

The Location of Firms in Unionized Countries*

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Abstract

This paper develops a two-country economic geography model with Cournot competition, where the labor markets are unionized so that trade unions bargain efficiently with each firm over wages and employment. Agglomeration forces are present due to wage premia obtained by the trade unions. It is shown that if the bargaining power of unions differs across countries then, as trade costs are reduced, the country with relatively weak unions gradually acquires all firms. However, for a range of trade costs, it is also a locally stable equilibrium for all firms to locate in the country with strong unions.

Keywords: Agglomeration; trade unions; international integration

JEL classification: F15; J51; R11

I. Introduction

The effect of increased integration on the location of economic activity has been analyzed within the framework of the Dixit and Stiglitz (1977) model of monopolistic competition and increasing returns to scale; see e.g. Krugman (1991) and Krugman and Venables (1995). It is suggested that as trade costs are reduced, production will tend to agglomerate in a few regions or countries. When trade is very costly, it is important for firms to supply markets locally such that production takes place in most countries. But as trade barriers are removed, firms have incentives to exploit scale economies as well as cost and demand linkages that arise when productive activity is concentrated in one location.

*This paper is part of my Ph.D. thesis; see Munch (2000). I would like to thank Torben M. Andersen, Robin Naylor, Søren Bo Nielsen, Jan Rose Skaksen and Peter Skott for helpful discussions and valuable comments. I am also grateful to Richard Baldwin, Stephen Redding, Lars Sørgaard, two anonymous referees and seminar participants at the Center for Economic Performance, London School of Economics, the Department of Economics, Copenhagen Business School and the Nordic International Trade Seminars, Bergen, for comments and suggestions. The views expressed do not necessarily reflect those of the Danish Economic Council.

However, this analysis has ignored that countries have different labor-market structures. Rates of unionization diverge across countries; see Calmfors, Booth, Burda, Checci, Naylor and Visser (2001) for a recent international comparison. The manufacturing wage rate also varies considerably among European countries. Even if productivity levels are taken into account, there are still significant differences in production costs; cf. Durand, Madaschi and Terribile (1998). A conventional point of view is that trade liberalization in such a scenario will lead to agglomeration of economic activity in countries with the most competitive labor markets as firms in these countries incur the lowest production cost. But this view does not clearly conform to empirical evidence for countries in Europe. So far, the countries with strong trade unions have managed to support a significant manufacturing base. For instance, the share of the manufacturing sector in GDP in the Scandinavian countries is of comparable size to most other European countries. Although this share has declined in most advanced countries, Denmark and Finland experienced the smallest decline among 14 OECD countries (less than 10%) from the mid-1970s to the mid-1990s; cf. Nickell, Redding and Swaffield (2001). Yet unionization rates in the Scandinavian countries are among the highest in Europe and much higher than in peripheral countries such as Greece, Portugal and Spain. Interestingly, Nickell *et al.* (2001) also provide evidence that labor-market institutions play a role in slowing down the process of “de-industrialization”.

This paper deals with these issues and, in particular, addresses the following question: are countries with strong trade unions able to hold on to industrial firms in the face of increased international integration? To this end, we develop a two-country economic geography model with a perfectly competitive sector and an industry in which oligopolistic rivalry prevails among firms. Hence, the widely used Dixit and Stiglitz (1977) model of monopolistic competition and increasing returns to scale is not applied. One way to capture different labor market structures is to incorporate trade unions into the analysis. It is assumed that firm-specific trade unions bargain efficiently with each firm over wages and employment, and that the bargaining power of unions is allowed to vary across countries. Optimal firm location is analyzed and it is found that when the bargaining power of unions differs across countries, then, as trade costs are reduced, firms will move to the country with relatively weak unions. However, for a range of trade costs, it is also a stable equilibrium for all firms to locate in the country with strong unions, thus suggesting an explanation for the aforementioned empirical observation.

The force working toward agglomeration consists of a demand linkage, in the sense that when firms cluster in one location, wage income is also concentrated so that a relatively large part of demand comes from the

industry center. Thus firms avoid trade costs for a relatively large part of demand, and this advantage more than countervails the disadvantage from bargaining with strong trade unions. Accordingly, the model explains how agglomerations can be sustained in locations with an inherent competitive disadvantage as represented by relatively strong trade unions. Furthermore, the force for agglomeration is found to be generated by union wage premia—a result which, so far, has not been reported in the related literature.

