

**Neural Patterns:
Artificial Intelligence Neural Networks
Link Consumer Behavior Patterns with
Perceptions of Economic Conditions**

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SUMMARY

Two factors are necessary for a method to be useful in a variety of country settings. An analysis technique to understand information available is required that is robust and not constrained. And, data of a comparable format and scope of measurement is needed to enable parallel analysis across countries.

Artificial intelligence neural networks and Consumer Confidence Surveys fit these criteria. This work provides an example of the power of this combination.

NEURAL PATTERNS

Marketers constantly face the dilemma of how best to implement a winning strategy from one market to another. Thinking globally and acting locally are no longer ideals for international marketers -- rather, thinking globally and acting locally are required for growth and profit. Differences in consumer perception, spending power, need states, and purchase habits complicate discerning the commonalities which are present. By example we will provide an approach to understanding the link between perceptions and spending that can be implemented in any market.

Two factors are necessary for a method to be useful in a variety of country settings. An analysis technique to understand information available is required that is robust and not constrained. And, data of a similar format and scope of measurement will be needed to enable parallel analysis across countries.

Artificial intelligence neural network models continue to provide a new dimension in data analysis for marketers. Because neural nets require no assumptions about a data set's structure, distribution, independence or relationship, they are able to discover patterns present in information that traditional statistical methods cannot address.

Neural networks use human-like trial and error learning methods to detect patterns existing within a data set. Additionally, neural nets have the ability to ignore data that is not significant and emphasize that data that is most influential. A neural network acquires its intelligence by training with a set of variables or features represented by a variety of encoding methods. This knowledge is then applied as a prediction of the patterns existing in this new data presented to the network.

Work by Bechtel et al. (1993) provides compelling evidence that consumer confidence tracking data is a reliable reflection of the macropsychology attitude-behavior link at the aggregate level of national economic conditions. Additionally we see confirmation of a strong sociotropic component of consumer confidence that exists across a number of EEC states.

Much use has been made of the components of consumer confidence. The Consumer Confidence Survey of The Conference Board, Inc., New York, is classified as a leading economic indicator by the U. S. Department of Commerce. This survey is generally referred to as the world's first and best known psychological indicator. According to Bechtel, adaptations of this index are reported in monthly surveys in each of the twelve nations of the European Economic Community.

Tracking this index and its various components proves beneficial at a macro analytic level. When attempting to use consumer confidence in industry specific forecasting, the results are less satisfying.

Building on this knowledge, we develop neural networks capable of learning the patterns of change over time in consumer confidence by country. These patterns are related with sales from a number of major retail categories, e.g. department stores, automobiles, grocery, food away from home, etc. Trained neural net models now generalize this learning and permit forecasts of consumer category sales in future time as well as in new geographic markets.

An example of a model using neural network pattern analysis to forecast department store monthly sales is now presented.

MODEL STRUCTURE

Guided by Bechtel we are able to construct a parsimonious model. This model is accurate and is of a general structure which may be used in a large number of individual countries.

Of course the model may be refined for each country with specific data available in the CCI study.

For this example we use neural pattern analysis to forecast the next month department store sales (SIC code 531) using current month confidence measures.

Neural networks such as the one we use here are comprised of a series of layers of neuron processing nodes (Grey-Tedesco, 1991). One layer each for input and output. Also a layer of neurons known as the hidden is constructed between the input and output layers. All neurons in each layer are connected to each neuron in the next layer -- input to hidden -- hidden to output. These connections are represented by weight values which are modified by the network during the course of training the network. Initially these weights are random numbers; as the neural net examines each new data record these weights change in order for the network output to more closely match the output of the current data example. It is the value of these connection weights that depict the knowledge gained by the model.

The input vector for the neural network contained a seasonality factor and the monthly Consumer Confidence Survey for the following:

Evaluation of the Present Situation

- Business conditions are good
- Business conditions are bad
- Business conditions are normal

