

CHAPTER 1

DIVISION OF LABOR AND CORNER SOLUTIONS IN POSITIVE TRADE THEORY

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“Even in a world of equals, trade offers mutuality of gain”

James Buchanan¹

1. Marginalism

Over the last one hundred and thirty years, or so, the notion that optimizing decisions are made “on the margin” has represented the pre-eminent vehicle for research in economics. Currently, the marginalist perspective is viewed by many as a, more or less, comprehensive framework of modern economic analysis, that encapsulates what arguably represent the two most fundamental parameters of economic decision-making: (i) the prevalence of *resource scarcity* – reflected in the, almost ubiquitous, regularity that economic *benefits* are accompanied by economic *costs*; and, *in the context of this nexus*, (ii) the requirement of economic rationality that is specifically characterized across economic agents by the presumption that, at least subconsciously, each subsequent step in any “incremental” *economic* action is undertaken only if it generates additional benefit that is greater than, or, at the very least, equal to, its associated additional cost^a.

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^a Typically, characterizations of “Marginalism” concentrate on (ii), though, in such cases, (i) is implicit.

The greatest asset of the marginalist framework has been its inherent intellectual clarity. For example, few would argue against the notion that, given a strictly quasi-concave utility function and *assuming a non-zero level of consumption*^b of a particular good, an individual would generally consume that amount that roughly equates her marginal utility with the prevailing price of this commodity^c.

Perhaps an equally important asset of the marginalist school of thought was the notable analytical talent of its early proponents including Augustin Cournot, J.H. von Thunen, H.H. Gossen, W. Stanley Jevons, and Alfred Marshall. The latter, who is perhaps the best known marginalist, was also a trained mathematician who readily translated the main elements of the theory into calculus. Together, these scholars skillfully developed the operational foundations of *Marginalism* – that they subsequently employed both in efforts to provide formal treatment to selected contributions of the classical economists, including Adam Smith and David Ricardo, as well as in their unwavering pursuit of innovation. This latter objective was predominantly focused on the development of an internally consistent and “generally applicable” theory of resource distribution – a contribution that represents the ultimate legacy of the neoclassical thinkers.

The fundamentals of the framework of analysis that resulted from the marginalist revolution may be difficult to characterize comprehensively. Still, even a crude attempt at such a characterization is likely to reflect the notion that, at the very least, this framework exemplified a well articulated process of study of economic behavior; that could be easily accommodated in the context of nineteenth century mathematical formalism; and which had considerable potential for application across the spectrum of economic inquiry. The recipe was irresistible. And

^b The importance of this second assumption has eluded the critical eye of the preponderance of mainstream literature. In general, and particularly in the presence of transaction costs, it is not clear whether a given consumer will consume *some of all goods* that enter her utility function. Corner equilibria are always possible, and acceptance of this premise alters the nature of the ensuing analysis considerably.

^c In the words of Stanley Jevons (1871)² “Our object will always be to maximize the resulting sum in the direction of pleasure, which we may fairly call the positive direction. This object we shall accomplish by accepting everything, and undertaking every action of which the resulting pleasure exceeds the pain which is undergone” (p. 32).

subsequent generations of economists eagerly followed the path outlined by the first marginalists to develop the body of literature known today as *Neoclassical Economics*.

2. Division of Labor vs. Theory of Distribution

The intuitive appeal of the neoclassical fundamentals, on the one hand, and an associated body of literature that relies on the largely uncontested marginalist orthodoxy and which extends for more than a century, on the other, implicitly define the contemporary preoccupations of the field of economics. It is perhaps for this reason that, as noted by Buchanan and Yoon³ (p. 512), “Modern economists...do not exhibit the history-of-ideas focus that would lead them to reexamine the late-nineteenth- and early-twentieth-century neoclassical developments in the theory of distribution”. Indeed, the majority of economists generally overlook the fact that the notional “switch” from the classical body of thought to the neoclassical, involved a *critically restrictive* reorientation of the early directions of the discipline.

