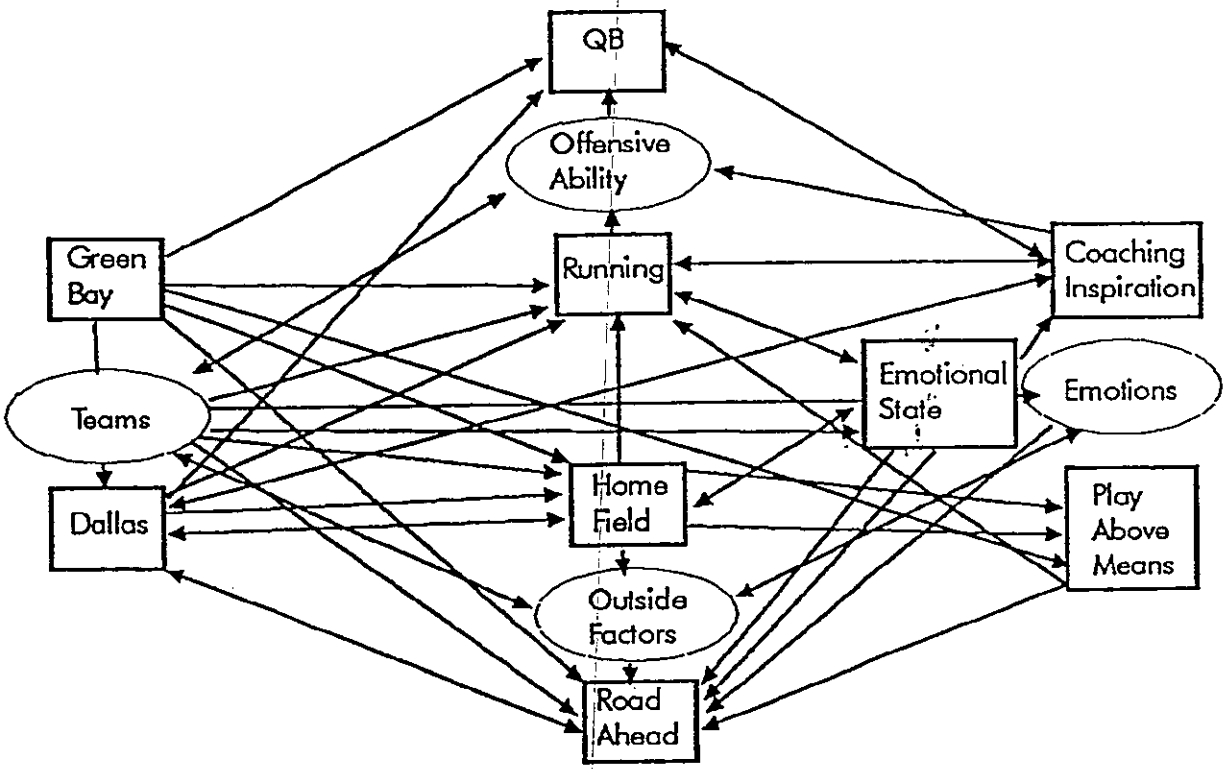

Figure 2b. The Costs

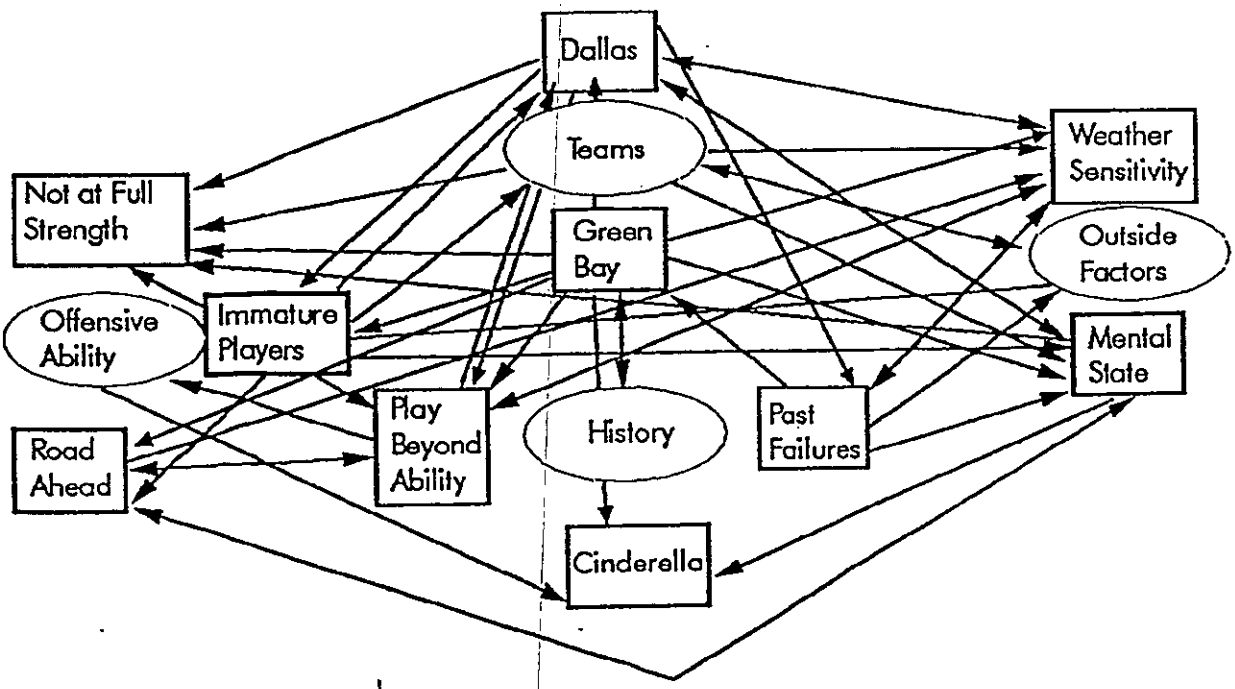

Figure 3: Local Weighted Benefits and Cluster Weights

Local Weights				Offensive		Emotions			Outside		Teams	
		Global	Local	QB Ability	Running	Play Above	Coaching	Emotions	Home Field	Road Ahead	Dallas	Green Bay
Offense	QB Ability	0.0297	0.0864				0.8000		0.8000			0.8000
	Running	0.3140	0.9136			1.0000	0.2000	1.0000	0.2000	1.0000		0.2000
Emotions	Play Above Ability	0.0037	0.0309						1.0000			
	Coaching	0.0235	0.1962							0.7500		
	Emotional State	0.0923	0.7724							0.2500	1.0000	
Outside	Home Field	0.0433	0.1055								1.0000	0.2000
	Road Ahead	0.3670	0.8945	1.0000	1.0000	1.0000	1.0000					0.8000
Teams	Dallas	0.1227	0.9693				0.7500		1.0000	1.0000		
	Green Bay	0.0039	0.0308				0.2500					

Cluster Weights

	Offense	Emotions	Outside	Teams
Offense	0.0000	0.2449	0.6442	0.7172
Emotions	0.2176	0.0000	0.0852	0.1947
Outside	0.0914	0.0902	0.0000	0.0881
Teams	0.6910	0.6648	0.2706	0.0000

Figure 4: Cluster Weighted and Limiting Supermatrix

Cluster Weighted

				Offensive		Emotions			Outside		Teams	
		Global	Local	QB Ability	Running	Play Above	Coaching	Emotions	Home Field	Road Ahead	Dallas	Green Bay
Offense	QB Ability	0.0297	0.0864				0.1959		0.5154			0.7125
	Running	0.3140	0.9136			0.7308	0.0490	0.7308	0.1288	0.6442		0.1781
Emotions	Play Above Ability	0.0037	0.0309						0.0852			
	Coaching	0.0235	0.1962							0.0639		
	Emotional State	0.0923	0.7724							0.0213	0.6885	
Outside	Home Field	0.0433	0.1055					0.0538			0.3115	0.0219
	Road Ahead	0.3670	0.8945	1.0000	1.0000	0.2692	0.0902	0.2153				0.0875
Teams	Dallas	0.1227	0.9693				0.4986		0.2706	0.2706		
	Green Bay	0.0039	0.0308				0.1662					