Expectations for Six Months Hence

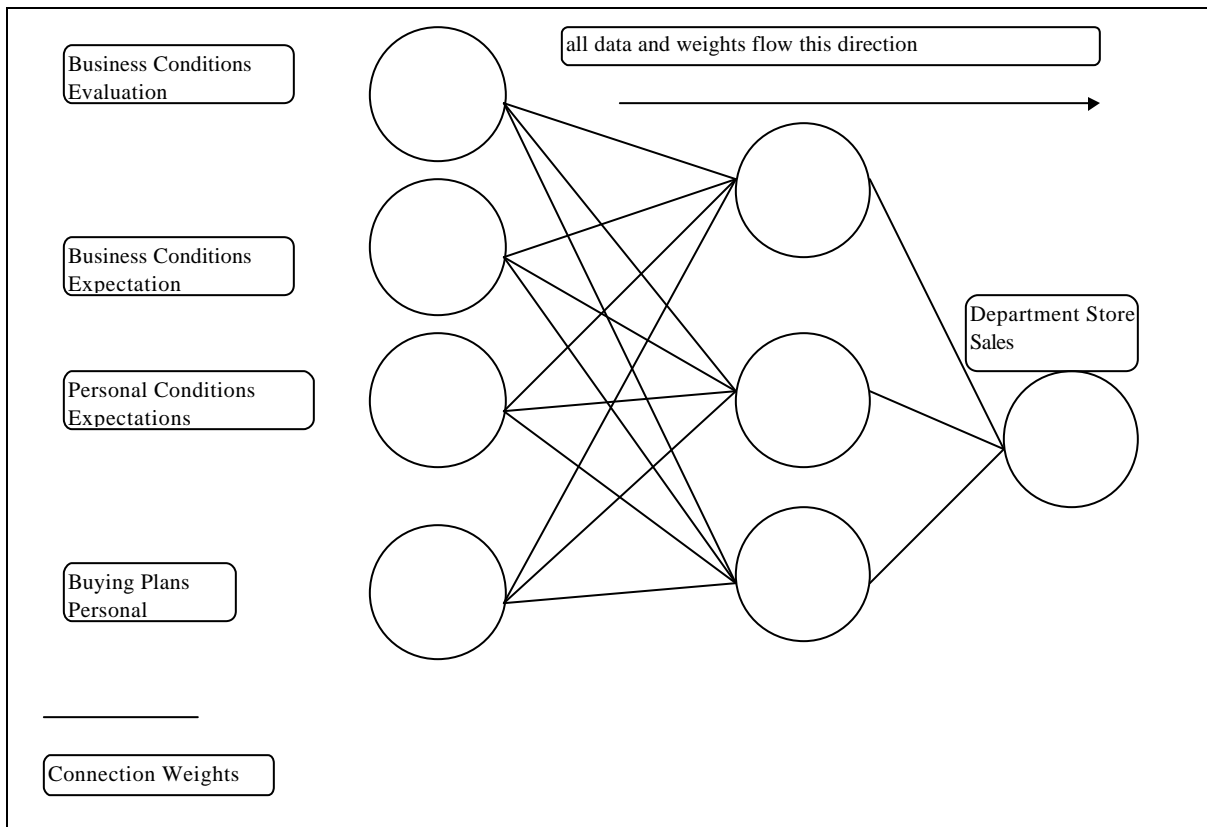
- Business conditions will be better
- Business conditions will be worse
- Business conditions will be the same

- Household income will increase
- Household income will decrease
- Household income will remain the same

- Will purchase an automobile
- Will purchase a major appliance

With the exception of the last two items, there are three categories for each of the above confidence measures. Therefore, the network input layer contains 26 individual neurons. It is common with neural networks to have an output vector with more than a single variable to predict. In this model only one month is estimated. Other models using this same confidence survey input are designed to estimate up to three months into the future simultaneously.

After preprocessing and design, the neural pattern model appears as follows:



FULLY CONNECTED NEURAL PATTERN MODEL

METHOD AND RESULTS

Monthly data for the period January, 1984 through December, 1994 in the United States is used in this model. Observations are presented to the neural network two at a time. And, the network is permitted to process for 11,000+ iterations through the data. Training is accomplished with approximately 90% of data, while the remaining 10% is withheld for testing the accuracy of the network's forecasting ability.

Using the test data, the model reports a reliability factor of 76% when projecting department store sales two months after the current month's confidence data, and 89% reliability when forecasting one month into the future. We use the term reliability to mean the percent chance of

the model being correct when forecasting sales for a new month. In other words, this neural pattern model will be correct almost nine out of ten times where it projects sales for the next one month.

Two meaningful uses of any neural pattern model are: 1) forecasting and 2) the analysis of the relative importance of the independent or casual variables.

The following table displays the forecast for the last three months of 1994 using this model.

Month	Actual Sales	Neural Network Estimates
October, 1994	\$18,688	\$18,323
November, 1994	\$22,631	\$21,061
December, 1994	\$33,793	\$31,755

all sales in \$MM

While the accuracy of this model does vary somewhat (2% to 6%), its application as a planning tool is a breakthrough is a search for commonality in quantifying the trends of consumer confidence. This value is due to the power of neural networks to determine the nonlinear relationships that exist in this data. By comparison, applying a multiple regression analysis to this same data produces a forecast accurate only a one in every five months.

Conducting a sensitivity analysis of the input layer of the neural network yields the relative importance of the causal variables. It is interesting to note in this model the it is the evaluation and expectations of business conditions that account for the largest impact from the confidence survey. This finding support the sociotropic component of consumer confidence as described in Bechtel.

Sensitivity Analysis

Input Measures	Impact on Sales
Seasonality	55%
Business Conditions Evaluation	16%
Business Conditions Expectations	16%
Personal Conditions Expectations	8%
Personal Buying Plans	5%

Neural patterns are now available as method for marketers to realize the heretofore untapped information available in a variety of consumer behavior data. This powerful technology is a bridge for the passage of global marketing strategies.

As more data is made available from sources through the varied interactive offerings, the ability to glean knowledge from this information grows in value. Artificial intelligence neural networks continue to offer the greatest opportunity to realize the expectations facing marketers.

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