Unlike the Marginalists, who were committed to the development of a theory of distribution, the classical economists, and Adam Smith in particular, focused primarily on matters of economic organization. In this context Adam Smith viewed the benefits of specialization resulting from division of labor central to the task of economic inquiry – a notion exemplified by the introductory sentence of the very first chapter of *The Wealth of Nations*⁴ (p. 4):

The 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 effects of the division of labour.

The first three chapters of the celebrated 1776 treatise elaborate on both the causes and the implications of changes in the level of division of labor, and provide insights of considerable intellectual gravity pertaining to the relevance, path, and evolution of economic organization. Along these lines, Adam Smith explained that enhancements in productivity

associated with increasing degrees of division of labor, are ultimately only limited by the extent of the market. In this context, Smith's path-breaking work provided a tangible link between economic growth and organization of productive effort: two fundamental dimensions of economic inquiry.

Sadly, neoclassical economists all but ignored Smith's important insights regarding the nature and relevance of economic organization. Perusing the neoclassical manuscripts, one notes that the downgrading of the topic of division of labor was distinctly subtle. Consider for example chapter 22 of Stanley Jevons' *Principles of Economics* entitled "Division of Labour" (p. 98)⁵, where he notes:

We now enter upon **one of the most important topics** in the whole range of economic science. Adam Smith begins the first chapter of his great work by remarking ... *on*^d the division of labour. ...**exception may be taken to the logical propriety** of commencing with this subject, **Smith's first three chapters**, all treating of the division of labour, form a **charming introduction** to his treatise^e.

Of course, having the benefit of hindsight, the subtlety of such language does not distract from the fact that the advocates of the neoclassical framework of analysis steered economic inquiry firmly away from questions pertaining to the division of labor and economic organization. Speculation on the relevant motivations is provided by Buchanan and Yoon³ (p. 512):

Neoclassical economists may have shied away from follow-on inquiry into Smith's proposition because they thought that acceptance of Smith's relationship would have wreaked havoc on their newly discovered theory of distribution. The advantages of specialization suggest increasing rather than constant or decreasing returns, and the observation that industries did not seem everywhere to become more and more concentrated suggests that abandonment of Smith's theorem was, empirically as well as analytically, less damaging than

^d Italics added for clarity.

^e Emphasis in the form of bold highlights added.

abandonment of the constant returns postulate so critical to their whole enterprise.

Houthakker⁶ (p. 62) adds to the relevant list of hurdles faced by the Marginalists:

It is in fact from indivisibilities that the division of labor takes its start ... such an analysis involves the use of methods that are rather unlike those by which the classical questions of economics are discussed. These classical questions are treated with the aid of traditional calculus methods (often disguised in literary form) but the latter are not suited to deal with indivisibilities.

a view shared by Yang⁷ (p. 8)

...the failure of Marshall and other neoclassical economists to formalise *the Smithian framework*^f of economic organisation can be explained by the fact that this would have involved corner solutions and related inframarginal analysis, for which the mathematical techniques were not available until the 1950s.

To summarize: division of labor was viewed by the neoclassical thinkers as leading to firm-specific increasing returns to scale^g that they considered irreconcilable with (i) their theory of distribution that relied on constant returns; as well as (ii) the empirical observation that industries did not seem to become increasingly concentrated – as would be expected under increasing returns – and, at any rate, division of labor relied on indivisibilities (hence, corner solutions) that were intractable using 19th century (calculus based) mathematics.

^f Italics added for clarity.

^g In Marshall's words⁸, "When the demand for a commodity becomes very large, the process of making it is generally divided among several distinct classes of workers, each with its proper appliances, and each aided by Subsidiary industries; for such a division diminishes the difficulty of making the commodity ... The Law of Division of Labour implies that an increase in the amount of capital and labour which is applied to any process of manufacture is likely to cause a more than proportionate increased return" (p. 57).

