Can consumer software selection code for digital cameras improve consumer performance?


October 18, 2006

Abstract

Forecasting the performance of products undergoing rapid technological change requires data and the knowledge to interpret that data. We surveyed students about one such product – digital cameras – and found that they lacked knowledge to interpret the data. To show that decision aids could improve their performance, we created a digital camera selection code that included an education module and in an experiment demonstrated its superiority to (1) the recommendations of sales clerks, (2) the recommendations of digital camera owners, and (3) the recommendations of subjects with Internet access, but without access to our code.

Referee: Go to http://www.eco.utexas.edu/Homepages/Faculty/Norman/code.html to gain quick access to the codes used in this paper.

Send correspondence to

Alfred Lorn Norman
Department of Economics
The University of Texas at Austin
Austin, TX USA 78712
E-Mail: norman@eco.utexas.edu
Phone: 512-346-4253
1 Introduction

Consumer buy products for future consumption and must predict product performance. This has become increasingly difficult because with accelerating technological change, modern consumers face a market with products with new features, if not genuinely new products. For example, the 20th century saw the advent of radio, television, VHS, DVD, digital cameras, personal computers, and cell phones. In addition, advancing production technology enables producers to produce a wide variety of products for niche markets creating large numbers of alternatives for consumers. For example, there are currently over one hundred and fifty new models of digital cameras on the market. A consumer must forecast both the relative performance of different niches and the alternatives within the niche she selects.

The faster the rate of technological change and the longer the gap between repeat purchases, the less a consumer can rely on prior experience and the more data a consumer must collect for forecasting. Such data includes specification sheets, brochures, salespeople’s advice, reviews in books, magazines, and websites, users’ opinions, and product interactions. In Section 2, we specify what data consumers could acquire in order to forecast digital camera performance, and we argue that the information value of data is positively related to its reliability and power to discriminate and negatively related to its processing cost. We also show that the demand for data is dwarfed by the amount of data that could be acquired.

In Section 3, we study the procedures that students use to select a digital camera. We focus on two aspects of their selection procedures: how much data they consider and what decision rules they employ to reach to their final selection. In Section 4, we discuss why consumers need innovation in selection procedures and conclude that better selection software could greatly improve consumer performance.

In Section 5, we discuss our approach to design better digital camera search software. Our
selection process aims to first find a small set of cameras with the features to take the type of pictures the consumer wants. This might be viewed as finding cameras that satisfy the requirements for a Becker household production function. Also, as consumers generally lack knowledge about digital cameras part of this code, is an education module. In the final part of the code, the user is presented with alternatives to find the preferred item from the small set.

We present our experiment and the results in Section 6. We focus on the first decision process, finding a small set with the required features. We found that the subjects using our digital camera selection code performed statistically better than salespeople in a digital camera store, subjects with the Internet access, but not our code, and subjects who owned a digital camera.

In Section 7, we present our conclusions from this procedural consumer study. This is the fourth paper in our efforts to create a theory of a procedural consumer. The other papers are Norman et al (2001), Norman et al (2003), and Norman et al (2004).

2 Data, Information, and Forecasting

In cases when prior experience is in sufficient, consumers collect data from 2nd and 3rd parties. Producers and sellers have incentives to provide consumers with product data and to a very limited degree enable consumers to test the product, as with a car test. Because millions of consumers search for similar goods, there are tremendous economies of scale for third parties to provide consumers with better data and the knowledge to interpret that data. For decades, entrepreneurs have created “how to” books and trade magazines, providing reviews of technological products such as automobiles and electronic devices. Two such digital camera trade magazines are Popular Photography and Digital Camera World. With the rise of the Internet, entrepreneurs have created numerous sites to provide consumers with decision support for technology products, especially in electronics. For digital cameras, a consumer can go to sites such as CNET.com, Consumerreports.org, Megapixel.net,
DCResource.com, DPReview.com, Imaging-resources.com, and Steves-digicams.com. Such websites provide some or all of: (1) digital camera overview articles, (2) tables of camera attributes, (3) glossaries of terms, (4) camera reviews, (5) files of customer experiences with the cameras, and (6) galleries of pictures taken using the reviewed cameras.

