International Review of Economics Education 16 (2014) 111–121

Contents lists available at ScienceDirect

International Review of Economics Education

journal homepage: www.elsevier.com/locate/iree

Students' overreliance on linearity in economic thinking: An exploratory study at the tertiary level

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ARTICLE INFO

Article history:
Received 26 October 2013
Received in revised form 18 April 2014
Accepted 27 April 2014
Available online 22 May 2014

JEL classification:
A20
A22

Keywords:
Learning macroeconomics
Learning microeconomics
Non-linearity
Overreliance on linearity
Undergraduate students

ABSTRACT

In mathematics education, a vast amount of research has shown that students tend to rely on linearity in situations that are not linear at all. Several researchers in economics and economics education acknowledge people's overreliance on linearity as a potential source of misperception of economic phenomena, but within these fields this tendency has never been studied empirically in a systematic way. This paper is a first attempt to fill this gap in the research literature. The paper consists of two main parts. First, we provide an overview of instances of, and comments on, people's overreliance on linearity in the economics (education) literature. Second, we present an empirical study with business economics students who were confronted with correct and incorrect linear statements about micro- and macroeconomic situations. Our results show that even tertiary level students over-rely on linearity when analyzing such statements. We also find that this phenomenon is affected by the economic domain and by the way statements are formulated.

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http://dx.doi.org/10.1016/j.iree.2014.04.004
1477-3880/

1. Introduction

Linear functions are a powerful tool for grasping real-life situations, even if these situations are only approximately linear. For that reason, one major goal of mathematics education at all levels and for all students is to obtain both procedural and conceptual understanding of linearity in its various forms and applications. However, the educational attention that is paid to linearity on numerous occasions in students' school careers, along with the intrinsic simplicity and intuitive nature of the linear model, has a serious drawback. It may lead to a persistent tendency in some students *and* adults to see and apply linearity everywhere, even in situations that are not linear at all. A famous historical example of this tendency can be found in Plato's dialog Meno where Meno's pupil-slave, when asked by Socrates to double the area of a given square, spontaneously doubles the sides of that square.

Over the last two decades the tendency to over-rely on linearity has been systematically studied with students when solving mathematical problems (for an overview of this research, see Van Dooren et al., 2008; Van Dooren and Greer, 2010). For example, Cramer et al. (1993) confronted 33 pre-service elementary school teachers with the following problem "*Sue and Julie were running equally fast around a track. Sue started first. When she had run 9 laps, Julie had run 3 laps. When Julie completed 15 laps, how many laps had Sue run?*" Thirty-two student teachers solved this problem by setting up and solving a proportion: $9/3 = x/15$; $3x = 135$; $x = 45$ instead of using the additive structure in the problem (i.e., Sue always has run six rounds more than Julie). Another example was documented by Van Dooren et al. (2003): many upper secondary school students respond proportionally ($2 \times 1/6 = 2/6$) to a probabilistic problem such as "*The probability of getting a six in one roll with a die is 1/6. What is the probability of getting at least one six in two rolls?*" – an erroneous reasoning process that can be easily unmasked because, following this reasoning, the probability of getting a six would become larger than 1 after more than six die rolls.[4] Students' overreliance on linear models has already been studied extensively in a variety of mathematical domains (e.g., elementary arithmetic, algebra, (pre) calculus, probability, and geometry) and at different educational levels, from primary school pupils (Van Dooren et al., 2005) to university students (Esteley et al., 2010). Recently, it was shown that students in science education also sometimes use linear reasoning as a default strategy, even after instructions on the relevant scientific contents (De Bock et al., 2011).

The economics (education) literature too contains some illustrations of students' overreliance on linearity, some of them leading to the misperception of the described economic phenomena. However, in the domains of economics and economics education this tendency has not yet been empirically analyzed in a systematic way. The present article contributes to filling this gap in the literature. The article consists of two main parts. In the first part, we provide the results of a systematic literature search concerning people's overreliance on linearity as discussed in the economics (education) literature. In the second and central part, we present an empirical study of this phenomenon in which business economics students were confronted with correct and incorrect linear statements about micro- and macroeconomic situations. However, to give the reader some background to our methodological approach, we start with a brief overview of some relevant results of research into students' overreliance on linearity in mathematics, more particularly in the field of geometry (for more details, we refer to De Bock et al., 2007).

2. Students' overreliance on linearity in geometry

The most extensively researched case in geometry relates to students' overreliance on linearity in problems about the effect of an enlargement or reduction of a plane figure or solid on its area and/or volume. The previously mentioned historical example of the duplication of a

[4] The correct (non-linear) solution can be found as follows: The probability of no six in one die roll is 5/6, thus the probability of no six in two rolls is $(5/6)^2$ and thus the probability of at least one six in two rolls is $1-(5/6)^2 \approx .3056$.