



# A structural theory of increasing returns<sup>☆</sup>



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## ABSTRACT

The long-standing interest in increasing returns stems from the attempt to identify causal relationships internal to the production system that would provide adequate explanations for the improvement of technical practice and production organization. What is missing both in classical and modern literature is an explicit discussion of (i) whether a general causal principle may be identified behind Smith's classical trio of advantages, and (ii) whether those advantages may be realized independently of specific conditions of the behavioural or institutional type. This paper addresses those issues by outlining a structural theory of increasing returns based on Babbage's law of multiples. The paper explores the implications of the law of multiples for decomposition or integration of production units and outlines the distinction between enabling conditions for increasing returns and their realization. The argument paves the way for the design and implementation of increasing returns policies, which are discussed in the concluding section.

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## 1. Introduction

Increasing returns are a vexed issue in economic analysis. Interest in this phenomenon stems from the age-old attempt to identify causal relationships *internal* to the production system that would provide adequate explanations for the improvement of technical practice and production

organization. Differently from technical progress, increasing returns can never be explained by the operation of purely exogenous conditions and causes: they are inherent to the dynamic potential of any given economic system provided certain conditions are satisfied. Features that keep increasing returns apart from technical progress as such are: (i) the role of enabling conditions independent of behavioural or institutional assumptions; (ii) the role of behavioural and/or institutional conditions that may or may not be satisfied in the context under consideration; (iii) *lack* of cumulative causation for realized increasing returns, due to the distinction between enabling conditions and the behavioural or institutional conditions making increasing returns an actual feature of technology and organization: for example, agents' behaviour may interrupt a trajectory of realized increasing returns, and thus interrupt a cumulative causation process, even if no change has taken place at the level of enabling conditions. Increasing

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returns are thus inherently dual: on the one hand, certain enabling conditions must be satisfied for increasing returns to be *feasible*, on the other hand, enabling conditions are not sufficient for increasing returns to be *achieved*. Economic theorists have seldom acknowledged this dual character of increasing returns. This is already apparent in Adam Smith's classical analysis of increasing returns in the *Wealth of Nations*: there increasing returns are explained by the operation of a trigger (the increasing extent of the market) that works itself out via division of labour *but through a plurality of causal mechanisms* (from increasing human dexterity to reduction of idle times and increasing likelihood of mechanical inventions). It is worth to recall Smith's 'advantages', as they have often reappeared, jointly or in isolation, in most subsequent treatments of increasing returns:

This great increase of the quantity of work which, in consequence of the division of labour, the same number of people are capable of performing, is owing to three different circumstances; first to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and lastly, to the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many (Smith, 1976 [1776], p. 17).

What is missing both in classical and modern literature is an explicit discussion of whether a general causal principle may be identified behind Smith's advantages, and of whether those advantages may be realized independently of specific conditions of the behavioural or institutional type.

This paper addresses the two above issues by outlining the fundamentals of a structural theory of increasing returns. The organization of the paper is as follows. Section 2 discusses Adam Smith's advantages in the light of Charles Babbage's 'fourth advantage' (a proportionality condition). This section argues that Babbage's analysis provides the cue to the identification of a fundamental causal principle behind the full range of Smith's advantages (Babbage's law of multiples). Section 3 explores the implications of the law of multiples for the decomposition and the integration of production units. Section 4 addresses the distinction between enabling conditions for increasing returns and their realization. This section argues that the law of multiples introduces a specific relationship between the scale of the production process and the set of technical practices that are feasible for any given scale (*scale-technology expansion*). The section also argues that activating increasing returns presupposes the proportionality condition expressed by the law of multiples, but also that such a condition is compatible with a variety of technological and organizational arrangements. The plurality of arrangements compatible with the law of multiples for any given scale of the production process highlights the role of behavioural patterns and institutions in determining the specific features of any historically given trajectory of increasing returns. It also highlights the central role of policy decisions (by public or private bodies) in turning increasing returns from a possibility grounded in

existing technology and organization into an accomplished sequence of technical arrangements. This approach paves the way for the design and implementation of *increasing returns policies*, which will be briefly discussed in the concluding section of the paper.

## 2. Smith's advantages and the law of multiples: a unifying framework

As noted in the Introduction, the building blocks of a structural theory of increasing returns are Smith's propositions on the relationship between 'extent of the market' and division of labour and Babbage's law of multiples. In some of the best known passages of the *Wealth of Nations*, Smith argues that '[t]he greatest improvement in the productive powers of labour, and the greater part of the skill, dexterity and judgement with which it is anywhere directed, or applied, seem to have been the effect of the division of labour' (Smith, 1976 [1776], p. 13), and that '[a]s it is the power of exchanging that gives occasion to the division of labour, so the extent of this division must always be limited by the extent of that power, or, in other words, by the extent of the market' (Smith, 1976 [1776], p. 31). As noted above, Smith mentions three 'different circumstances' as giving rise to this increase in the productive powers of labour: increase of dexterity, saving of time, and invention of machines (see Section 1). *Prima facie*, only the saving of time is directly associated with the rearrangement of the internal structure of the production process, and it does not presuppose further conditions concerning a change in the set of available and known technical practices (learning and invention). However, Smith's argument can be and has been extended so as to cover cases in which previously unknown technical practices can be learned or invented through exploration of the new problem space generated by the division of labour and the specialization of workers in specific tasks. In particular, Nathan Rosenberg has called attention to the problem-solving character of learning and innovation. In the case of learning, this can be seen in the way in which 'increasing skill in production' is developed through involvement in productive activity 'after the product has been designed' (*learning by doing*) (Rosenberg, 1982, p. 121), or in the way in which better understanding of the 'minutiae of the productive sequence' are obtained through the utilization of intermediate goods (generally machines) whose performance results from interaction between parts whose outcome 'cannot be easily predicted' (*learning by using*) (Rosenberg, 1982, p. 122). In the case of invention, its problem-solving character has been emphasized, especially in view of the fact that 'inventive activity is [...] best described as a gradual process of accretion, a cumulation of minor improvements, modifications, and economies, a sequence of events where, in general, continuities are much more important than discontinuities' (Rosenberg, 1972, p. 7). Here, the discovery of technical imbalances between components of a production process *in operation* is a critical factor in the search for new technological and organizational solutions: '[c]omplex technologies create internal compulsions and pressures

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