# Variable Elasticity of Substitution and Economic Growth: Theory and Evidence*

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**Summary.** We construct a one-sector growth model where the technology is described by a Variable Elasticity of Substitution (VES) production function. This framework allows the elasticity of factor substitution to interact with the level of economic development. First, we show that the model can exhibit unbounded endogenous growth despite the absence of exogenous technical change and the presence of non-reproducible factors. Second, we provide some empirical estimates of the elasticity of substitution, using a panel of 82 countries over a 28-year period, which admit the possibility of a VES aggregate production function with an elasticity of substitution that is greater than one and consequently of unbounded endogenous growth.

**Key words:** Elasticity of Substitution, Endogenous Growth, VES Production Functions

**JEL Classification:** O42

## 1 Introduction

The elasticity of factor substitution plays a crucial role in the theory of economic growth. Among others, it is one of the determinants of the level of economic growth; see, for example, de La Grandville [4] and Klump and de La Grandville [14]. It affects the speed of convergence towards the balanced growth path; see Klump and Preissler [15]. It can alter the behavior of the savings rate during the transition; see Smetters [31]. It influences the aggregate distribution of income; the seminal work on this topic is Hicks [9]. Finally, it may itself be a source of unbounded growth; see Solow [143] and Palivos and Karagiannis [26].

Most papers of economic growth that attempt to provide some quantitative properties of growth models rely on the Cobb-Douglas specification of the production

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function, which, as it is well known, describes a process with an elasticity of factor substitution equal to one. Recently, several papers in the literature have investigated both theoretically and empirically the role played by the Constant Elasticity of Substitution (CES) production function, which allows the elasticity to take constant values that are either greater or lower than one. Examples include, among others, Klump and de La Grandville [14], Klump and Preissler [15], Miyagiwa and Papageorgiou [22], Duffy et al. [7] and Masanjala and Papageorgiou [20].

This paper extends this literature a step further by analyzing the role of a variable elasticity of substitution (VES) within a standard Solow-Swan growth model. Whereas the CES production function restricts the elasticity of substitution to be constant along an isoquant, this paper employs a specification, first introduced by Revankar [27], which allows the elasticity of substitution to interact with the level of economic development.

More specifically, a change in the economy's per capita capital affects the elasticity of substitution between capital and labor. This change feeds back into the economy influencing capital accumulation and output. It is shown that the model can exhibit unbounded endogenous growth despite the absence of exogenous technical change and the presence of non-reproducible factors, e.g., labor. Moreover, the paper uses a panel of 82 countries over a 28-year period to estimate an aggregate production function with variable elasticity of substitution. The estimation results provide first evidence in favor of a VES production function. In addition, the estimated elasticity of substitution in the sample is greater than one, which provides empirical support to the aforementioned theoretical result regarding unbounded endogenous growth.

The remainder of the paper is organized as follows. Section 2 analyzes the properties of Revankar's VES production function. Section 3 introduces this production function in an otherwise standard Solow-Swan model and derives necessary and sufficient conditions for unbounded endogenous growth. Section 4 offers a short review of the previous studies that have estimated VES functions. Section 5 discusses the data, the estimation techniques and the empirical results. Finally, Section 6 concludes the paper.

## 2 A VES Production Function

### 2.1 The Revankar VES Production Function

We use standard notation to denote a general production technology as $Y = F(K,L)$, where $Y$, $K$, and $L$ stand for output, capital and labor, respectively. Following Revankar [27], we consider the following specification:[4]

$$Y = AK^{a\nu}\left[L + baK\right]^{(1-a)\nu}. \tag{1}$$

We mostly assume that the production function exhibits constant returns to scale, i.e., $\nu = 1$. This production function can be written in intensive form, $y = f(k)$ where $y \equiv Y/L$ and $k \equiv K/L$, as

[4] A very similar VES specification was developed by Sato and Hoffman [30].