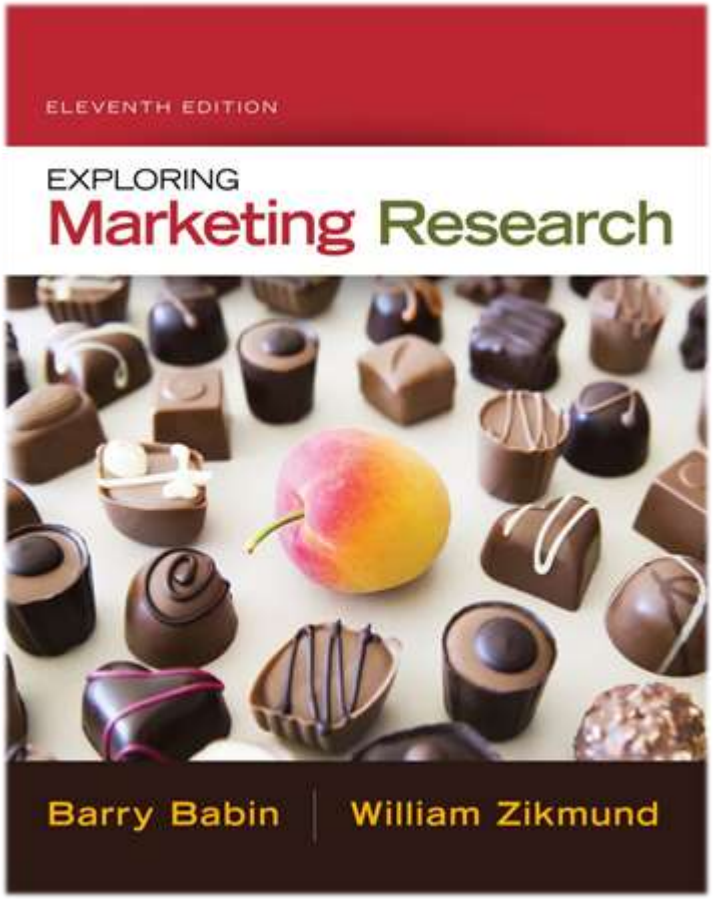


Chapter 19 Testing Hypotheses with GLM Procedures

LEARNING OUTCOMES

After studying this chapter, you should

1. Test hypotheses with regression analysis
2. Understand the basics of interpreting hypotheses of mediation
3. Know that moderation accounts for context effects
4. Conduct and interpret hierarchical linear regression

Introduction

- The General Linear Model (GLM) takes on any one of several forms depending on the nature of the data and the type of hypotheses involved in a market research project
  - Both mediation and moderation are commonly offered as theoretical processes by which predictor variables shape outcomes
  - As a consequence, any marketing analysts should develop a working knowledge of both concepts

Testing Hypotheses with Regression Analysis

- A theory represents a much more comprehensive explanation than does a hypothesis, whereas a hypothesis represents a specific prediction about two variables
  - Sometimes, the hypothesis may involve more than two variables and propose that, in some way, the dependent variable is a function of two other variables
- Linear models play a key role in testing hypotheses

Stating Hypotheses Effectively

- Good hypotheses:
  - Are shorter, not longer
    - State any hypothesis in as few words as possible
  - Are specific, not general
    - State things in terms of the actual phenomena measured
    - State the specific direction of a proposed relationship
  - Are meaningful, not trivial
    - Hypotheses should propose relationships that are of key interest to the decision statement at hand
  - Are questionable, not certain
    - Present relationships that are not presumed true on inspection or presumed true based on a plurality of input from previous studies examining the variables

Stating Hypotheses Effectively (cont'd.)