It is likely that the empirical observation that industries did not seem to become increasingly concentrated over time lent faith to the marginalists' belief in the general prevalence of constant returns and, therefore, to their theory of resource allocation. Yet, the intellectual integrity of the latter required a formal reconciliation with Smith's proposition (and its presumed *returns to scale* implications). In the spirit of such an effort Marshall⁹ advocated an analytical framework in which the production functions of firms within the same industry are interdependent in a manner that facilitates greater scale economies as the network of the division of labor expands. However, in Marshall's model, such scale advantages are realized in the form of "external economies" and may not be exploited by any given firm. In particular, Marshall considered that a sufficiently pronounced skill diversification that facilitates meaningful frameworks of division of labor is more likely in geographically concentrated, or "localized", industries where there is sufficient demand, and many alternative sources of employment, for the various "specialists"^h. In the context of such a setting, as localization intensifies, skill diversification in the relevant pool of labor expands, within-firm division of labor deepens, and increasing returns to any given firm's variable scale are realized.

Hence, while the *potential* for increasing returns via a greater degree of division of labor exists, it may not be managed *directly* by any given firm and is, at least in general, *not fully realized*ⁱ. As a result, with the mere invention of "external economies", Marshall evicted the relevance of division of labor from the mainstream field of study of neoclassical economics.

Contemplating this particular facet of the evolution of thought in economics – and particularly the "switch" from the classical to the neoclassical focus – George Stigler¹⁰ notes that the division of labor represents one of Adam Smith's "improper failures" (p.1208) – "a success that Smith should have achieved, but did not" (p.1208).

^h See Marshall⁹, p. 267-277.

ⁱ See Marshall⁹, p. 278-290.

The author explains:

How can it be that the famous opening chapters of his book, and the pin factory he gave immortality, can be considered a failure? Are they not cited as often as any passages in all economics? Indeed, over the generations they are. The failure is different: almost no one used or now uses the theory of division of labor, for the excellent reason that there is scarcely such a theory ... Smith gave the division of labor an immensely convincing presentation – it seems to me as persuasive a case for the power of specialization today as it appeared to Smith. Yet there is no evidence, so far as I know, of any serious advance in the theory of the subject since his time, and specialization is not an integral part of the modern theory of production ... (p. 1208)

In an earlier piece, Houthakker⁶ (p. 62) is somewhat more critical of the discipline:

It is not to the credit of economists that in the 180 years following the publication of the “Wealth of Nations” so little should have been done to clarify that *the division of labor is limited by the extent of the market*[†].

Ironically, it turns out that Marshall’s decision to banish Smith’s proposition to the intellectual periphery of “external economies” was both unnecessary, as well as misguided given that “...the implications of Smith’s principle were not at all those that most neoclassical economists implicitly inferred...” (Buchanan and Yoon³, p. 517).

As argued by a number of authors, including Young¹¹; Houthakker⁶; Rosen¹²; Yang and Borland¹³; and Buchanan and Yoon³ – to name a few, a broad interpretation of the effects of division of labor extends beyond firm-specific notions of increasing returns to scale. According to such an interpretation, as the economy-wide market expands and as greater degrees of division of labor and specialization are made possible, agents find it profitable to switch from self-production to market production thereby contributing to an environment in which the value of final economy-wide output, relative to the value of required inputs, increases. Rosen¹² refers to this result as “superadditivity”, Buchanan and Yoon³

[†] Italics added for clarity.

favor the term “generalized increasing returns” (GIR), while Yang⁷ employs the designation of “economies of specialization” (ES)^k.

