Mathematical Modelling for Economists
112, 08 11382

Colin Rowat
Room 220, J.G. Smith Building
c.rowat@bham.ac.uk
www.socscistaff.bham.ac.uk/rowat

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Mathematicians are like Frenchmen: whatever you say to them they translate into their own language, and forthwith it is something entirely different. *Johann Wolfgang von Goethe*

I have had my results for a long time: but I do not yet know how I am to arrive at them. (Carl Friedrich Gauss)

1 Goals

This module emphasises the process of modelling ways of thinking about economic problems. It aims to help you ‘think like economists’. This is accomplished by studying examples from the literature, chosen both by the lecturer and the students.

On completion of this module, you will:

1. better understand the role of modelling in economics;
2. be better able to pose economic problems formally;
3. understand some important examples of insight in the literature; and
4. see structural similarities between apparently dissimilar problems more easily.

This module is similar to the third year extended essay as it is built around research of your choice. Thus, the term will involve not only lectures from me, but reading on your own, and presentations from you about your research. This structure is designed to give you the opportunity to explore the questions that have drawn you to economics, and to encourage a habit of active engagement with learning and research. As the presentations will take place in groups, the module also seeks to improve your teamwork skills.

**WARNING:** this module begins easily, but will demand more of your time later in the term than other first year modules.
2 Lectures and office hours

2.1 Lectures
There are two one hour lectures session weekly from 28 September, both held in Strathcona LT4 (G13). Monday’s lectures are held from 1-2pm, Tuesday’s from 12 - 1pm. The week of 19 October will be treated as a reading week: thus, there will be no lectures on 19 and 20 October. Further, there will be no lecture on 26 October: instead, that lecture will take place on 27 October from 11am - noon (room TBA).

2.2 Office hours
During term time, my office hours are: 14:00 – 15:30 on Mondays and 10:30 - 12:00 on Tuesdays. In emergencies, I can arrange by e-mail to see you outside these hours.

3 Module outline
The following outline is provisional and may shift with time.

1. Introduction
   - example: how much does monopoly cost?
   - why economic modelling?
   - reading: Solow (1997), available here
   - background reading: von Neumann and Morgenstern (1953, Ch1, §1) for a early defense of mathematical modelling in economics
   - 4 lectures: weeks of 28 Sept, 5 Oct

2. Good questions and good theories
   - what is a good question?
   - what is a good theory?
   - reading: at least section VIII of Stigler (1950b); the full article and Stigler (1950a) give the full background
   - research tools
   - initial discussion of student projects; groups decided
   - 2 lectures: week of 12 Oct

3. Examples from the literature
   - recommended readings to come
   - 4 lectures: weeks of 27 Oct (see above for date changes), 2 Nov

4. Initial presentations: introducing a topic
   - time limit to come once enrolment known
• what do we need to know about this topic, in brief? What are the interesting questions? (A good guide might be one page articles in *The Economist*)

• 3 lectures: 9, 10, 16 Nov

5. Final presentations: modelling a question and deriving results

• time limit to come once enrolment known
• introduce a simple model, *prove something to us*, and present clear intuitions for your result
• easiest if you explain a result from existing work in the literature
• *not a* literature review
• it is OK for questions to change from the initial stage, and to ask for help

• 7 lectures: 17 Nov – 8 Dec

4 Assessment

Assessment is on the basis of presentations and submitted work, as shown in the table.

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Introducing a topic</td>
<td>15%</td>
<td>initial oral presentation</td>
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<tr>
<td></td>
<td>15%</td>
<td>1 page written submission [due noon 23/11/15]</td>
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<tr>
<td>Proving a result</td>
<td>30%</td>
<td>final oral presentation</td>
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<tr>
<td></td>
<td>30%</td>
<td>5 page written submission [due noon 09/12/15]</td>
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<tr>
<td>Class participation</td>
<td>10%</td>
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</tbody>
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Table 1: Assessment for Mathematical Modelling

At the ‘introducing a topic’ stage, you should:

1. think of an *economic phenomenon* that interests you (*not an analytical tool*);

2. introduce your topic, and convince us that it is an interesting one; and

3. tell us what you have learned about it by describing your understanding of the arguments presented in the academic articles (not websites) that you have read.

One approach I’ve occasionally recommended at this stage is to simultaneously pursue two questions initially, an ambitious one that you’d really like to work on, and a more standard one that you can fall back on if the first becomes too difficult. If I think that a topic is not sufficiently interesting to pursue further, I will clearly recommend that the group find something else to work on.¹

At the ‘proving a result’ stage, you should:

¹For example, variants of the Monty Hall problem have become so well known that they are not surprising; further, presentations of them are often formulaic, teaching the audience little. Material that you have learned at A-level is also typically not a good choice, unless you push beyond what you have already learned; otherwise, you risk not being interested in your topic, making it harder to interest your audience.
1. Briefly introduce your question;

2. Clearly explain a simple model for thinking about your problem;² and

3. Prove something to us about its properties. (Working with an empirical or experimental paper is not appropriate as they do not generally contain proofs. It would be appropriate to derive the properties of a particular econometric technique, and what the properties of that technique are.)

