An Intro and a Quick Look at the Literature:

- According to Naumenko and Moosavian (2016), the spatial organization of visual models enables the learner to process the elements as a whole at once (Larkin and Simon, 1987).
- Additionally, they state that “the aesthetics of visuals play a role in learning as well. Embellished learning materials aid by attracting attention and reinforcing new synaptic connections” (Mangunrub, 2005).
- According to Zhang (2016), “traditional and conventional approaches to teaching economics have not been friendly to students with kinesthetic preferences.” By using the tools introduced in the present paper, economics students with strong kinesthetic preferences can also get a chance to rely on their learning preference.
- Moreover, as Nilson (2007) mentions, the visual argument theory hypothesizes that visuals make material more memorable, by conveying information more efficiently than any other tool, and as a result, they require less working memory and fewer cognitive transformations than other forms of sharing information.
- Moosavian (2016) states that “there is enormous potential with visualization to improve the quality of teaching and learning in economics, which has not yet been fully employed to resolve some of the issues with the teaching of economics.” The present paper is indeed an attempt to take advantage of a three-dimensional visualization method to resolve one of these issues that has to do with understanding the nature and properties of utility and production functions.

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Abstract:

- Utility and production functions are two major building blocks of economics as a discipline.
- Teaching and learning the geometric and mathematical properties of utility and production functions (including, but not limited to, the concavity of the functions, convexity of their level curves, homotheticity, and homogeneity) have always been difficult in the classroom for instructors and students, while effectively teaching and completely learning these properties are of crucial importance for economics students to thrive academically and professionally in the discipline.
- As introduced and proposed by Zeytoon Nejad Moosavian (2017), “a novel, innovative way to teach these functions is to use the “materialized demonstrations” of utility and production functions, enabling students to actually “observe” what instructors usually try to describe verbally or at best graphically.
- As he explains, “this way, students can actually “see” and even “touch” the functions, and get a hands-on experience with utility and production functions. These innovative pedagogical tools can highly enhance the quality of teaching and level of learning.”
- The present paper builds on Zeytoon Nejad Moosavian (2017) to introduce an innovative way to teach the mentioned properties of these functions with a special emphasis on homogeneity and homotheticity. Thereby, economics students can use even the sense of touch in learning such a highly theoretical science, i.e., economics. Advantages and applications of this approach are discussed from a pedagogical point of view in the paper. By using these tools, economics students get a chance to “see” and “touch” a set of actual, colorfully-designed, 3D-printed prototypes and models of multiple essential utility, and production functions that have the capability to illustrate delicate geometric subtleties and desired mathematical properties of utility and production functions.

Key Words: Homotheticity, Homogeneity, 3D Utility Functions, 3D Production Functions, 3D Printed Prototypes, Teaching of Economics, Pedagogy

JEL Classification: A10, A22, A23, C60

Prototypes for Three Main Types of Preferences:

- Perfect Complements, Relative Substitutes, Perfect Substitutes

Homogeneity:

- Homogeneous functions have the property that \( f(\lambda x, \lambda y) = \lambda^k f(x, y) \) for \( \lambda > 0 \) and for some \( k \), which is said to be homogenous of degree \( k \), for short HODK.
- The mathematical notion of “homogeneity” is primarily associated with the economic notion of “return to scale.” In economics, when a production function is HODK, if \( k > 1 \), it is said that the function exhibits increasing returns to scale, or for short IRTS. If \( k < 1 \), then it is said that the function exhibits decreasing returns to scale (DRTS).
- When \( k = 1 \), it is said that the function exhibits constant return to scale (CRTS), which is a popular theoretical assumption in many economic theories and applications, such as production theory, economic growth, and growth accounting, primarily because of the intuitive predictions that it makes, which are close to real-world economic phenomena. Homogeneity has also interesting applications in consumer theory. Homogeneity is a cardinal property. Employing homogeneity has also interesting applications in regional economics, economics of finance, and a host of other fields.

Homotheticity:

- Homothetic functions have the property that \( f(\lambda x, \lambda y) = \lambda^k f(x, y) \) for \( \lambda > 0 \).
- A homothetic function is a monotonic transformation of a homogenous function.
- A weaker condition than homotheticity.
- More important for consumer theory and utility functions.
- Economic applications include Modeling MRS, MRTS, etc.
- Non-example: Linear-Linear utility functions.
- Non-example: Quasi-linear utility functions.

References:


An example of a non-homogenous function (Stone-Geary function on the left) and an example of an non-homothetic function (Quasi-linear function on the right)

Three examples of Cobb-Douglas production functions, which are homogenous of different degrees, being less than one, one, and greater than one, from left to right, respectively.

A visual summarizing the characteristics of homogeneity and homotheticity, and illustrating their relationships, connections, distinctions, similarities, examples, etc.