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Effects of Poor Transportation on Lean Production and Industrial Clustering: Evidence from the Indian Auto Industry

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Summary. — Conventional wisdom suggests that poor transportation systems adversely affect industrial competitiveness by raising the unit cost of freight. This study finds that freight is neither the only nor the most significant cost that poor transportation creates for auto firms in India. Poor transportation also raises the damages incurred in transit, total inventories, and ordering and overhead costs. Worse, it creates external diseconomies by introducing inefficiencies and unreliability in the supply chain, making it difficult for assemblers to implement lean production. These external diseconomies—rather than excessive freight prices or other direct costs—may be the more debilitating impact of poor transportation infrastructure on industrial performance. In India, transportation constraints and the imperatives of lean production are driving assemblers to create auto clusters. © 2001 Elsevier Science Ltd. All rights reserved.

Key words — transportation, infrastructure, industrial performance, industrial districts, lean production, automobile industry, India

1. INTRODUCTION

Industrial firms in developing countries have to contend with highly ineffective freight transportation systems. The physical infrastructure—the ports, airports, and road and rail networks—is capacity constrained and poorly maintained, and the freight services provided by private and public sector operators tend to be limited in range, poor in quality, and often technologically obsolete. Consequently, industrial firms in these countries operate under a handicap relative to their competitors in advanced industrialized countries. But, neither the extent of this handicap nor the mechanisms through which inadequate infrastructure harms competitiveness are well understood (see, e.g., Diamond & Spence, 1989; World Bank, 1994; Anas & Lee, 1996). [1] To bridge this gap in our understanding, this paper empirically examines the impact of poor transport infrastructure on industrial performance in a developing country. The illustrative case in this study is the automobile industry in India.

The literature on transportation in developing countries tends to focus on the more obvious and easy to quantify linkages between transport infrastructure and industrial performance. This literature, primarily generated by development practitioners and institutions such as the World Bank, notes that poor transportation systems result in slow movement of goods and in high unit cost of freight (see, e.g., India Infrastructure Report, 1996; World Bank, 1995, 1996b). Perhaps because it is hard to estimate the value of time, this literature relies on indicators such as "unit freight cost" and "vehicle operating cost" to estimate the relative costs or benefits of different transportation systems. [2] From this perspective, the key problem with badly maintained and inadequate road networks is that they directly raise the cost of freight by (a) increasing the cost of operations and maintenance (due to greater wear and tear and higher fuel consumption); and (b)

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increasing transit time, which, in turn, means that both labor (driver) and capital (the truck) are deployed for a longer period of time to complete a given delivery. The literature thus suggests that improvements in the transportation system would result in lower freight costs and greater competitiveness. [3]

This paper quantifies the logistics costs borne by India's largest auto assembler, Maruti, and analyzes the transport solutions devised by Maruti, Ford, and some other assemblers. [4] It shows that the analytic approach discussed above is inadequate for understanding how transport infrastructure affects competitiveness and suggests a broader analytical framework within which to consider the issue. In contrast to much of the existing development literature, this study finds that—for the example of auto assemblers in India—freight costs are neither the only nor the most significant cost that poor transportation systems create. An inadequate transportation system also increases the damages incurred in transit, the total inventories that firms have to maintain, and the ordering and overhead costs associated with managing material flows. Taken together, these variables constitute the "total logistics cost" borne by a firm. This total logistics cost equation offers a more comprehensive approach for calculating the direct costs that poor transportation imposes on a firm. Specifically,

$$\begin{aligned}\text{Total logistics cost} = {} & \text{freight cost} + \text{damages} \\ & + \text{inventory} \\ & + \text{ordering/overhead costs} \\ & + \text{packaging costs.}\end{aligned}$$

This equation allows for better estimation of quantifiable firm-specific costs, but it does not capture those transportation-created costs that go beyond a particular firm and affect the supply chain as a whole (i.e., the external diseconomies). [5] Moreover, the quantification alone does not shed light on how individual firms (in this case, the car assemblers) perceive the transportation problem and the relative importance they attach to various components of the logistics equation. To capture such information, this study examines not just the direct logistics cost borne by a particular firm but also the transportation costs over its supply chain. The quantitative supply chain analysis is supported by semi-structured interviews with firm managers and an inductive analysis of the coping strategies firms have devised to limit the adverse impacts of poor transportation.

This analysis reveals that auto assemblers are highly concerned about the inefficiency and unreliability that poor transportation systems introduce into their supply chains. This is because, as the literature on industrial competitiveness emphasizes, efficient and well-managed supply chains are critical for competitive success in global industry (Gereffi & Korzeniewicz, 1994; Porter, 1990). Assemblers find that poor transportation is a major obstacle to their efforts to implement lean production and supply chain management strategies. Poor transport systems thus hurt their competitiveness not only by raising direct costs but also by creating external diseconomies that adversely affect the efficiency of supply chains and, indeed, entire networks of firms. Further, these external diseconomies—rather than excessive freight prices or other direct costs—may be the more debilitating impact of poor transportation infrastructure on industrial development and competitiveness.

Although this paper takes the literature on transportation and industrial performance in developing countries as its point of entry, it also draws upon and contributes to two additional and traditionally separate bodies of literature. First, it contributes to the literature on industrial districts by showing how clustering in the Indian auto industry is being driven by a relatively straightforward and mechanistic logic—lack of infrastructure. Second, it contributes to the lean production literature by questioning the argument that the only significant difference between lean and nonlean firms is management attitude (not variables such as infrastructure) and that lean production can be fully implemented anywhere in the world (Womack, Jones, & Roos, 1990). Third, this paper suggests connections between these two separate models of industrial performance and competitiveness—it shows how auto firms in India are combining the geography of the industrial districts model with the hierarchy of the lean production model to enhance industrial performance.

This study leads to a different understanding of the links between transportation and industrial performance because it modifies and augments the standard methodological approaches used in the transportation and infrastructure development literature. First, the unit of analysis is the firm and its supply chain. This analytical approach lies in between the