Limiting Supermatrix

		Offensive		Emotions			Outside		Teams	
		QB Ability	Running	Play Above	Coaching	Emotions	Home Field	Road Ahead	Dallas	Green Bay
Offense	QB Ability	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297	0.0297
	Running	0.3140	0.3140	0.3140	0.3140	0.3140	0.3140	0.3140	0.3140	0.3140
Emotions	Play Above Ability	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037
	Coaching	0.0235	0.0235	0.0235	0.0235	0.0235	0.0235	0.0235	0.0235	0.0235
	Emotional State	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923	0.0923
Outside	Home Field	0.0433	0.0433	0.0433	0.0433	0.0433	0.0433	0.0433	0.0433	0.0433
	Road Ahead	0.3670	0.3670	0.3670	0.3670	0.3670	0.3670	0.3670	0.3670	0.3670
Teams	Dallas	0.1227	0.1227	0.1227	0.1227	0.1227	0.1227	0.1227	0.1227	0.1227
	Green Bay	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039

Figure 5: Local Weighted Costs and Cluster Weights

Local Weights

				Offensive			History			Outside		Teams	
		Global	Local	Road Ahead	Immature Players	Not Full Strength	Cinderella	Play beyond ability	Past Failures	Mental State	Weather	Dallas	Green Bay
Offensive	Road Ahead	0.1529	0.4034					0.8000		0.8000		0.7500	
	Immature Players	0.0000	0.0000										0.2000
	Not Full Strength	0.2261	0.5966				1.0000	0.2000	1.0000	0.2000	1.0000	0.2500	0.8000
History	Cinderella	0.0011	0.0041							1.0000			0.7500
	Play Bey Ability	0.2002	0.7278			0.8333					0.7500		0.2500
	Past Failures	0.0738	0.2683			0.1667					0.2500	1.0000	
Outside	Mental State	0.0121	0.0673		0.8571							0.8333	1.0000
	Weather	0.1683	0.9332	1.0000	0.1429			1.0000				0.1667	
Teams	Dallas	0.1653	1.0002					1.0000		1.0000	1.0000		
	Green Bay	0.0000	0.0000										

Cluster Weights

	Offense	History	Outside	Teams
Offense	0.0000	0.3614	0.6267	0.7172
History	0.0877	0.0000	0.0936	0.1947
Outside	0.1392	0.0650	0.0000	0.0881
Teams	0.7731	0.5736	0.2797	0.0000

Figure 6: Cluster Weighted Costs and Limiting Supermatrix

Cluster Weighted

		Offensive					History			Outside		Teams	
		Global	Local	Road Ahead	Immature Players	Not Full Strength	Cinderella	Play beyond ability	Past Failures	Mental State	Weather	Dallas	Green Bay
Offensive	Road Ahead	0.1529	0.4034					0.2891		0.5014		0.5379	
	Immature Players	0.0000	0.0000										0.1434
	Not Full Strength	0.2261	0.5966				1.0000	0.0723	1.0000	0.1253	0.6267	0.1793	0.5738
History	Cinderella	0.0011	0.0041							0.0936			
	Play Beyond Ability	0.2002	0.7278			0.8333					0.0702		0.1460
	Past Failures	0.0738	0.2683			0.1677					0.0234	0.1947	0.0487
Outside	Mental State	0.0121	0.0673		0.8571							0.0734	0.0881
	Weather	0.1683	0.9332	1.0000	0.1429							0.0147	
Teams	Dallas	0.1653	1.0002							0.2797	0.2797		
	Green Bay	0.0000	0.0000										