Models of economic geography usually incorporate a cost linkage through a real wage increase for workers who move with firms, or through a lower price of intermediate inputs. Since this paper is concerned with international relations, there is no labor mobility between countries and, in order to keep the model simple, firms do not use intermediates.

When countries are symmetric with respect to size, preferences and union bargaining strength, we derive analytical results concerning stability of equilibria where production is divided equally between countries, and where all firms are located in one country. In line with the related literature, e.g. Fujita, Krugman and Venables (1999), it is found that high trade costs lead to an equal division of production between countries, whereas if trade costs are sufficiently low then all firms choose to locate in one country. In this respect, the structure of equilibria in the new economic geography carries over to a model with firms which behave strategically and an imperfectly competitive labor market.

The labor-market structure with efficient Nash bargaining resembles that of Mezzetti and Dinopoulos (1991) and Zhao (1995). Whereas these studies focus on issues involving multinational corporations, we consider the location of industrial activity in a setting with trade costs and scale economies. Driffill and van der Ploeg (1995) study integration of countries with labor markets dominated by monopoly unions, but there are no demand linkages or forces for agglomeration and they do not allow for international differences in labor-market structures. To our knowledge, the present paper is the first to address the issue of location of firms when countries are unionized in the spirit of the “new economic geography”.

The remainder of the paper is organized as follows. The model, which is based on Brander and Krugman (1983), is introduced in Section II. Section III considers the location of firms under symmetric and asymmetric labor-market structures. A numerical example provides an idea as to how the forces for agglomeration and dispersion interact, after which the stability of equilibria is formally analyzed. It is also shown that the rent obtained by trade unions in a core–periphery allocation adds to core-country income, thereby creating a market-size linkage which, for an intermediate range of trade costs, dominates the disadvantage from bargaining with relatively strong unions. Section IV contains a brief conclusion.

II. The Model

We begin by developing a simple model of international trade and imperfect competition. There are two countries, Home and Foreign, and two sectors, one perfectly competitive with constant returns to scale and the other characterized by Cournot competition among firms. The firms in the imperfectly competitive industry produce a homogeneous good z . The markets for z in Home and Foreign are segmented, so that each firm treats the markets separately and chooses a profit-maximizing quantity for each country, as in Brander and Krugman (1983). Firms enter and exit the market until profits are bid down to zero, i.e., the number of firms is endogenously determined. The good produced in the competitive sector is freely tradable, and it is taken as the numéraire; due to constant returns to scale, the wage rate in this sector is also one.

Firms

In the imperfectly competitive industry there are n and n^* identical firms in Home and Foreign, respectively. The number of firms, n and n^* , need not be equal, and the labor-market structures may differ. Otherwise, the countries are symmetric in all respects. Firm j in Home produces y_j for domestic consumption and x_j for exports, and y_j^* and x_j^* are the corresponding quantities for firm j in Foreign.

Although firms behave strategically and engage in Cournot competition in each market, it is nevertheless assumed that they do not take into account their influence on aggregate income and demand. However, the model can easily be extended to include several industries, so that the actions of a single firm only have a negligible impact on income.¹ As this extension does not alter any of the results; to save notation we focus on the simple model with only one imperfectly competitive industry.

Firms incur fixed set-up costs in order to produce and, for convenience, it is assumed that f units of the good produced in the perfectly competitive sector are required. Thus, in a zero-profit equilibrium, capital income is completely channeled into the competitive sector and only labor income matters for demand for the imperfectly competitive good. In the case of a firm in Home, the labor input required to deliver y_j units of output to the Home market is $l_{y_j} = y_j$, whereas delivery of x_j units to the Foreign market requires $l_{x_j} = \tau x_j$. Trade costs, $\tau \geq 1$, are of the "iceberg" type, i.e., τ units of the good must be shipped in order to meet demand of one unit. These costs cover those incurred due to both transport and other trade impediments.

¹This is shown in the Appendix.

Total employment in firm j is $l_j = y_j + \tau x_j$. The cost function is then given by $C_j = w_j(y_j + \tau x_j) + f$, where w_j is the wage rate in firm j . The operating profit of firm j is now

$$\pi_j = p y_j + p^* x_j - w_j(y_j + \tau x_j), \quad j = 1, \dots, n, \quad (1)$$

and, in equilibrium, profits are zero due to free entry and exit of firms, i.e., $\pi_j = f$.

