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International trade with endogenous mode of competition in general equilibrium☆

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ABSTRACT

This paper endogenizes the extent of intra-sectoral competition in a multi-sectoral general-equilibrium model of oligopoly and trade. Firms choose capacity followed by prices. If the benefits of capacity investment in a given sector are below a threshold level, the sector exhibits Bertrand behavior, otherwise it exhibits Cournot behavior. By endogenizing the threshold parameter in general equilibrium, we show how exogenous shocks such as globalization and technological change alter the mix of sectors between "more" and "less" competitive, or Bertrand and Cournot, and affect the relative wages of skilled and unskilled workers, even in a "North–North" model with identical countries.

1. Introduction

One of the oldest themes in international economics is that larger or more open economies are likely to be more competitive. This notion has been formalized in a variety of ways. Partial-equilibrium models of oligopoly have shown that trade liberalization or increases in market size generate a competition effect which reduces output and profit margins of incumbent firms and may make it harder for them to sustain collusion in repeated interactions.[2] Krugman (1979) showed that competition effects can also arise in a general-equilibrium model with differentiated products, free entry and general additively-separable demands. However, most subsequent studies of trade in general equilibrium have used the Dixit–Stiglitz model of monopolistic competition with CES preferences, which implies that firms' price-cost margins, and hence the degree of competition in the economy, are independent of market size. Melitz (2003) introduces firm heterogeneity into such a framework, and shows that trade liberalization favors more efficient firms at the expense of less efficient ones. However, this is a selection effect rather than a competition effect, since in the Melitz model each individual firm always has the same mark-up. Melitz and Ottaviano (2008) show that this can be relaxed in a model with a quadratic demand system similar to the one we use in this paper. However, since they assume that preferences are quasi-linear, they do not model the impact on factor markets. Much remains to be done to understand the implications of allowing firm mark-ups and the degree of competition to be endogenous in a general-equilibrium model.

In this paper we provide a new explanation of how exogenous shocks such as growth or trade liberalization can lead to changes in the degree of competitive behavior throughout the economy. We do this by embedding a model of firm behavior along the lines of Kreps and Scheinkman (1983) in a framework of general oligopolistic equilibrium presented in Neary (2003a, 2007). In the model of Kreps and Scheinkman, as simplified and reduced to an equilibrium in pure strategies by Maggi (1996), firms producing differentiated products first invest in capacity and then set their output prices. Although firms

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[2] Brander (1981) is an early example of the former; Rotemberg and Saloner (1989) and Fung (1992) illustrate the latter.

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always compete in a Bertrand manner in the second stage of the game, the outcome may or may not resemble that of a one-stage Bertrand game. It will do so if the cost savings from prior investment in capacity are below a threshold level.[3] By contrast, if the cost savings exceed the threshold, then the outcome is "as if" the firms were playing a one-stage Cournot game. Since it is well-known that, other things equal, Bertrand behavior is more competitive than Cournot (implying higher output and lower mark-ups), this model implies that the nature of technology in a sector is an independent determinant of the extent of competition there.[4]

All previous applications of this approach have considered only a single sector in partial equilibrium.[5] Moreover, they have assumed that the crucial threshold parameter is exogenous. By contrast, a major contribution of our paper is to show that it is endogenous in general equilibrium. As in previous work, the threshold parameter depends on a *technological* component, which varies across sectors. In addition, it depends on a *cost* component, which is linked to economy-wide factor prices. This is because investing in capacity installation is assumed to require a different factor mix from routine production. Specifically, we assume that investment uses skilled workers while production uses unskilled. (Our results are qualitatively unchanged as long as capacity installation uses skilled labor more intensively than production.) This assumption is supported by much of the empirical literature on technology, trade and wages, where the distinction between production and non-production workers is assumed to coincide with that between unskilled and skilled workers. See for example Berman et al. (1994), Hanson and Harrison (1999), Feenstra (2003, p. 101) and Bernard et al. (2008). Its implications have also been explored in a number of other theoretical studies.[6]

An immediate implication of this view of the technology of production is that shocks to an equilibrium, such as trade liberalization, affect factor prices and therefore alter the cost component of the threshold parameter. As a result, such shocks change the mix of sectors between "more" and "less" competitive, or, equivalently, between those exhibiting Bertrand and Cournot behavior. The model thus suggests a new mechanism whereby exogenous changes can affect the degree of competition in an economy. It also throws new light on the impact of trade liberalization and technological change on the relative wages of skilled and unskilled workers.

To set the scene, we begin by considering the model in the absence of oligopolistic interaction. Section 2 examines the case of a closed economy where each of a continuum of sectors has only a single firm. We show how the level of investment in capacity is chosen and in Section 3 illustrate the determination of equilibrium. Section 4 extends this model to an integrated world economy with home and foreign firms active in each sector, and explains how the mix between "Bertrand" and "Cournot" sectors is determined. Section 5 considers the effects of shocks to the initial equilibrium. Finally, Section 6 compares the autarky and free-trade equilibria, and shows how opening up such a world to trade affects the degree of competition and the distribution of income, even though the two countries in our "North–North" model are identical.