There are several ways a consumer could learn which attributes are needed for the type of picture he requires and could judge the performance of cameras with those attributes. He could seek advice from those with prior experience such a digital camera owner or salesperson. In some cases in a camera store, he can take in-store pictures, although his evaluation would be limited to the LCD screen image. In a book store or library he could read articles in digital camera magazines or books. Online at a digital camera site he could peruse the types of data listed above. The question is how much data should an efficient consumer collect and process. We shall use digital cameras to illustrate our qualitative analysis of this issue.

2.1 Processing Cost

The first factor limiting data demand is cost. Even without acquisition fees, getting and processing data requires resources. Finding alternatives’ specifications, for example, can require examining several brochures or visiting several Internet sites. In addition, the consumer, if faced with new technology or previously unencountered choices, may have to learn how to interpret the data. Consequently, the cost of data to the consumer should include not only the time and resources spent on acquiring the data, but also the cost or learning how to interpret the data, and the resources spent on interpretation.

We also argue that the Internet processing cost is less than the physical space processing cost for a variety of reasons:

1. **Travel**: It is cheaper to go from site to site in cyberspace than store to store in physical space.
2. **Evaluation**: It is easier to find material on the Internet than it is in physical space. For example, online to find digital camera product reviews, a consumer can go to Google.com and enter the product name with the word “review,” to obtain a long list of sites with reviews of the product. This is much more efficient than driving to a local bookstore or library to look through the digital photography magazines in the magazine rack.

3. **Tools**: Cyberspace also dominates physical space in the provision of tools to consumers. Let us consider tables in physical space versus cyberspace. Magazine review articles frequently include tables with a side-by-side comparison of the discussed products attributes, but these tables are fixed. Websites can create personalized attribute tables of only those products that interest the visitor. These tables can also include links to reviews, and current prices. Creating something nearly as useful in physical space would require acquiring and lining up the relevant tables in manufacturers’ brochures, which lack a common format.

4. **Price**: It is much easier to perform a price search in cyberspace than in physical space. If a consumer knows what she wants to buy, she can input the product name into a search engine like Froogle.com, PriceGrabber.com, or Dealtime.com. They will return a price distribution of the product prices through linked merchants. With a click, prices of the product including shipping costs can be ordered from lowest to highest, and an estimate—frequently given as a number of stars and testimony of previous customers—of the seller’s reliability. Thus, a consumer can judge whether a low price is a legitimate offer. In the case of digital cameras, the seller sometimes takes the camera out of the box and tries to sell the package components as extras. Obtaining such information in physical space from a large number of sellers would be prohibitively expensive because of travel costs or time delays in reaching a salesperson by phone.

Nevertheless, even with the aid of computers, more data, even if free, is not neces-
sarily better than less data. Consider how much data could possibly be provided to a consumer in order to evaluate digital cameras. While a consumer has a limited ability to take pictures with a camera before purchase, in some cases a consumer could borrow a camera owned by a friend or look at pictures in the LCD screen of a demo in a digital camera store. A consumer could go to the manufacturer’s site to examine the product description and the user’s manual. A consumer could read all the reviews in magazines and at digital camera sites to see the results of the each reviewer’s tests, which differ among reviewers. This is still only a fraction of the data that could be supplied to the consumer. The potential buyer could be supplied with the detailed specifications of every component of the digital camera, the production details, the research and development reports, and the details of all the testing programs. The consumer could even be supplied with electron microscope pictures of the structure of the sensor. A data file describing the position of molecules on the sensor surface could be obtained. Indeed, the limit of data that could possibly be supplied to a consumer is only set by the Heisenberg uncertainty principle. More data is not necessarily better than less: such a massive data file would be prohibitively expensive to obtain and would overwhelm the consumer’s processing capabilities. Indeed, it might well intimidate consumers into making poor decisions. Although a computer-aided consumer can inexpensively process a great deal more data than a consumer without a computer, the amount of data that could be tractably processed is still miniscule in comparison to the potential limit.

