Introductory Mathematics for Economists with Matlab

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Contents

Preface

This is a work-in-progress course website for Mathematics for Economists, an upper-level undergraduate economics course offered by Piruz Saboury and Fan Wang. The course covers a subset of topics from *Mathematics for Economists* (Simon and Blume, 1994). Applications focus on households' optimal borrowing and savings problems and firms' optimal inputs problems. Matlab is used throughout.

> **bookdown site** and **bookdown pdf**.

Materials are written in matlab (The MathWorks Inc, 2019) livescript files and shown as HTML files. For HTML files, click on the links below. The livescript files can be downloaded and modified inside matlab. Files are from the Math4Econ repository.

Please contact Piruz Saboury or Fan Wang for issues or problems.

From other repositories: for research support toolboxes, see matlab toolbox, r toolbox, and python toolbox; for code examples, see matlab examples, stata examples, r examples, python examples, and latex examples; for packaging example, see pkgtestr for developing r packages; for teaching, also see intro statistics for undergraduates.

The site is built using Bookdown (Xie, 2020).

Chapter 1

Notations and Functions

1.1 Local and Global Maximum

Go back to Introductory Mathematics for Economists with Matlab (bookdown site). Also see M4Econ and MEconTools.

Definition

- **Global Maximum:** Function f defined on domain X has a **global** maximum at $x^* \in X$ if for all $x \in X$, $f(x) \leq f(x^*)$
- **Local Maximum:** Function f defined on domain X has a **local** maximum at $x^* \in X$ if there exists an open interval (a, b), such that $x^* \in (a, b)$, and for all $x \in (a, b)$, $f(x) \leq f(x^*)$

It should be noted that Many functions do not have maximum. We have utility function, production function, and budget constraints (and other functions) in economic models. When households make utility maximizing choices, they pick the bundle of goods that gives them the highest level of utility. Many of the production and utility functions that we use do not have local or global maximum. For example, a Cobb-Douglas production function will produce ever higher output with more labor and capital input. And a log utility function will give higher utility with higher levels of consumption. When we combine preference and budget together, we could think about the optimal bundle of choices that achieves the highest level of utility given fixed budget in a household maximization problem.

Quadratic Utility

A special utility function, quadratic utility, however, does have a single maximum.

$$U(x) = x - \alpha \cdot x^2$$

We can write down the equation using matlab's symbolic package

```
% Parameter
a = 0.20;
% Create symbolic equation in matlab
syms x
f(x) = x - a*x^2
```

f(x) =

$$x - \frac{x^2}{5}$$

Matlab Analytical Global Maximum for Quadratic Utility

Matlab can find the x value that maximizes the function by using the following functions from its symbolic toolbox:

- **diff** function: taking the derivative of f with respect to x

- **solve** function: finding where the derivative crosses 0

```
% Solve
maxofx = solve(diff(f, x), x)
```

maxofx =

$$\frac{5}{2}$$

```
% Convert symbolic to double precision
maxofx = double(maxofx)
```

```
maxofx = 2.5000
```

We have found the global maximum for the function.

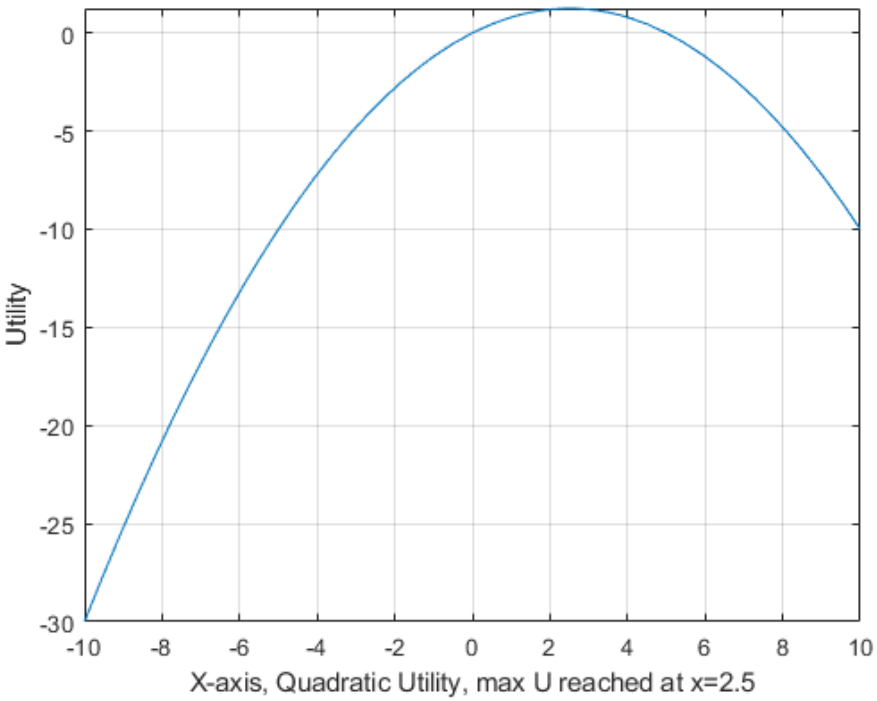
A household will try to consume exactly this optimal amount of good if their budget allows.

With quadratic utility over one good, even if the household can afford to buy more goods than the maximum amount, they will not.

This could be used to approximate consumption of say how much rice a consumer wants for example.

Matlab Graphical Solution

```
% Graph equation
close all;
figure();
% Create minimum x and maximum x point where to draw the graph
x_lower_bd = min(-10, maxofx-abs(maxofx)/2);
x_upper_bd = max(10, maxofx+abs(maxofx)/2);
% Draw the function
fplot(f, [x_lower_bd, x_upper_bd]);
% Label
xlabel(['X-axis, Quadratic Utility, max U reached at x=', num2str(maxofx)])
ylabel(['Utility'])
grid on
```



Appendix A

Index and Code Links

A.1 Notations and Functions links

1. Local and Global Maximum: **mlx** | **m** | **pdf** | **html**
   - local and global maximum.
   - **m**: *syms + solve() + diff() + double() + double(solve(diff(f,x),x)), fplot(f,[x_low, x_high])*

Bibliography

Simon, C. P. and Blume, L. (1994). *Mathematics for Economists*. W. W. Norton & Company, New York City, New York, 2nd edition. ISBN 978-0393117523.

The MathWorks Inc (2019). *MATLAB*. Matlab package version 2019b.

Xie, Y. (2020). *bookdown: Authoring Books and Technical Documents with R Markdown*. R package version 0.18.