Limiting Supermatrix

		Offensive			History			Outside		Teams	
		Road Ahead	Immature Players	Not Full Strength	Cinderella	Play beyond ability	Past Failures	Mental State	Weather	Dallas	Green Bay
Offensive	Road Ahead	0.1529	0.1529	0.1529	0.1529	0.1529	0.1529	0.1529	0.1529	0.1529	0.1529
	Immature Players	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Not Full Strength	0.2261	0.2261	0.2261	0.2261	0.2261	0.2261	0.2261	0.2261	0.2261	0.2261
History	Cinderella	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
	Play Beyond Ability	0.2002	0.2002	0.2002	0.2002	0.2002	0.2002	0.2002	0.2002	0.2002	0.2002
	Past Failures	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738
Outside	Mental State	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121
	Weather	0.1683	0.1683	0.1683	0.1683	0.1683	0.1683	0.1683	0.1683	0.1683	0.1683
Teams	Dallas	0.1653	0.1653	0.1653	0.1653	0.1653	0.1653	0.1653	0.1653	0.1653	0.1653
	Green Bay	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Figure 7. Benefits:

Quarterback (0.030):		
Average (0.091)	Good (0.281)	High Ability (0.691)[GB,D]
Running Game (0.314):		
Average (0.084)	Good (0.211)[GB]	High Level (0.705)[D]
Play Above Potential (0.004):		
Average (0.075)	Good (0.229)[D]	High Level of Play (0.696)[GB]
Coaching Ability to Inspire (0.023):		
Not A lot (0.078)	Somewhat (0.205)[D]	Heroic (0.717)[GB]
Emotional State (0.092):		
Apathy (0.082)	Mediocre (0.236)	Excitement (0.682)[GB,D]
Home Field Advantage (0.043):		
Neutral (0.105)	Some Effect(0.258)[GB]	Significant Effect (0.637)[D]
The Road Ahead (0.367):		
No Effect (0.082)	Some Effect (0.236)[D]	Very Confident (0.682)[GB]
Dallas' effect on the ultimate outcome (0.123):		
Low Effect (0.094)	Medium (0.280)	Greatly Influenced(0.627)[GB,D]
Green Bay's effect on the ultimate outcome (0.004):		
Not Much (0.105)	Medium (0.258)	Greatly Influenced(0.637)[GB,D]

Figure 8. Costs:

The Road Ahead (0.153):		
Low Effect (0.085)	Somewhat (0.271)[GB,D]	High Effect (0.644)
Not at Full Strength (0.226):		
Few Injuries (0.091)	Some Injuries (0.218)	Big Injury Problems(0.691)[GB,D]
Playing Beyond Ability (0.200)		
Not a factor (0.094)[GB,D]	May Falter (0.288)	Vulnerable (0.627)
Past Failures (0.074):		
Good History (0.082)[GB]	Mixed Past (0.236)[D]	Can't get it done (0.682)
Mental State of Preparedness (0.012):		
Ready (0.122)[GB]	May Be Hurt (0.230)[D]	Unready (0.648)
Cinderella Team (0.001):		
Not Cinderella (0.082)[GB,D]	Good Team, Lucky (0.236)	It's Midnight (0.682)
Weather Sensitivity (0.168):		
Anything Goes (0.095)[D]	Small Sensitivity (0.250)[GB]	High (0.655)
Dallas' Effect (0.165):		
Small (0.163)	Medium (0.297)	High (0.540)[GB,D]
Green Bay's Effect (0.000):		
Small (0.105)[D]	Medium (0.258)	Big Effect (0.637)[GB]
Immature Players (0.000):		
Veterans (0.082)[D]	Some Experience (0.236)[GB]	Young Players (0.682)

- With respect to Green Bay, Quarterback is equally to moderately more important than Dallas. Here we are comparing an aspect of the Green Bay team relative to the opponent, Dallas. Effectively, we are asking, which is more important to Green Bay's success, the fact that they have Brett Favre, or the fact that they are playing Dallas. The judgment was made that while Favre is an outstanding quarterback, the fact that he is facing Dallas may be enough to counteract his abilities.