2.2 Capacity to Discriminate

Another important attribute of data is the capacity to help the consumer discriminate among alternatives’ probable performance. Akerlof (1970) was the first to raise this issue in his discussion of the used car market, where buyers were unable to judge the reliability of a used car. Spence (1973) expanded the discussion by highlighting the market incentives of the market participant to provide signals to allow the other party to make a judgement of future performance. A good signal discrim-
inates with low processing cost. In the case of used cars, auto dealers have developed a certification program where used vehicles pass inspections and are backed by warranties. Some of the signals provided by manufacturers include a list of product specifications, such as a list including a digital camera’s number of megapixels and size. Third parties also provide market signals. For example, Imaging-resource.com tests the focus time and shutter lag of a digital camera, and DPRreview.com makes detailed picture noise measures for dSLR cameras.

For new products that the consumer first needs signals to discriminate among camera niches to find the niche with the attributes for the intended use. For the intended use a consumer might need some combination of the following attributes: (1) an autofocus assist light, (2) a wide angle lens, a telephoto lens or both, (3) a video capability and if so of what quality, (4) the capacity to make 8" × 10" prints, or (5) an external flash in addition to the internal flash. As will be shown in our code, sample pictures can provide signals to decide about (2) and (5). The video capability can be signaled by the video picture size such as 640 by 480 pixels, the number of frames per second such as 30 fps, and whether the video length is restricted only by the available memory. The number of megapixel is a signal for picture size detail as the amount of detail in a pictures increases by the square root of the number of megapixels.

Once the consumer has found the best niche, he then needs to judge the performance of the cameras within this niche. For this purpose, a consumer might use the brand such as Canon as a signal. This signal is not a perfect discriminator because not all Canon cameras are winners. To obtain a better discriminator the consumer might also read several reviews to judge performance or examine the picture and video galleries taken by a particular camera.

2.3 Reliability

The final factor considered in the data’s information value is its source’s reliability. Second and third parties provide data beyond the consumer’s direct sensory interaction with the products. The
former-manufacturers and retailers-present data to sell their products and this data might not be
the most useful to enable the consumer to judge among all alternatives in the market. Third-party
owners of products, such as friends, relatives, and acquaintances, can provide useful data about a
product from their experiences, but they generally know much less about products they didn’t buy.
Experts who provide product reviews in magazines and websites generally have a conflict of interest.
While experts are generally financed by advertising rather than by the prospective buyer, they must
provide useful information to attract readers in order to increase their advertising revenue. Thus,
consumers are likely to regard expert third-party sources as more reliable for inter-firm product
comparisons than a firm comparing its own products with its rivals’ products.

The reliability of third party sites depend on how the entrepreneur gets paid for his services.
ConsumerReports.org charges the viewer a flat annual fee to access the site while others make money
through advertising, sponsorships, and pass through fees. The more independent the site is from the
sellers the greater its reliability. If sites that advertise are too critical, they risk losing sponsorships.

2.4 Information Value

The information value of data as positively related to its reliability and ability to discriminate
among alternatives and inversely related to its processing cost. Note that the same data can have
different information value for different people because they may have different knowledge bases and
different processing capabilities.

3 Digital Camera Selection Procedures

How do students search for a digital camera? To find out we first interviewed 20 students to guide
two surveys of students who had purchased a digital camera: 27 students in 2003 and 40 students
in 2006. Of the last group 23 students were given a follow-up survey. Interviewed students were
paid $10 for the interview. Surveyed students were paid $5 each and those that participated in the
continuation survey an additional $3. We shall focus on the last two surveys.

