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# Fragmented trade and manufacturing services—Examples for a non-convex general equilibrium

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## Abstract

This paper applies the Jones–Kierzkowski model to the contract manufacturing service industry. Stylized facts of that industry imply a theory of non-convex general equilibrium. The cost structure combines a constant marginal cost and a positive fixed cost; Marshallian free entry-free exit prevails. This implies a distinct market structure (which is neither perfect nor monopolistic competition, nor the usual Bertrand oligopoly) and a generalized equilibrium concept, based on the ‘full employment’ and ‘competitive profit’ conditions.

In a class of examples where the technology is Ricardian for fabrication and Leontief for assembly, with fixed costs for ‘service links’, it is proved that there always exists Pareto optimal allocations, supported by a concept of generalized equilibrium (but—as shown by Koopmans—not by the Walras equilibrium, where the firms with increasing returns operate as price takers). Implications on specialization and cross country income distribution are noted.

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## 1. Motivation

The recent rise of the contract manufacturing industry shows that managing supply chains is not cost free. Otherwise, manufacturers would never pay for such service. Clearly, the fragmentation

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studies of Jones and Kierzkowski (“JK”) (in press) have captured the essence of international division of labor in the era of globalization. To explore its full implications, this study casts their pioneering studies as a non-convex general equilibrium, based upon assumptions distilled from empirical observation. There may be other and better interpretations of both the observed reality and what JK really meant than what appear in this study. But for analysis, we study models, one at a time.

In the study of increasing returns, real life relevance is a proper concern. It is now well known that there may never be one theory satisfactory for all applications (see, for example, Quinzii, 1992). Attention must be focused on the more relevant applications.

The next section distills observations on contract manufacturers into stylized facts, before interpreting JK and proposing a new equilibrium concept which confirm ‘market supports efficiency’. It has novel implications on what one may observe in resource allocation and income distribution, and how we may apply JK to real life issues. Some digression is made about the foundations of micro-economic analysis of the firm to shed light on the equilibrium concept we introduced.

In a class of simple cases, we shall first prove the existence of Pareto optimal allocations, then establish their distinct properties. We show that, even with scale economy, the suggested new equilibrium concept implies that decentralized decisions support optimality (though the Walras equilibrium does not). Novel properties of such solutions are then noted. This study also clarifies some classical issues of international economics and comments on possible generalizations.

## **2. Facts: old and new**

The advantage of mass production has been recognized since the Industrial Revolution. Adam Smith (1776), a contemporary observer, noted that (a) efficient pin-making took 18 operations and (b) the division of labor is limited by the extent of the market.<sup>1</sup> For economists, how to choose the degree of division of labor almost became a lost art, once Ricardo made the division of labor an either—or choice of ‘to trade or not to trade’. Yet Smith’s concern about scale economy remains clear. If it is desirable and costless, one should always observe the fullest division of labor. But if the division of labor is desirable but costly (say, in managing the supply chains), a larger market is then needed to justify this management. Hence, this is a situation with increasing returns.

The above discussion is even more relevant today than in the days of Smith. Traditional trade theory adapts well to such traded inputs like crude oil and pig iron-bulky goods with standard specifications, transacted at arms’ length. Today, goods like clothing, automobiles, and electronic products not only have complex composition but also experience frequent style change. To manage the large number of parts and components of diverse origin becomes an independent activity: they must meet specifications, be ready on time, in large volumes, and at a competitive

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<sup>1</sup> This is the title of Chapter 3 of his Book I, which explains how had water carriage reduced the cost of the ‘service link’ (in JK terms), thus enlarging the market and facilitating the division of labor. This resembles how has the Internet ushered in the outsourcing of backroom service jobs of corporate America to South Asia, today.

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