- Good hypotheses:
  - State something, not nothing
    - A hypothesis should propose that something exists, such as a relationship
    - Do not state a tautology (a circular explanation)
  - Should invite a comparison with data
    - A hypothesis should imply the way the test should take place
    - In terms of hypotheses tested by regression results, the hypotheses should be stated in terms of the nature of the relationship

Testing Basic Hypotheses with Multiple Regression

- The chapter uses a data set involving golfers to illustrate how to test hypotheses using multiple regression
  - Hypotheses used in this chapter:
    - H1: The distance that respondents hit the golf ball is related positively to their satisfaction with the golf experience
    - H2: The price of the golf balls is related positively to respondents' satisfaction with the golf experience
  - Both hypotheses are based on logic and prior research

Testing Direct Effect Hypotheses

- The most basic type of hypothesis in descriptive or causal research designs is the direct effect
  - A direct effect assesses the relationship between an independent variable and a dependent variable where the hypothesis suggests a relationship that depends on no other variable
  - In a regression context, the analyst assesses a direct effect through a straightforward examination of the parameter coefficient between the independent and the dependent variable
  - A direct effect may be tested along with the presence of control variables

Testing Direct Effect Hypotheses (cont'd.)

- In the golfer data, a direct effect hypothesis offered by the researcher is:
  - H1: The average distance of respondents' drives relates positively to satisfaction with the golf experience
- Explanation
  - The results support a positive relationship between the distance of drives and satisfaction with the golf experience
  - The word "support" is appropriate
  - We do not "prove" the result with inferential statistics

The Basics of Testing Mediation

- A mediator variable fits between an independent variable and a dependent variable and serves to facilitate a relationship between an independent variable and a dependent variable
  - Marketing researchers often think of price effects as involving mediation in some way
    - For instance, price promotions can increase sales
    - However, price promotions may increase sales only when the promotion creates a perception of increased value
    - Thus, perceived value mediates the effects of price promotions on sales

The Basics of Testing Mediation (cont'd.)

- An indirect effect is a relationship consisting of two parts
  - The first part is the relationship between an independent variable and a mediator variable
  - The second part is the relationship between the mediator and the ultimate dependent variable
    - Price promotions affect purchase behavior indirectly through their impact on value perceptions
    - If price promotions affect value perceptions only a little, then the indirect effect through value perceptions will be small