Subjects were given a list of possible data sources. For each source, subjects were asked whether they used it and if so, how useful it was where the response “not useful” was recorded as 1, the response “useful” as 2 and the response “very useful.” as 3. The results are displayed in the table below:

<table>
<thead>
<tr>
<th>Source</th>
<th>Type</th>
<th>Fraction</th>
<th>Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>People</td>
<td>Friend or Relative</td>
<td>0.73</td>
<td>2.21</td>
</tr>
<tr>
<td>People</td>
<td>Sales clerk</td>
<td>0.6</td>
<td>2.21</td>
</tr>
<tr>
<td>Website</td>
<td>Manufacturer’s Website</td>
<td>0.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Text</td>
<td>Photography or PC magazine</td>
<td>0.28</td>
<td>2.5</td>
</tr>
<tr>
<td>Text (Website)</td>
<td>Consumer Reports</td>
<td>0.35</td>
<td>2.31</td>
</tr>
<tr>
<td>Website</td>
<td>CNET</td>
<td>0.25</td>
<td>2.5</td>
</tr>
<tr>
<td>Website</td>
<td>Online Site (See a below)</td>
<td>0.48</td>
<td>2.44</td>
</tr>
</tbody>
</table>

where (a) on the questionnaire “Online Site” was “Online Site such as DCRsource.com, DPre-view.com, Imaging-Resource.com, and Steves-digicam.com. “Fraction” is the fraction of the 40 subjects who used the indicated quality factor. In addition, the fraction of subjects that used either a friend or sales clerk was 0.9 and the fraction that used at least one of the Text or Website sources was 0.75.

Let us consider how the three data properties of processing cost, discrimination, and reliability affected the subjects’ search. Let us start with reliability. The subjects used an average of 4.2 sources suggesting the need to double-check the data from any one source. Also, subjects found the data from 3rd party sites to be more useful than 2nd party sites.

Now let us consider processing cost. Students searched an average of 9.8 hours over an average of 1.2 months to buy their camera. Search time ranged from 2 to 60 hours. DCRsource.com has over 60 camera review of 15 pages or more. If the subject read these reviews at 20 pages an hour he would take 45 hours. But, there are 6 sites with reviews and numerous articles and reviews in magazines and books. Even the subject who searched for 60 hours processed only a small fraction
of the available data, which as we pointed out is a miniscule fraction of what could be provided.

To reduce their processing costs, subjects generally select a small set of cameras using the criteria listed below, and then evaluate this small set much more carefully. In the second survey when asked, “Consumer search procedures vary widely in buying digital cameras. Many consumers first choose a small set of cameras that they evaluate closely to determine the final selection. How many cameras did you evaluate closely? (For example, evaluating closely might mean you examined the camera physically, read a review, took or looked at pictures - several minutes in each activity).” One subject responded with “1”; twenty-five subjects responded with “2 or 3”; thirteen subjects responded with “4 to 6”; and, one subject responded with “more than 6.”

Now let us consider the property of discrimination. In the market there are currently over 150 new digital camera models. How did consumers reduce this number to the number they listed above? In the continuation survey, subjects were asked to rank the following attributes in order that they applied them to their decision:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Importance</th>
<th>Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (Tiny, Small, Large)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Type (point and click, small with manual controls, Telephoto, prosumer, dSLR)</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Megapixel (2,3,4, 5 and so on)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Brand (Canon, Nikon, Sony and so on)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Special feature (Optical zoom, autofocus assist light, great video. Any special feature that camera must have such as external flash)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Budget (price must be less than budget)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Style (Must be a fashion statement)</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

where importance and order are the ordinal rankings of the averages. The inconsistencies can be attributed to allowing the subjects to list factors as ties. The top four were size, megapixel, budget, and brand.