The most common mistakes made include:

1. At the initial stage, telling us that a paper is very interesting without showing us the information to form our own views.

2. At the final stage:

   (a) Trying to cover too much of a paper, or trying to present material that you do not thoroughly understand. The latter mistake can be avoided by preparing well in advance: understanding even a single result requires much more time than you expect. Hints that you’re on the wrong track include: narrating the author’s proof (“then they . . .”), cutting and pasting from their paper.

   (b) Telling us about the related literature, the history of the question or topic – rather than proving a result.

   (c) Expressing mathematical objects or operations verbally (e.g. telling us about a budget constraint, rather than writing down the budget constraint).

3. At either stage:

   (a) Telling the audience or reader about yourself or your group (e.g. “First I didn’t know what to do but my group didn’t either so decided would do something about sports but then . . . so I said . . . Then we read some papers but because they were hard we decided to do . . .”).

   (b) Not getting my views on the appropriateness of your proposed question or format (e.g. e-mailing me a few days before your presentation to show me what you’re working on for the first time).

   (c) Tiny footnotes to squeeze everything in to the page limit

   (d) Above all, ignoring these instructions.³ (My favourite: ignoring page limits. There is no way anyone should lose marks this way.)

Most of these instructions apply both to the oral and written work.

²A model is not just an equation, but a complete way of thinking about a problem. Typically, a model involves a number of equations.

³I initially wrote this when marking final submissions. They told me a lot about what the group did, and a problem’s history; they often discussed a result, and showed the relevant equations; most did not prove a result.
4.1 Oral presentations

When preparing a presentation always ask: would I learn from this, and enjoy it, if I were in the audience? You are advised to use visual aids; you may not use notes. Reciting or writing lines of algebra without explanation will not help us understand. Rehearse in advance. You may simplify the result that you prove in your final presentation: if there is unused notation, or the basic idea comes through with fewer stages, etc. it is often clearer to simplify. Each group member will receive the same mark for their group’s presentation; thus, there is no need for each to present; your goal should instead be to make the presentation as effective as possible.

4.2 Written submissions

As deadlines for the written work are after the presentations, feedback received during the presentation can be incorporated. All written work should be submitted online via Canvas in one of the following formats: .doc or .docx (MS Word), .rtf, or .odt (Open Document). The file should be named SID-initial, or SID-final, where SID is your student number.4 This is to be written and submitted individually, and will be assessed individually.

Submissions should be self-contained documents: do not assume that readers have seen your presentation, or know your articles; if you want to refer to a graph, you need to present it to us. The final submission should include:

1. an Abstract (one paragraph): mention the result to be proved, its source, and briefly state its context or importance;

2. The model, including definitions and assumptions: state these (introducing the mathematical notation), and comment briefly on each of interest. This should flow well: typically a block of equations followed by a block of assumptions, etc. does not flow well.

3. Main result: state the theorem to be proven, and its proof, arranged in a way that you understand it thoroughly;

4. Discussion (one or two paragraphs?): reflect on the proof (not the underlying problem), perhaps commenting and expanding on a key step or any other feature of interest.

This need not take five pages; in the past, some of the best final reports have only been two or three pages long. As much as possible, this should be laid out to ‘look like’ maths, rather than looking like narrative: definitions, theorems and proofs should be clearly set, for example.

When marking oral presentations, I recognise that those presenting earlier have had less time to prepare.

4.3 Class participation

The class participation mark will be – by necessity – largely based on ‘good citizenship’ in your groups – e.g. submitting names of group members, and topics on time. To the extent that I can get to know you individually, I will also base this on your individual contributions in the lectures.

4Please direct questions about Canvas submissions to the Undergraduate Office.
5 Reading material

Your interests will largely determine the relevant readings in this module. This will often include articles published in academic journals. In many cases, the articles will be held both in the library and electronically. Those available electronically can usually be found with Google’s specialist academic search engine, www.scholar.google.com. If trying to read published articles off-campus, go to universityofbirmingham.service-now.com, log-in, and search for ‘proxy’.5

Beyond this, you may find books on mathematical problem solving of interest. The person most commonly associated with this is George Pólya, whose best-known book, Pólya (1957), is available online. You may find the Tricki a useful website to browse through.

If I hand material out in class, I shall also post it on my website. Any important announcements that I might make during a lecture will also be posted there.6

References


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5The University has an IT Helpdesk: if you are having IT difficulties, including finding articles online, please seek help either from a classmate or from the University’s dedicated IT support.

6Thus, if you miss a lecture, please catch up by first speaking to a classmate.