There are key differences between economies of specialization and the neoclassical thinkers’ definition of (external or internal) increasing returns to scale (IRS)^l. Economies of specialization are realized in the form of technological advancements that emerge from a greater division of labor *across* the various productive processes that operate in any given economy as the economy-wide market expands. By contrast, IRS reflect “fixed” technology, and are not *directly* linked to the size of the economy-wide market – though they are linked to the market size of the specific output of any given firm^m. In this context we note that while IRS derive from the production circumstances that link *scale* and *returns*, it is not possible to provide a similarly general characterization of the defining sources of economies of specialization. For example, economies of specialization *may* derive from localized economies of individual productive agents’ scale of manual activity. However, even in the absence of such localized economies of activity, economies of specialization may very well derive from exogenous sources of comparative technological advantage across productive agents (or countries) similar to those examined in the Ricardian model of trade (see for example Cheng, Sachs, and Yang¹⁵). Hence, economies of specialization may therefore be considered to relate more closely to diseconomies of scope than economies of scale.

^k Other characterizations nominated by the same author include “network effects of the division of labor” and “cross-labor-market economies of occupation diversity”.

^l In this chapter I do not investigate recent formalizations of technical economies of scale (TES) such as those outlined in Hart¹⁴. Still, it is important to note that, unlike the case of IRS, TES may prevail outside the defining parameters of a firm given an absence of asymmetric residual rights to control and returns relevant to a productive capacity characterized by scale economies.

^m Of course, as the size of the market pertaining to the product of any one industry expands, the size of the economy-wide market also expands. In this context, it is important to note that according to the framework proposed by the neoclassical thinkers, it is enlargement of the former that leads to an expansion of division of labor, not expansion of the latter. It is also important to note that even in the absence of enlargement of any one *established* industry, the economy-wide market may still expand as improvements in transaction efficiency can stimulate specialization and transform home production to market production: a process that would entail the creation of new industries.

Whatever the source giving rise to economies of specialization, such economies prevail at the market- or economy- wide level, while IRS are firm-specific. More importantly, as ES do not require good-specific scale advantagesⁿ, they are perfectly consistent with constant returns to scale within each and every productive process, as well as for the economy at large. That is, given a fixed network of division of labor, successive increases in inputs lead to proportionate increases in outputs in the context of constant returns (Buchanan and Yoon³).

3. Inframarginal Economics

Better understanding of the causes and implications of division of labor that has been achieved during the earlier part of the 20th century represents a necessary first step in the reintroduction of division of labor and economic organisation to the mainstream of economic inquiry. This process was however made possible only with the development of appropriate analytical frameworks of non-classical mathematical programming^o that allow the formalization of corner solutions. The importance of such elements derives from the fact that they represent key dimensions in common patterns of economy-wide networks of production and consumption that characterize the nature and evolution of division of labor, and which typically involve corner equilibria. The combination of the Smithian focus on division of labor and the extent of the market, together with the classical perspective of optimizing agents characterized by dual consumer-producer identities (and who are not artificially required to assume the distinct nature of either a producer or a consumer *ex ante*)^p, in conjunction with economic frameworks that allow

ⁿ Though, it should be noted, existence of such good-specific scale advantages may very well give rise to economies of specialization.

^o This includes linear and non-linear programming, mixed integer programming, dynamic programming, and control theory.

^p The importance of the Smithian feature of dual producer-consumer identities cannot be underestimated in the context of models that investigate matters relevant to the division of labor. This feature represents a requirement for well defined labor allocation matrices for productive agents, and in its absence economy-wide as well as intra-firm levels of division of labor assume vacuous dimensions.

the prevalence of corner equilibria is referred to in the literature as *Inframarginal Economics*⁷ or *New Classical Economics*¹⁶.

Inframarginal Economics assumes its name from its reliance on *Inframarginal Analysis: a methodology* that represents the backbone of any comprehensive study of general equilibrium models that, on the one hand, do not assume an *ex ante* dichotomy between consumers and firms and, on the other, allow not only interior solutions (that may be adequately studied using marginal – calculus based – analysis), but also the possibility of corner solutions.