There are a variety of ways students chose the small set that they closely evaluated. What is important to note is that specifying a size, megapixels, budget, and brand can define a small set. For example, a tiny Canon with 4 or 5 megapixels costing less than $350 gives you a small set.
The response to the question, “How did you judge the quality of the digital camera you purchased?” is shown in the table below:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Fraction</th>
<th>Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected most megapixels for budget as measure of quality</td>
<td>0.85</td>
<td>2.21</td>
</tr>
<tr>
<td>Took the advice of a roommate, friend, relative on quality of camera</td>
<td>0.53</td>
<td>2.14</td>
</tr>
<tr>
<td>Took the advice of a sales person on quality of camera</td>
<td>0.52</td>
<td>2.29</td>
</tr>
<tr>
<td>Choose a particular brand based on reputation, for example Canon or Nikon</td>
<td>0.8</td>
<td>2.38</td>
</tr>
<tr>
<td>Read review(s) of particular cameras either in magazine or online</td>
<td>0.63</td>
<td>2.6</td>
</tr>
<tr>
<td>Determined quality of pictures by looking at the LCD viewfinder pictures</td>
<td>0.4</td>
<td>2.1</td>
</tr>
<tr>
<td>Examined galleries of pictures and determined the quality of pictures yourself</td>
<td>0.38</td>
<td>2.47</td>
</tr>
</tbody>
</table>

Fraction and Usefulness are defined in the same way as in the first table in this section. Note that while only 63% read camera reviews, this data source was considered the most useful.

4 Need for Innovations in Consumer Selection Procedures

Consumers need better search procedures, not only because of product proliferation, but also because of the increasing value of adults’ time. In the stereotypical ’50s household, the husband brought home the paycheck while the wife stayed at home, applying her labor to household production procedures such as preparing meals and shopping. Female workforce participation has increased dramatically since then, with a consequent rise in the value of their time. Household production procedures have less labor input. Fewer meals are cooked from scratch, and there is less time to search for goods and services.

Not only do household members have less time to solve consumer selection problems, but the problem has also become more difficult with the advance of technology. With the shift from mass to niche production, consumers have many more alternatives to consider and with rapid technological change, consumers find that previous experience with products is less useful in creating decision rules to solve the consumer selection problem. The problem is less notable for products like cars, where an adult consumer has generally acquired enough knowledge through previous experience
to determine the type of car that best meets his needs. But in products like a digital camera, a consumer may not be able to determine the type of digital camera without knowledge acquisition. In the U.S., the problem is exacerbated by the decline in retail salespeople’s knowledge as retailers reduce incentives towards knowledge (such as commissions) and shift to hiring part-time workers to reduce fringe benefits.

The area where great improvements can be made is creating procedures to better educate consumers and to provide them tools for selecting digital cameras. Fifty-five percent of the subjects answered yes to the question, “Were you overwhelmed by the about of details you had to understand in order to make your decision?” We also gave the subjects a short quiz about digital cameras and found the average score was 6.7 out of 10 so even after doing their research to buy a digital camera, the subjects are not that knowledgeable. For digital cameras DCRource.com and DPRreview.com have simple noncompensatory decision aids to find the set of digital cameras with the list of clicked attributes. Imaging-Resource.com has a digital camera selection aid based on compensatory rules where the consumer indicates weights of importance on sliding scales of the various attributes created by MyProductAdvisor.com. In selecting their cameras only 9 out of 40 subjects used a digital camera selection program at an online site. They rated the average usefulness at 1.8, which is less than useful. We concluded that a digital camera selection program must educate the consumer as well as provide a decision structure. None of the digital camera selection codes that we listed educated the consumer as part of the selection process.

Better educated consumers are less likely to commit forecasting errors. With respect to student selection of digital cameras, the most obvious error in attributes needed for the intended use was the failure of 6 out of the 40 students in the second survey to select a camera with an auto focus assist light. This light improves the speed and accuracy of focusing in dim light, something students regularly encounter in their night life. Students also used two poor criteria for judging performance:
the quality of the picture in the LCD screen and the of megapixels. The number of pixels in the LCD screen is important in the displayed picture and its relationship to the quality of picture in memory varies among digital cameras. The quality of pictures in picture galleries is a much better indicator of quality. One student simply choose the camera with the most megapixels within his budget at an Overstock outlet on eBay. The relationship of quality to more megapixels across brands can not be inferred just be the number of megapixels.

