Using Exact Sciences Modeling Tools to Understand Social Phenomena

Course #: 55772

Exercise #3: Riding the Saddle – Bass Diffusion model
Due: Wed May 23rd, 11:50 pm, on Moodle

General Instructions:

- Unless stated otherwise, submission is done individually. We rely on trust. You may discuss assignments verbally, but do not share solutions with other students.
- You may use examples from the Internet, but use them as an inspiration and make them your own.
- Your homework should be submitted through Moodle. Please zip your files to ex_6_First_last.zip (with your first and last name). The zip should include: 1) a PDF document (no .docx and no jpg) with your responses, explanations, insights etc. 2) Your Excel files with the estimations or the code files which you used for the optimization. Your code/Excel will not be tested, but we might use it as a reference in case we need clarifications. Please keep good coding standards, and document your code properly.
  You may use MatLab, Python, C/C++, or Java. If you want to use other programming language, please get our approval first.
- Please use proper language and correct grammar (Hebrew or English), explain clearly what you do, use graphs and charts if needed.
- No scanned handwritten works please.
- We respect the business etiquette: No late submission.

<u>Grading</u>
The homework grading will be based on the following parameters:

1. Correctness of the analytical response, clarity of presentation
2. Model compatibility: how does your model matches the description?
3. Insights quality: Try to find non-trivial insights.
4. Creativity
5. Visualization: Your insights should pop-out of the figures you choose.

   Tips for visualization:

   - Label each figure
   - Explain each figure in the text
   - Label each axes + what are the units?
   - Clean figures: Avoid unnecessary details in figures.

Task 1: The Saddle phenomenon – Extending the Bass model and parameter estimation

1. Please read the attached paper by Goldenberg, Libai and Muller 2002. Read pages 1-6, till the top of page 6 (until the header "A cellular automata model").
2. Now, look at the following extension to the Bass model:
   Assuming the market is composed of two segments – early market with a market potential of m_i, and main market with a market potential of m_m. Adopters communicate with potential adopters within their own segment, but also across segment (for simplicity, we assume that the early market adopters influence the main market, but not vice versa. Make sure you understand why this is a reasonable assumption). Denote diffusion parameters p_i q_i for the early market, p_m q_m for the main market, and q_{im} is the inter-segment influence, we can describe the diffusion process using a set of the following two equations:

$$\frac{dI(t)}{dt} = p_i\big(m_i - I(t)\big) + q_i \frac{I(t)}{m_i}\big(m_i - I(t)\big)$$

$$\frac{dM(t)}{dt} = p_m\big(m_m - M(t)\big) + q_m \frac{M(t)}{m_m}\big(m_m - M(t)\big) + q_{im} \frac{I(t)}{m_m}\big(m_m - M(t)\big)$$

   When the total $\frac{dN(t)}{dt} = \frac{dI(t)}{dt} + \frac{dM(t)}{dt}$

   I(t) and M(t) are the numbers of adopters of the early and main market, respectively.

   Make sure you understand the reasoning.
   Here is what we ask you to do:

   1. Please explain what is the purpose of the model, what are the assumptions – focus on what assumptions of the classic Bass model are relaxed here, what are the parameters and what are the variables.
   2. Estimate the diffusion parameters of consumer electronic products, based on the above saddle model. To do so, please
      a. Download the Excel estimation file '*ChasmEstimation.xlsx*'
      b. The file contains the data of seven consumer electronic product categories. Each worksheet contains the data of one of the products, with all the formulas needed for parameter estimation. The parameters are set to arbitrary initial values. For simplicity, we use p_i=0.

         Note that to make the solver/optimizer run faster and to get a more accurate results you can add constraints to the solver, for instance:

$$0 \le p_i, p_m, q_m, q_i, q_{im} \le 0.5$$

$$total\ number\ of\ people \le m$$

c. Use the Excel Add-in Solver, or Matlab lsqcurvefit to estimate the parameters (q_i, p_m, q_m and q_{im}). Create a table with the parameter values. Note in the table which product had a saddle, and measure its dimensions according to the definitions in the paper. Report your fit quality (e.g., R-square)
d. What are the managerial insights you can get from the numbers?