2. Autarky with monopoly in general equilibrium

2.1. Technology

We consider an economy with a continuum of sectors indexed by z, which varies along the unit interval: $z \in [0,1]$. Until Section 4 we focus on the autarky equilibrium, in which there is a single firm in each sector. Each firm takes two decisions: how much to invest in capacity, and how much output to produce. We follow Maggi (1996) in assuming that capacity is not a rigid constraint on output: firms can produce beyond capacity though they incur higher marginal costs when they do so. In addition, we extend Maggi's framework to allow for the possibility that firms may not invest in capacity at all, choosing instead to incur the penalty of producing above capacity on all units they produce. We consider how a firm chooses its optimal capacity in the next sub-section. In the remainder of this one, we explain our second main departure from Maggi: the links between technology and factor demands which allow us to embed the model in general equilibrium.

As already discussed, production and capacity installation require different factors of production, unskilled and skilled labor respectively. Factor markets are economy-wide, so all sectors face the same factor prices: w for unskilled labor and r for skilled labor. The skilled labor requirement for a unit of capacity is the same across all sectors, equal to δ.[7] By contrast, sectors differ in their technologies for production. For all units up to capacity the unskilled labor requirement in sector z is $\gamma(z)$; while each unit of production above capacity requires $\theta(z)$ additional unskilled workers. Hence, letting $q(z)$ and $k(z)$ denote the levels of output and capacity in sector z, respectively, total costs can be written as:

$$C(z) = r\delta k(z) + \begin{cases} w\gamma(z)q(z) & \text{if } q(z) \le k(z) \\ w\gamma(z)q(z) + w\theta(z)[q(z) - k(z)] & \text{if } q(z) > k(z). \end{cases} \quad (1)$$

Without loss of generality, we order the sectors such that $\theta(z)$ rises (or at least does not fall) with z. Thus:

$$\theta'(z) \ge 0. \quad (2)$$

In addition, we will sometimes assume that $\gamma(z)$ falls (or at least does not rise) with z; this is not essential for our results, though it helps with the interpretation of the model. In diagrams and simulations it is convenient to specialize to the case where both $\gamma(z)$ and $\theta(z)$ are linear in z: $\gamma(z) = \gamma_0 - \gamma_1 z$, where $\gamma_0 \ge \gamma_1 \ge 0$; and $\theta(z) = \theta_0 + \theta_1 z$, where $\theta_0 \ge 0$ and $\theta_1 \ge 0$.[8]

To interpret these assumptions about factor requirements, note from Eq. (1) that firms in effect have a choice between two technologies: an unskilled-labor-intensive technology for units produced above capacity, and a skilled-labor-intensive technology for units produced at or below capacity. The parameter $\theta(z)$ measures the penalty which a firm in sector z incurs for saving on skilled labor by producing above capacity. Maggi (1996) interprets this as either a cost of outsourcing or a premium that must be paid to unionized

[3] Strictly speaking, in sectors below the threshold level in which the equilibrium level of investment in capacity is strictly positive, the outcome is a "quasi-Bertrand" one, as we explain in Section 4.

[4] This underlies one of Maggi's key results: the greater the cost savings from investing in capacity, the more the outcome resembles that of a less competitive Cournot game, and hence the more likely an export subsidy is to be optimal.

[5] The Kreps–Scheinkman model has been further explored by Davidson and Deneckere (1986), Friedman (1988), Madden (1998), and Boccard and Wauthy (2000), and has been applied to trade issues by Venables (1990) and Ben-Zvi and Helpman (1992) as well as by Maggi.

[6] This assumption of non-homotheticity in production has been made in some models of trade under monopolistic competition. Lawrence and Spiller (1983) distinguish between physical capital and labor (rather than skilled and unskilled labor) and assume that they are exclusively used in fixed and variable costs respectively. Flam and Helpman (1987) allow for differences in the ratio of skilled to unskilled labor between fixed costs (which they interpret as R&D costs incurred in product development) and variable costs. Forslid and Ottaviano (2003) show that the core-periphery new economic geography model can be solved analytically when the geographically mobile factor is used exclusively in fixed costs and the immobile factor in variable costs.

[7] Assuming that δ is common across sectors can be rationalized in terms of a competitive sector supplying capacity-installation services, as in Mussa (1978), though without costs of adjustment. Relaxing this assumption complicates the model considerably without yielding additional insight.

[8] When both γ' and θ' are zero (corresponding to $\gamma_1 = \theta_1 = 0$ when the functions are linear), all sectors are identical. This very special case is called the "featureless economy" in Neary (2003b) and will not be considered further.