5 Selection Code Development

Our digital camera selection code has three components: an education module, a module to select a small set of cameras capable of taking the desired type of pictures, and a module to select the preferred camera from this set.

The educational component was the most challenging to develop. To help consumers make better choices a fundamental question is how much data to incorporate into the educational component. Again, the greater the detail the greater the processing cost for a consumer to master the material. Because our subjects demonstrated little knowledge about digital cameras, our first code, developed in 2004, provided the user with explanations for less than half the detail considered by DPREview.com, the most technologically advanced site. Explanations of each incorporated feature were at least two levels deep: the first was a brief overview, and the other levels provided much greater detail. The code taught the consumer which features were needed for different types of shots. The module also gave them an estimate as to how long it would take them to learn how to use various features such as shutter control. It provided tests the user could perform to decide what size of camera best suited them and the details megapixel and sensors. There was an online questionnaire that when filled out gave the user a list of “essential” and “desirable” features for taking the user’s desired pictures. The education function consisted of over 40 html pages that test
subjects could not be mastered in an hour, but could master if given a week. The code can be found at http://www.eco.utexas.edu/Homepages/Faculty/Norman/000Cam.

We then refined our code with the goal of subject mastery of the first decision process in 20 minutes. We did so by integrating the education program with the decision structure. The new decision structure began with a decision whether to pick a small or large camera. Subjects were given the tradeoffs between the two groups: small cameras are easier to carry around, but lack the features and picture quality of large cameras. To clarify the difference between the two groups we provided pictures to illustrate why the external flash hotshoe of a large camera is necessary to take pictures of large groups in dimly lit large spaces. We also explained the concept of optical zoom noting that the large cameras have greater optical zoom, and explained why dSLRs are necessary for indoor sports shots.

If the user clicked on large camera the viewer was provided with a page of pros and cons to decide among a telephoto, a prosumer, or a dSLR digital camera. If they chose the dSLR option, we assumed had some camera knowledge and we provided them with a table of links to reviews of the dSLR cameras. If the subject selected telephoto, prosumer, or originally chose small camera, the next page educated the subject about digital camera attributes. We shall focus of the small camera page as the telephoto and prosumer pages are similar. To accomplish the 20 minutes goal, we aggregated the number of defined attributes for a small or tiny camera to ten features: “Best Camera List,”; auto focus assist light, video quality, manual controls, capture the moment, ease of use, camera size, lens, megapixels; and price. A cameras on a “Best Camera List” meant that at least one reviewer thought the camera was superior. For nine of the attributes we provided a one sentence explanation and a “More Info” button. For example, the short explanation of the auto focus assist light was “An auto focus assist light, afal, enables a camera to focus properly in dim light.” The “More Info” explanation is “An auto focus light is highly recommended for taking pictures
in low light conditions, such as those at parties for young adults. Without an auto focus assist light, your camera is likely to have difficulty focusing in such conditions. Remember if you want to take pictures of large groups in low light, you also need an external flash. While some small cameras have slave external flashes for mid sized groups, better external flashes are found on Large prosumer and dSLR. " The first sentence was in bold red letters for emphasis. The short explanation for the other attribute, camera size, was “Play DEMO video, a must see =>” in bold red letters. If the subject responded, she viewed a short video that demonstrated the difference between small and tiny cameras.

The ten attributes aimed to provide as much discrimination among alternatives as possible. For example, the attribute “Manual Controls” divided cameras into those that did and did not have aperture and shutter priority. The former generally have a complete set of controls, while the latter are point-and-click cameras. For subjects without much digital camera knowledge, this easily understand distinction provides reasonable discrimination capacity.

