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Infrastructural change and secular economic development

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Abstract

Long-term economic development is determined by changes to the infrastructure, especially material and non-material infrastructural networks that link agents in different locations. The infrastructure consists of the slowly changing, collective arena that supports production, exchange, and consumption, such as the built environment, transport networks, and institutions. In the short run the infrastructure can be regarded as fixed. Changes to the infrastructure are under normal conditions small enough to be disregarded by producers and consumers. With the creation of a *critical link of a network*, there will however be a revolutionary restructuring of the arena. Critical links are here defined as additions to infrastructural networks that create opportunities for new information and transport flows between previously unconnected regions. Such a revolutionary restructuring of infrastructural networks has been called a logistical revolution. Certain institutional pre-conditions are necessary for a logistical revolution, while the creation of a critical link is both a necessary and a sufficient condition. This paper discusses the three logistical revolutions that occurred in the 13th century, around 1600, and in the 19th century, which each had crucial similarities with the current "information revolution."
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1. Introduction

The games of both markets and politics take place on an arena. The arena facilitates certain types of actions and decisions, while making others more difficult. The possibility to *predict* what will occur in markets and political decision-making depends on our ability to identify long-term changes to the arena.

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What matters in the long run are the slowly changing factors that have collective impacts on individuals and firms. We refer to these slowly changing, collective, factors as the infrastructure of a society. The infrastructure does not only comprise roads, railways, and other durable physical assets, but also the soft (non-material) infrastructure of legal systems, common values, and shared knowledge.

While this definition of the infrastructure may create the impression that it includes much of what is usually seen as 'exogenous' to the economic system, such an impression is mistaken. The infrastructure is *both* collective *and* durable in relation to the space and time period of the economic phenomenon that is being studied. For example, if the space–time combination of interest is the US economy in the 1970s, then the relevant infrastructure does not include more rapidly changing collective phenomena such as legislated budget expenditures, trade fairs, fashions or news, nor does it include more durable phenomena that only apply to a subset of the collective, such as firm-level institutions and private housing. What is included in the relevant infrastructure is the set of inclusive, longer-term entities such as the legal system, the voting system, the English language and the road network.

Economic development always takes place on an arena of hard and soft infrastructures. The soft infrastructure is made up of generally accessible knowledge (e.g., a shared spoken language and writing system, technological know-how, and organization practices), political and legal systems, and informal rules of behavior. The hard, physical, infrastructure mainly consists of the built environment, and transport and communication networks, which link producers and consumers in different locations to one another.

In economic development analyses, it has become conventional to treat the infrastructure as a constant factor for the relevant forecasting or planning period. This treatment seems self-evident to a short-term empirical economist, in the same way that an actor considers the theatre and its stage to be a constant, unchanging, environment. And such an arena perspective is appropriate for a five-year or ten-year economic forecasting and planning period. In long-term contexts, however, infrastructural changes become decisive and must be included in any meaningful analysis. The cumulative growth (or decay) of the infrastructure in the course of a century is substantial enough to completely transform the conditions for production and exchange.

2. A simple model of network expansion

The unifying theory that underlies this paper sees economic interaction between two nodes i and j (e.g. cities or regions) as a function of node-specific prices of goods, transport costs (this subsumes telecommunications costs when applied to the fourth logistical revolution) and transaction costs. Transport costs depend on the transport infrastructure, where an investment in a critical link causes a phase transition to occur which creates a larger integrated transport network. Transaction costs depend on networks of institutions; and the corresponding phase transition refers to the institutional integration of nodes which previously had little or no economic interaction. Economic agents may either treat the node-specific price of a tradable good as given *or* as subject to price-reducing process innovation. Formally, we may represent the change of the interaction volume (x_{ij}) over time (t) as $\mathrm{d}_{ij}/\mathrm{d}t$, where

$$\mathrm{d}x_{ij}/\mathrm{d}t > 0 \text{ iff } p_j(x) - p_i(x) > \varphi_{ij}(x) + \tau_{ij}(x); \tag{1}$$

$p_j(x)$ price (p) in node j as a function of a tradable set of goods (x)
$p_i(x)$ price (p) in node i as a function of a tradable set of goods (x)
$\varphi_{ij}(x)$ transport cost between nodes i and j as a function of a tradable set of goods (x)
$\tau_{ij}(x)$ transaction cost between i and j as a function of a tradable set of goods (x)