- With respect to Dallas, the Road Ahead is strongly more important than Home Field Advantage. The Road Ahead refers to future games that the team may have to play if the team continues on. Here, the relative ease of the road ahead for Dallas, based on the record of the AFC in the Super Bowl, makes it less important than the fact that Dallas is playing Green Bay, possibly its biggest obstacle to win the Super Bowl, on its home turf.

- With respect to Dallas, Running Game is equally to moderately stronger than Quarterback. This judgment is based on the fact that while Dallas' quarterback is excellent, the team's Running Game is quite often the league's best.

- With respect to Dallas, Quarterback is strongly to very strongly more important than Coaching Inspiration. The basis for this judgment is the fact that Dallas' coach, Barry Switzer, has exhibited no great gift for inspiration; the team has much talent, especially in the quarterback position.

In addition, some judgments were based on the game, not on the specific teams. For instance, if we look at Coaching Inspiration, Running Game is moderately more important than Quarterback. That is to say, in this *particular* game of Dallas and Green Bay, Coaching Inspiration is likely to be more important in a successful running game. This is based on the perception that both quarterbacks seem to be relatively self reliant and self motivated, while running games are more receptive to coaching inspiration.

For the Costs Model:

- With respect to Green Bay, Mental State is strongly more important than Weather Sensitivity, simply because Green Bay's Mental State could be more easily called into question (may not be tough enough) than their Weather Sensitivity (they are very insensitive to poor weather conditions).

- With respect to Dallas, Mental State is moderately more important than Weather Sensitivity. While the team is not highly Weather Sensitive, their excessive confidence causes us some concern and it may be their undoing.

- With respect to Green Bay, Not at Full Strength is moderately more important than The Road Ahead. The basis for this being that Reggie White, a very important player on the team, is not 100% well, and this is likely to have a larger impact than any AFC team that Green Bay might meet in the Super Bowl because, as we said before, AFC teams have not posed a great threat in recent years. Conversely, if we look at an AFC matchup, the Road Ahead would in most cases have a large impact due to the fact that AFC teams are usually unsuccessful against NFC teams in the Super Bowl.

- With respect to Green Bay, Dallas is strongly more important than Cinderella. This translates to mean that any Cinderella Story that Green Bay may be enjoying is likely to be overshadowed by the fact that they are playing Dallas. While Green Bay is not widely considered to be a Cinderella, the label would have a larger effect on a team like the Indianapolis Colts when they played Kansas City.

- With respect to Dallas, Not at Full Strength is strongly more important than Immature Players. While Dallas has many veterans, its biggest problem in this comparison could be injuries to key players such as Charles Haley.

- With respect to Dallas, Past Failures are equally important as Play Beyond Ability. Not only is Dallas

playing to its potential, it has few grave failures of the past to look back on.

As with the Benefits model, there are judgments that are based on the game and not necessarily on either team. For instance with respect to Past Failures, we felt that the Mental State of the Team is strongly more important than Weather Sensitivity. That is to say that if Past Failures are to be a factor in the game, they are more likely to come from a less than peak Mental State.

Conclusion

It is our hope to use this model to forecast future Super Bowl competitions. Undoubtedly, there will be additional modifications. The basic ideas learned here can be used to forecast the outcome of other competitive games. It appears that the use of intangibles is significantly more important in the forecast than the strict accuracy of the statistics, although one cannot do without the statistics which tell more about performance than about attitude and environment.

References

[1]Saaty, T. L. and Vargas, L. G. (1991) *Prediction, Projection, and Forecasting*, Kluwer Academic Publishers.

[2]Saaty, T. L. (1996) *The Analytic Network Process*, RWS Publications.