The next page is a set-selection-by-aspects decision rule, Norman et al (2004). There are so many new digital cameras on the marketplace that a user can specify the characteristics determined by the intended use such as size and features to obtain a much smaller set for detailed study. On the first six attributes we listed the user was given the choice of “Yes” or “Doesn’t Matter.” For the others the user had a small number of choices. For example, for price the user chose among “Price no more than $200, $300 , $400 , Doesn’t matter.” Below the attribute table we had a box listing the number of cameras with the selected criteria. Initially the number of small cameras was 129 and is reduced by each selection of a new criteria. If the number falls to 0 the user is recommended to relax some of the criteria. Because the code works quickly the user can play “what if” scenarios to determine tradeoffs. Once the user has a manageable list, she can click on a button at the bottom to obtain this list of cameras in a table giving their features.
The final page gives the user alternative approaches to selecting the final choice such as reading camera reviews, the alternative considered most useful in our survey. The user can decide how much time to spend depending on how much detail he wishes to consider. The reader wishing to examine the Oct 2005 version of this code can go to http://www.eco.utexas.edu/Homepages/Faculty/Norman/01Cam/final.html.

We chose this decision procedure over a code with a compensatory decision rule with sliding scales (for example, see http://www.myproductadvisor.com/mpa/camera/inputSummary.do) for each attribute where the value chosen on each sliding scale indicates the importance of that attribute. This approach assumes that users that have little knowledge about cameras have formed preferences over the attributes. Also, how the code weighs the sliding scales to obtain the outcome is not readily apparent to the user. Thus, to obtain a set of cameras with the attributes needed for a particular type of picture can be a difficult task.

6 Experiment

We devised an ANOVA experiment with the Duncan test to test whether our code was better at the task of determining a small set of digital cameras for a particular type of pictures, the first decision process, than (1) asking the advice of a digital camera sales clerk, (2) asking the advice of a digital camera owner, (3) having access to the internet, but not our code.

The subjects were asked to find three quality cameras for each of the following scenarios:

1. A soccer mom has a budget of $300 and wants a camera that fits in her medium sized purse to take pictures of her children in outdoor sports, flowers in her garden and small groups of people outdoors and indoors under artificial light. She wants a camera that will allow her to take the best pictures possible for her budget and she has the time to learn how to use all the features of her camera.
2. A student who has a budget of $550 wants a camera to take great pictures of birds outdoors both still and flying. Sometimes in the evening before sunset. The student also wants great pictures of UT football games from seats in the upper deck.

3. if female answer a and if male answer b

a. A female student with a budget of $300 wants a camera to fit in her small date purse to take pictures and small videos of small groups of friends at clubs on 6th street at night.

b. A male student with a budget of $300 wants a camera to fit in his shirt pocket without showing to take pictures and small videos of small groups of friends at clubs on 6th street at night.

For the experiment there were 52 subjects, evenly divided into four groups. Each had the following resources:

1. Students with our code. The experiment version of code to be found at http://www.eco.utexas.edu/Homepages/Faculty/Norman/00Cam. To avoid confusion it ended with the first decision process.

2. Students who had access to the Internet, but did not have access to our code

3. Students who owned a digital camera. Students who own digital cameras frequently do not know the model number of their own camera let alone others. In order to get these students to specify the brand and model number they were given pictures of the various cameras with the name and model number, but no additional data.

4. Salespeople in stores selling digital cameras. Students and the first author memorized each scenario, went to each store, and acted as consumers, orally requesting the sales clerk’s recommendation.
The first three groups were given one and a quarter hours to answer a quiz and finish their
task. Their incentives were a flat fee of $10 and chance to win an additional prize: $100 for best
performance, $50 for 2nd, or $20 for 3rd, and $10 for each of the three next best performers, and
$5 for each of the four next best performers after that. Each of the four groups had $220 in prize
money and an expected earnings of $27. Because we wanted to see how salespeople would respond
to their store incentives, we did not offer this group any additional incentive, nor did we give them
a time limit.