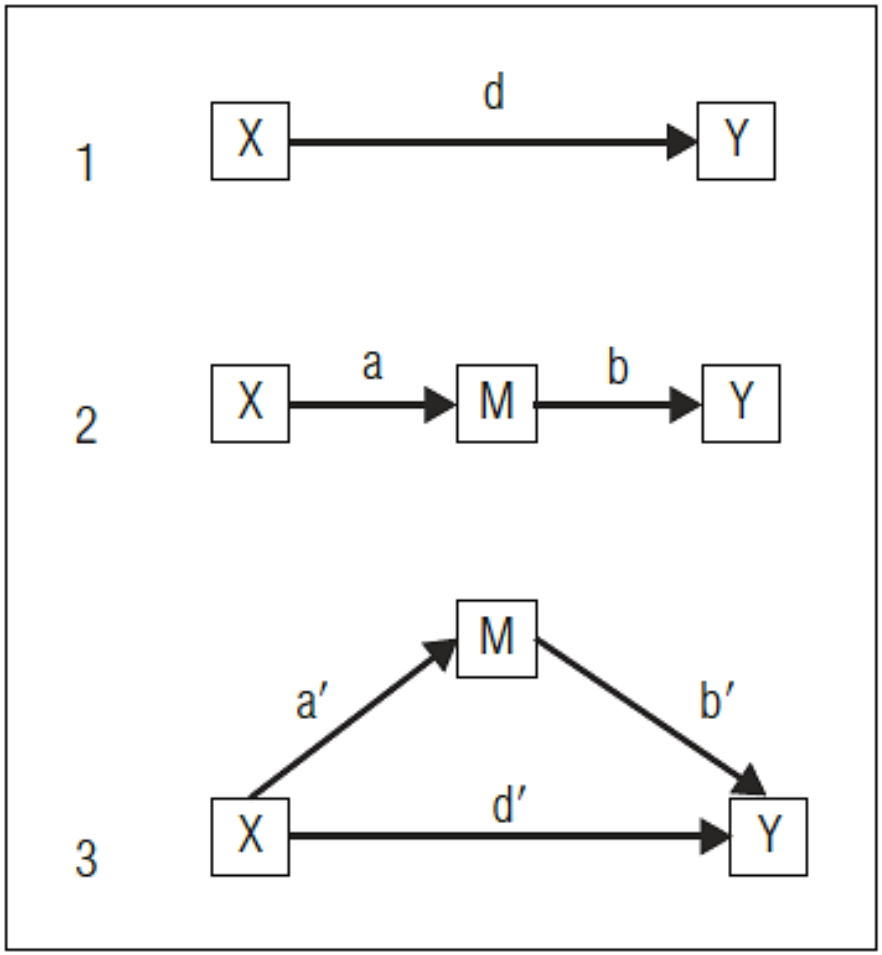
Conditions of Mediation

- Exhibit 19.3 depicts a way to go about examining mediation
  - The exhibit helps make these points:
    - The first stage depicts the notion that *X* is related to (causes) *Y*
    - The second frame depicts the notion that the relationship between *X* and *Y* is indirect and works through an intervening, or mediating, variable, *M*
    - The third stage depicts the comparative effects of direct and indirect effects of *X* on *Y*

Conditions of Mediation (cont'd.)

- Presuming evidence of a relationship between *X* and *Y* is established by estimating *d* in step 1, and that an indirect effect exists as described in step 2, and *d′* is estimated in this step, the comparison of *d* and *d′* provides crucial evidence
  - If $d' \geq d$, no evidence of mediation exists.
  - If $d' < d$, but *d′* remains statistically significant, partial mediation exists
  - If *d′* is not significantly different than 0, complete mediation exists

EXHIBIT 19.3 Breaking Down Mediation



Mediation Illustrated

- Using the golfer satisfaction example, we illustrate a test for mediation
  - Here, the researcher hypothesizes that price (*X*) affects satisfaction (*Y*) but that the relationship works through distance (*M*) as a mediator
    - A simple regression predicting satisfaction with price paid suggests that price does significantly relate negatively to satisfaction
    - Separate simple regression models provide evidence suggesting that price paid affects distance and that distance affects satisfaction
    - In this example, we could conclude that distance fully mediates the effect of price on golf experience satisfaction

Details of Mediation

- Potential biases can occur in calculating the statistical significance of mediation effects
  - The analyst faces several questions when considering how to deal with potential bias:
    - Can the bias be ignored?
      - When the analyst is interested only in an assessment of the potential mediation of the relationship between *X* and *Y*, he or she may choose to ignore the bias
      - The analyst can ignore the bias if an examination of the residuals for predicted values of *Y* in the step 3 multiple regression suggests no obvious patterns, or if an additional analysis suggests no residual correlation

Details of Mediation (cont'd.)

- What are the implications of the potential bias for the regression results?
  - Like with multicollinearity and heteroscedasticity, the *t*-tests of the parameter coefficients become unreliable as the bias becomes substantial
- Are alternative approaches available to assess the statistical significance of a mediated effect?
  - One alternative for dealing with the potential for correlated residuals involves more complicated linear modeling approaches
  - Bootstrapping involves taking the available data and using sampling with replacement, generating many, many samples (typically 500, 1,000, or 2,000) and estimating the parameters in each of those samples

Using A Mediation Macro

- Researchers' desire to offer explanations rather than only predictions creates concern over the mechanism of observed covariation
- Mediation, being one of the commonly proposed explanations for causal effects, provides a focus for much discussion among researchers
- Exhibit 19.4 illustrates a basic application of PROCESS (for use in SPSS) using a data set that involves consumer perceptions of a service environment

