Mathematical Modelling for Economists
112, 08 11382

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January 11, 2019

> 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*

> mathematical translation is itself a substantial contribution to theory. Mathematics has become the dominant language of the natural sciences not because it is quantitative — a common delusion — but primarily because it permits clear and rigorous reasoning about phenomena too complex to be handled in words. *Herbert Simon*

1 Goals

Economists, famously, build models — often on unrealistic assumptions. Why do we do this? Should we? This module addresses these questions by studying examples from the literature, chosen both by me and by you: you tell me what interests you, why you were drawn to economics; I will help you identify research on your interests; from them, you understand one theorem well enough to be able to prove it to the class.

The module therefore teaches economics as a way of thinking about problems, rather than a set of answers. It encourages you to actively explore economic research, rather than merely accepting what you are told. Much of your work this term will take place in groups, helping develop 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 16 January, each running from noon – 1pm. Wednesday's lecture is held in Watson's Lecture Theatre A

(G23), except on 27 February, which is in University House G12. Thursday's lecture is in Haworth 203. The week including 20–21 February will be treated as a reading week, with no lectures. Further, the lectures the previous week (13 and 14 February) are cancelled, and replaced by a two-hour lecture on Monday 11 February, from 13:00 - 15:00 in Law Lecture Theatre 1 (room 303).

2.2 Classes

Each student on this module is registered for one of the class groups in the table. These will be used primarily to make progress with the group projects: it is generally beneficial for group members to be spread across class groups.

class	usual	unusual
1	9-10am, JGSM-G22: 17 Jan, 31 Jan, 28 Feb, 14 Mar	n.a.
2	10-11am, EDUC-G39: 31 Jan, 28 Feb, 14 Mar	10-11am, JGSM-111: 17 Jan
3	11-12am, JGSM-G22: 17 Jan, 31 Jan, 28 Feb, 14 Mar	n.a.
4	2-3pm, UNIH-G06: 17 Jan, 31 Jan, 28 Feb, 14 Mar	n.a.
5	9-10am, JGSM-G22: 24 Jan, 7 Feb, 7 Mar, 21 Mar	n.a.
6	10-11am, JGSM-G22: 24 Jan, 7 Feb, 7 Mar, 21 Mar	n.a.
7	11-12am, JGSM-G22: 24 Jan, 7 Feb, 7 Mar, 21 Mar	n.a.
8	2-3pm, UNIH-G06: 24 Jan, 7 Feb, 7 Mar, 21 Mar	n.a.

2.3 Office hours

During term time, I have office hours on Wednesdays from 2:00 – 3:30pm and on Thursdays from 3:00 – 4:30pm. In emergencies, I can arrange by e-mail to see you outside these hours.

3 Module outline

1. Introduction
   - example: how much does monopoly cost?
   - why economic modelling?
   - reading: Solow (1997), available here
   - reading throughout the term: ch.1 of Friedman (1953), available here
   - background reading: von Neumann and Morgenstern (1953, Ch1, §1) for an early defence of mathematical modelling in economics; Simon (1978) for a later, broader (even prescient?) treatment
   - 4 lectures: weeks of 14, 21 Jan
2. Good questions and good theories
   - what is a good question?
   - what is a good theory?
   - reading: Stigler (1950, §VIII), Samuelson (2005, §2)
   - groups (7–8 members) formed

- 2 lectures: week of 28 Jan

3. Examples from the literature
   - reading: Rubinstein (2006)
   - 4 lectures: weeks of 4, 11 Feb

4. Initial presentations: interesting us in a topic
   - 7 min time limit
   - 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* — whose style guide is here)
   - 3 lectures: 27, 28 Feb, 6 Mar

5. Final presentations: prove a theorem
   - 16 min time limit
   - introduce a simple model, prove a theorem based on it, 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
   - 7 lectures: 7 Mar –

4 Assessment

Assessment is as shown in the table.

Item	Value	Notes
Introducing a topic	30%	initial group presentation [‘summative’]
	0%	1 page group written submission [‘formative’; due noon 13/03/19]
Prove the theorem	10%	final group presentation [‘summative’]
	60%	5 page individual written submission [‘summative’; due noon 01/04/19]

At the initial stage, you should:

1. think of an interesting *economic phenomenon* (not an *analytical tool*);
2. teach us something about it, aiming high: help us understand facts and arguments not just waffle and opinion. (Thus, don’t just report on what others have said.)