The subjects scored 1 point each for most of the correct attribute selected – a few attributes
required a scale. The scoring is shown in the following table:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>auto focus assist light</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>best video</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>manual controls</td>
<td>1</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>on “Best Camera List”</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>price less than budget</td>
<td>1</td>
<td>See b below</td>
<td>1</td>
</tr>
<tr>
<td>quick when prefocused</td>
<td>1</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>small size</td>
<td>1</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>stabilized lens</td>
<td>N/A</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>tiny size</td>
<td>N/A</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td>zoom</td>
<td>See b below</td>
<td>See c below</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Where a means 1 if less than budget, -1 or -2 if more than $200 or $1000 over budget, respectively
b means 0.5 if 2x, 1 if 3 x, 1.5 if 4-9x and 2 if 10x
c means 1 if zoom > 4x and 2 if zoom > 10x

The scores were normalized on a 0 - 10 scale. The ANOVA results for four groups, three scenarios,
and fifty-two subjects with nine observations each are:

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>62</td>
<td>1475.894863</td>
<td>23.804756</td>
<td>6.72</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Error Corrected</td>
<td>467</td>
<td>2911.619890</td>
<td>3.545000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Duncan test with an α of 0.05 grouped the performance of the 4 groups into three groups,
A, B, and C as follows:
<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>N</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8.7076</td>
<td>117</td>
<td>Our Code</td>
</tr>
<tr>
<td>B</td>
<td>7.1330</td>
<td>117</td>
<td>Sales Clerks</td>
</tr>
<tr>
<td>B</td>
<td>6.7818</td>
<td>117</td>
<td>Own Digital Camera</td>
</tr>
<tr>
<td>C</td>
<td>6.2770</td>
<td>117</td>
<td>Access to Web</td>
</tr>
</tbody>
</table>

Our code was statistically superior. The performance of the sales clerks was better than the subjects who owned digital cameras, but not statistically superior. The subjects who only had access to the Internet placed last.

We tested minor changes in the scoring and determined that small changes considered in the scoring resulted in a variation of F value from 6.72 to 7.41. The performance order of the four groups was the same, although in some cases the sales clerks performance became statistically superior to the subjects who owned digital cameras. Also, in an earlier experiment we found our code statistically superior to the sliding scale code created by myproductadvisor.com, see Norman et al (2005). Our assessment was that the sliding scale code did not provide the user with any education so subjects did not know what features were needed for each scenario. The codes at the other sites mentioned also did not have an education module, so were not considered worth testing.

What we found out is that salespeople at four of the stores selected, the stores of a major camera shop chain, have perverse incentives with respect to consumers. They have incentives to sell add ons and insurance and have financial incentives to push certain new cameras. Until the first author learned this, he could not understand some of their camera recommendations. They would consistently recommended not the best cameras that either cost much less than budget or were newly released. Students who own digital cameras rarely know much about digital cameras in general and searching on the Internet takes considerable time for surfers not familiar with the topic.

It required several years effort to create a code that was statistically better than sales people. The difficulty is how to educate subjects quickly to make good decisions.
7 Conclusion

It is important to point out the difference between our efforts and marketing. In codes developed for marketing purposes the aim is to sell the products of the seller not to educate the consumer about all the possibilities in the marketplace. Economists are interested in social welfare, hence the effort is towards all consumers. There are great improvements to be made in these codes. For example, a few students using our code in scenario 2 did not realize that they need a camera with a telephoto lens. A video emphasizing the point might be effective. An alternative approach would be for the user to simply input the types of pictures she wished to take and the code would recommend cameras for those conditions. Third party data providers are generally too small to do research in this area. Also, there are numerous markets in new technology or infrequent decisions where such codes could be useful. Developers need to seriously consider including an education module in creating such codes.

References