EXHIBIT 19.4 Using the PROCESS Macro

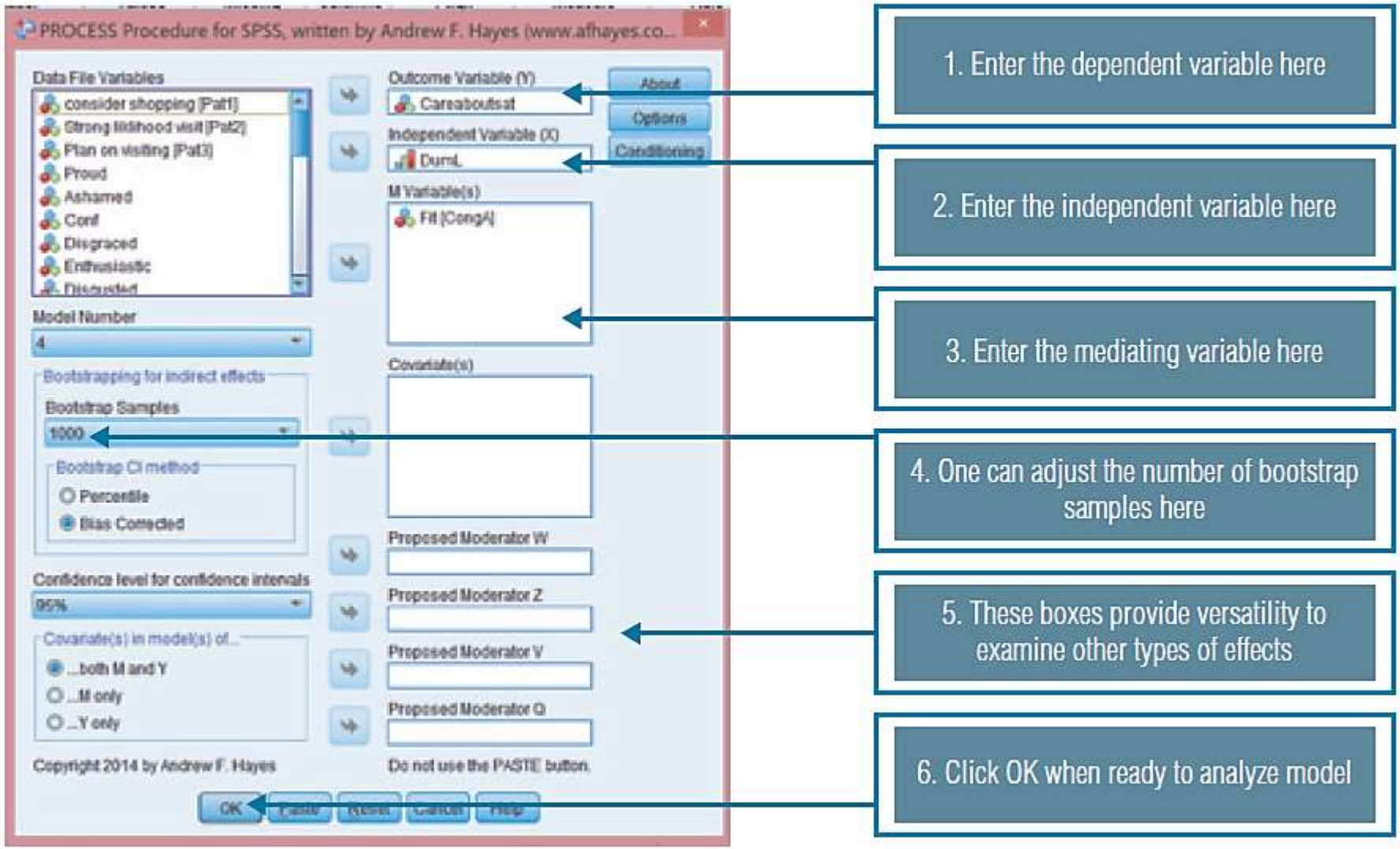
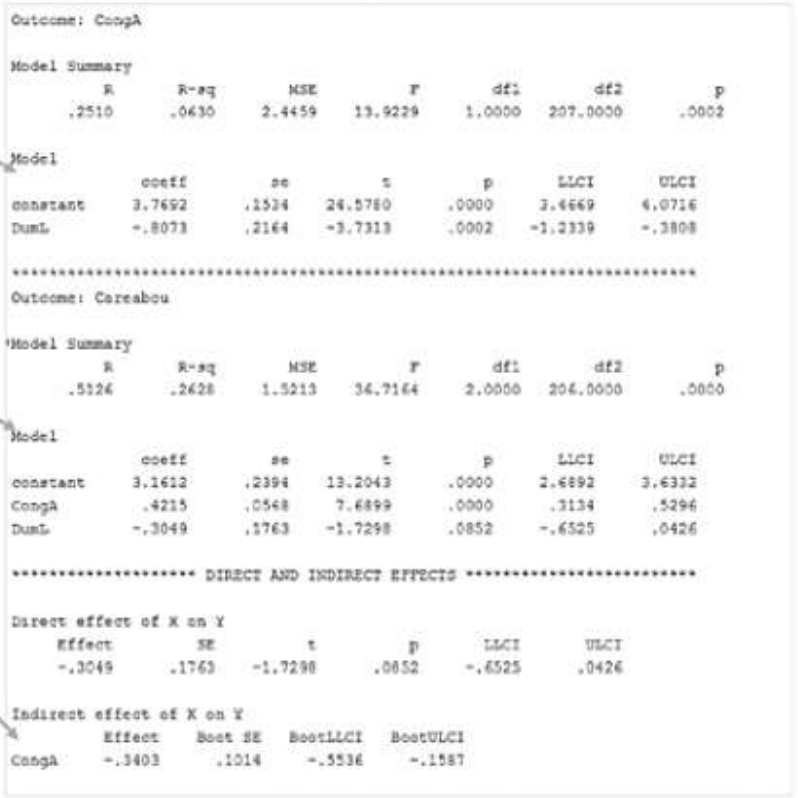