You *may* want to 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 tell you.[1]

At the ‘prove the theorem’ stage, you should:

[1]For 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. explain the model you are using;
2. state the theorem;
3. *prove* the theorem to us.

Common mistakes include:

1. presenting a paper that doesn't have a theorem (e.g. often, empirical or experimental papers; it *would* be appropriate to prove the properties of an econometric technique).
2. copying the structure of examples from the website.
3. focusing on you rather than the problem (e.g. "first I didn't know what to do but my group didn't either so decided we would do something about sports but then …so I said …Then we read some papers but because they were hard we decided to do …").
4. 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).
5. tiny footnotes to squeeze everything in to the page limit
6. ignoring these instructions.[2] (My favourite: ignoring page limits. There is no way anyone should lose marks this way.)
7. skipping classmates presentations (thus missing the feedback they get), ignoring feedback given on your presentations.
8. telling us things we already know (e.g. that GDP stands for gross domestic product, and is a measure of economic output; the assumptions are not realistic)
9. waffling vaguely (e.g. "it can be argued", "some say"): teach us something.
10. at the initial stage, *telling* us that something is interesting without *showing* us the information to form our own views.
11. at the 'prove the theorem' 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 (inc. figures).
    (b) telling us about the related literature, the history of the question or topic – rather than proving a result.

[2] I 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.

(c) expressing mathematical objects, assumptions or operations verbally (e.g. telling us about a budget constraint, rather than writing down the budget constraint).[3]

(d) presenting first order conditions as sufficient, using sloppy notation (e.g. mixing upper/lower case, ignoring subscripts).

4.1 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*. Standard advice on slides includes: once you've prepared a slide, cut the number of words on it in half — and then do it again; if you write something on the slides, say it during the presentation. Reciting or writing lines of algebra without explanation will *not* help us understand. Rehearse in advance as much as you would if you were acting in a play. 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.

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

4.2 Written submissions / problem sets

As deadlines for the written work are after the presentations, feedback received during the presentation should be incorporated. All written work should be submitted online via Canvas as a PDF file.[4] After uploading the file, check it to ensure that the maths displays properly. Each group should submit only one copy of the first submission; all group members will receive the same mark. The second submission 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, show 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 explain, not merely look mathsy: a block of equations followed by a block of assumptions, etc. typically does not explain.

3. The theorem to be proved

4. The proof, arranged in a way that you understand it thoroughly;

[3] A good combination is to express the object mathematically, but provide a verbal intuition or explanation.

[4] Please direct questions about Canvas submissions to the Undergraduate Office.

5. Discussion (one or two paragraphs?) *if* you have something interesting to say about the theorem, its proof, its significance.

The above should not be followed formulaically: when you have drafted your final submission, scrutinise it carefully to see whether it actually makes sense.

This need not take five pages; in the past, some of the best final reports have only been two or three pages long.

5 Reading material

Your interests will largely determine the relevant readings in this module. This should include articles published in academic journals. I usually first search with 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. Körner (1996) contains some good, creative examples of mathematical modelling. Let me know if you find the Tricki a useful website.

Material I hand out in class I will also post on my website. I will also post important announcements that I might make during a lecture there.[6]

References

Friedman, Milton (1953). *Essays in Positive Economics.* Chicago and London: University of Chicago Press. ISBN: 0-226-26403-3.

Körner, Thomas William (1996). *The pleasures of counting.* Cambridge University Press.

Pólya, George (1957). *How to solve it: a new aspect of mathematical method.* 2nd. Princeton University Press.

Rubinstein, Ariel (July 2006). "Dilemmas of An Economic Theorist". *Econometrica* 74.4, pp. 865–883.

Samuelson, Larry (Mar. 2005). "Economic Theory and Experimental Economics". *Journal of Economic Literature* 43.1, pp. 67–105.

Simon, Herbert A (1957). *Models of man: social and rational.* Wiley.

— (1978). "The uses of mathematics in the social sciences". *Mathematics and Computers in Simulation* 20.3, pp. 159–166.

Solow, Robert M. (Winter 1997). "How Did Economics Get That Way and What Way Did It Get?" *Daedalus* 126.1, pp. 39–58.

Stigler, George J. (Oct. 1950). "The Development of Utility Theory. II". *Journal of Political Economy* 58.5, pp. 373–396.

von Neumann, John and Oskar Morgenstern (1953). *Theory of Games and Economic Behavior.* 2nd. Princeton University Press.

[5] If you are having IT difficulties, including finding articles online, please first seek help either from a classmate or from the University's dedicated IT support.

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