Generally speaking, inframarginal analysis represents a three-step approach. In the first step, the theorist determines all potential globally optimum networks of division of labor. In the second step, marginal analysis is employed to determine optimum decisions that may prevail in the context of any local equilibrium characterized by any given (potentially globally optimum) structure of a network of division of labor. Finally, the theorist undertakes a demarcation of the parameter space in parameter value subsets within which each local equilibrium represents the global equilibrium. Inframarginal comparative statics are performed by considering discontinuous jumps across the various structures representing alternative patterns of production, consumption, and exchange, that may be initiated as parameters reach certain critical values – or as parameter values shift between parameter value subsets that demarcate the relevant structures.

The first applications of such a methodology can be found in Coase (1946)¹⁷; Koopman (1957)¹⁸; and Arrow *et al.* (1958)¹⁹. The term “inframarginal analysis” was coined by Buchanan and Stubblebine in 1961²⁰, and a systematic development of the inframarginal approach in conjunction with a consolidated framework of new classical economics has been pioneered by Gary Becker (1982)²¹, Sherwin Rosen (1978¹², 1983¹²), Avinash Dixit (1987²², 1989²³), and Xiaokai Yang^q, and was further developed by these and other authors – many of whom are represented in this volume – over the course of the last two decades^f.

^q A recent survey of this author’s relevant contributions may be found in Yang (2001)⁷.

^f Excellent reviews of this literature may be found in Yang and Y-K Ng (1993)¹⁶ and Yang and S. Ng (1998)²⁴.

4. An Inframarginal Approach to Trade Theory

Trade theory represents a field of economics that appears to have benefited disproportionately from the inframarginal revolution. This is largely due to the fact that, perhaps more so than other fields of the discipline, neoclassical trade theory – encompassing new trade theory – is characterized by important weaknesses that derive directly and explicitly from its excessive reliance on classical mathematical programming, which is confined to the limiting parameters of interior solutions, and its resulting neglect of classical insights regarding the relevance of economic organisation. By way of a few key examples, we note that dependence on marginalism and interior solutions:

(a) has hindered the study of key aspects of the *economic process* that leads to the *emergence* of trade;

(b) has undermined efforts to endogenize the degree of market integration (or the degree of globalization) *in conjunction with* the degree of specialization by individual agents;

(c) requires that comparative advantage either derives from exogenously determined characteristics of production frameworks that differ across countries (such as technology in the Ricardian model, and factor endowments in the Heckscher-Ohlin²⁵), or is “acquired” (as in the case of new trade theory) in the sense that it derives from the extent to which trade facilitates exploitation of scale economies. Hence, orthodox trade theory does not allow the study of endogenous comparative advantage that, as shown by papers included in this volume, can derive from the potential of trade to facilitate more pronounced cross-country frameworks of division of labor;

(d) has, at least in the case of the Heckscher-Ohlin model of trade – the workhorse of trade theory, promoted an exogenous treatment of cross country patterns of production that has consistently relied on outcomes that prevail within the diversification cone. The predominant force responsible for concentrating research effort on the study of such outcomes is likely to have methodological origins as the study of equilibria that exist outside the cone, represented by *corner solutions* in the optimization framework, extends beyond the reach of the marginal perspective. Focus on outcomes consistent with the diversification cone

represents an important limitation of relevant research given that core propositions of the Heckscher-Ohlin, such as factor price equalization, require this assumption in order to hold⁵.

The inframarginal approach to trade theory can extend the scope of inquiry of the neoclassical perspective in the important directions outlined above, as well as in a plethora of related areas. For this reason the ensuing field of study has attracted considerable – and rapidly expanding! – interest in recent years. Yet, little has been done by way of organizing the accumulated knowledge in a single volume.

This book fills this gap by collecting a selection of key articles that mark distinct stages in the evolution of research in the area of inframarginal applications to trade theory. In this context, this volume represents an excellent introduction of this novel and exciting field of study to the new researcher, and an invaluable source of reference to those actively involved in inframarginal applications to trade theory.

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