EXHIBIT 19.5 Mediation Analysis Macro Output

The first "model" provides the relationship between the independent and dependent variable (d)

The second "model" provides the relationship between the independent variable and dependent variable while controlling for the mediator (d')

The bottom part summarizes the direct effect of X and Y and provides the confidence interval for the indirect effect of X and Y through the mediator



```
Outcome: CongA

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .2510      .0630     2.4459    13.9229     1.0000   207.0000     .0002

Model
              coeff         se          t          p       LLCI       ULCI
constant     3.7692     .1524    24.5780     .0000     3.4669     4.0716
DumL         -.8073     .2164    -3.7313     .0002    -1.2339     -.3808

************************************************************************
Outcome: Careabou

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .5126      .2628     1.5213    36.7164     2.0000   206.0000     .0000

Model
              coeff         se          t          p       LLCI       ULCI
constant     3.1612     .2396    13.2043     .0000     2.6892     3.6332
CongA         .4215     .0548     7.6899     .0000     .3134      .5296
DumL         -.3049     .1763    -1.7298     .0852    -.6525      .0426

****************** DIRECT AND INDIRECT EFFECTS *************************

Direct effect of X on Y
     Effect         SE          t          p       LLCI       ULCI
     -.3049      .1763    -1.7298     .0852    -.6525      .0426

Indirect effect of X on Y
          Effect   Boot SE   BootLLCI   BootULCI
CongA     -.3403     .1014    -.5536     -.1587
```

Mediation Terminology

- Presuming that the simple direct effect (*d*) and the indirect effect of *X* on *Y* are statistically significant, complete (sometimes called full) mediation results when the effect of *X* on *Y* becomes insignificant in the presence of *M*
- Partial mediation results when the effect of *X* on *Y* when controlling for *M* remains significant but is reduced in size compared to the simple relationship
- In other words, *d′* remains significant but is less than *d*

Moderation Means Context Effects

- An interaction plays a big role in examining statistical moderation, which represents the fact that some third variable affects the relationship between an independent and a dependent variable
  - Very often, the moderator accounts for some context
  - A context variable captures factors unique to time, space, conditions, or person traits that may affect some hypothesized relationship
    - Time pressure, time of day, region, and demographic variables provide common context variables

Hierarchical Regression Analysis

- Examining context effects with moderators in regression involves a test of interactions in one way or another
  - Thus, problems with a lack of independence of independent variables occur with continuous variable interactions
    - Hierarchical regression involves adding sets of predictor variables sequentially in multiple stages of a regression analysis and examining the change in the models' predictive power at each step
    - The focus shifts to a difference in the model F statistics and R^2 at each subsequent stage

Hierarchical Regression Analysis Steps

- Enter all control variables and use them to predict *Y* ► interpret the model results
- Add all the independent variables to the regression model and predict *Y* ► interpret the model results with an emphasis on the change in model results
- Add the interaction term(s) to the regression model and predict *Y* ► interpret the model results with an emphasis on the change in model results
- Use the predicted values of *Y* at two values of the independent variable (such as + or - 1 standard deviation away from the mean) to plot the moderation results as routinely done for an interaction in ANOVA

Hierarchical Regression Illustration

- Exhibit 19.6 illustrates results from hierarchical regression using the golfer data
  - The hierarchical regression involves three stages:
    - Handicap is entered as the control variable in Model 1
    - In Model 2, the routine adds the standardized direct effects of distance and ball to the regression equation from step 1
    - In Model 3, the interaction represents the moderator (ModDisPri) formed by multiplying the standardized distance variable by the standardized ball price variable
    - Given that the interaction is not significant, the researcher may not plot the interaction means
      - The analyst would draw the conclusion that distance drives satisfaction positively as a direct effect, but no interaction, and therefore no moderation, is suggested by these results

EXHIBIT 19.6 Hierarchical Regression Results

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.190	1	14.190	6.525	.013[b]
	Residual	132.667	61	2.175		
	Total	146.857	62			
2	Regression	52.190	3	17.397	10.842	.000[c]
	Residual	94.667	59	1.605		
	Total	146.857	62			
3	Regression	52.193	4	13.048	7.994	.000[d]
	Residual	94.664	58	1.632		
	Total	146.857	62			

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.311[a]	.097	.082	1.475	.097	6.525	1	61	.013
2	.596[b]	.355	.323	1.267	.259	11.841	2	59	.000
3	.596[c]	.355	.311	1.278	.000	.001	1	58	.969

a. Predictors: (Constant), Handicap
b. Predictors: (Constant), Handicap, Zscore: Ball Price, Zscore(Distance)
c. Predictors: (Constant), Handicap, Zscore: Ball Price, Zscore(Distance), ModDisPri

EXHIBIT 19.6 Hierarchical Regression Results (cont'd.)

Coefficients[a]								
		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	5.484	.505		10.868	.000		
	Handicap	−.093	.037	−.311	−2.554	.013	1.000	1.000
2	(Constant)	4.526	.478		9.470	.000		
	Handicap	−.019	.035	−.062	−.534	.596	.800	1.250
	Zscore(Distance)	.795	.177	.516	4.483	.000	.824	1.214
	Zscore: Ball Price	−.222	.169	−.145	−1.318	.192	.909	1.100
3	(Constant)	4.529	.486		9.321	.000		
	Handicap	−.019	.036	−.063	−.531	.598	.797	1.255
	Zscore(Distance)	.798	.202	.519	3.945	.000	.643	1.555
	Zscore: Ball Price	−.221	.173	−.144	−1.277	.207	.877	1.140
	ModDisPri	.005	.140	.005	.039	.969	.735	1.361

a. Dependent Variable: Satisfaction

Depicting Hierarchical Regression Interaction

- Refer to Exhibit 19.7
  - When a hierarchical regression analysis suggests moderation, the best way to interpret the result is using a graphical depiction
  - Suppose the researcher conducted another analysis examining the potential interaction of a moderator, ball price (*BP*), with an independent variable predicting satisfaction, durability (*Dur*)
    - From the graph, we see that durability affects satisfaction more strongly in the high-price condition
    - The term slopes test sometimes is used to refer to the comparison of slopes in interpreting an interaction's effect

EXHIBIT 19.7 Plot of Interaction Effect