Consumers

There is a representative consumer in each country and they each supply one unit of labor. Utility for the representative consumer is assumed to be of the Cobb–Douglas type:

$$U = z^\mu z_0^{1-\mu}, \quad (2)$$

where z_0 is consumption of the good produced in the competitive sector. Demand for z in Home is given by

$$z = \frac{\mu Y}{p}, \quad (3)$$

where Y is labor income. Equilibrium between supply and demand in the Home market hence requires that $z = \sum_{j=1}^n y_j + \sum_{j=1}^n x_j^*$, and similarly for Foreign, $z^* = \sum_{j=1}^n y_j^* + \sum_{j=1}^n x_j$.

Wage and Employment Determination

Equilibrium of the model is determined in two stages. In the first stage, firms enter the imperfectly competitive sector until profits are driven down to zero (anticipating the wage and employment outcome of the second stage), after which the firms' set-up cost, f , is sunk. Labor markets are unionized in the imperfectly competitive industry and, in the second stage, it is assumed that wage rates and employment in each firm are determined simultaneously through efficient Nash bargaining between the firm and a firm-specific union.² The

²Alternatively, the negotiations could concern the wage rate only, leaving the employment decision unilaterally to the firm, i.e., the "right-to-manage" assumption. This bargaining model is used in e.g. Brander and Spencer (1988) and Bughin and Vannini (1995), but in our model efficient bargaining is assumed for the sake of analytical simplicity. A supplementary Appendix, available on request, shows that the main results of the paper carry through if a "right-to-manage" bargaining model is assumed.

bargaining process is modeled in, for example, McDonald and Solow (1981) and applied to international trade in Mezzetti and Dinopoulos (1991).

The competitive sector is a buffer sector, i.e., workers can always find employment here at the wage rate 1, and it is assumed that the union's objective is to maximize the surplus above the competitive wage rate.³ Hence, union j in Home maximizes

$$\Omega_j = (w_j - 1)l_j, \quad j = 1, \dots, n. \quad (4)$$

Union j and firm j now bargain cooperatively over w_j and $l_j = y_j + \tau x_j$. Taking output levels from all other firms as given, they aim to maximize

$$\Psi_j(w_j, l_j) = \pi_j^{1-\alpha} \Omega_j^\alpha, \quad j = 1, \dots, n, \quad (5)$$

where α is the bargaining power of the unions which, for simplicity, is assumed to be equal for all unions.⁴ The bargaining power of Foreign unions, α^* , may be different. There may be reasons to believe that the position of trade unions has been weakened in recent decades due to globalization or increased international integration; see e.g. Golden, Wallerstein and Lange (1998). For simplicity, however, it is assumed that union bargaining power, α , is unaffected by changes in trade costs.

It should be noted that firms in the imperfectly competitive industry attract workers from the competitive sector because of higher wages due to rent sharing. Those workers who do not find a high-wage job are employed in the competitive buffer sector. Thus, in disregard of the fact that all workers are assumed identical, the model implies that only workers employed in the unionized industry earn labor market rents. This is in accordance with empirical results. For the US economy, Katz and Summers (1989) have found significant inter-industry wage differences which cannot be accounted for on the basis of labor quality.

Consider now stage 2 of the game. As can be seen from (1), the firm can treat each market independently, so that (5) is equivalently maximized with respect to w_j , y_j and x_j by substituting for $l_j = y_j + \tau x_j$ in (4):

³Thus, the threat point of the union is the wage rate in the competitive sector. However, it could be argued that the threat point depends on the location of economic activity in the sense that high-wage employment opportunities for displaced workers improve with the number of unionized firms in the economy. In order to avoid such endogeneity problems of the threat point, it is assumed that when hiring, firms give priority to workers among members of their own firm-specific union, such that in the case of no agreement, the relevant alternative employment opportunities are in the competitive sector.

⁴The operating profit appears in Ψ_j because the entry decision has been made in stage 1, so the set-up cost, f , is sunk and therefore not relevant in stage 2 of the game.

$$\frac{\partial \Psi_j}{\partial w_j} = \Psi_j \left[\frac{\alpha}{w_j - 1} - \frac{(1 - \alpha)l_j}{\pi_j} \right] = 0 \quad (6)$$

$$\frac{\partial \Psi_j}{\partial y_j} = \Psi_j \left[\frac{\alpha}{l_j} + \frac{1 - \alpha}{\pi_j} \left(\frac{\partial p}{\partial y_j} y_j + p - w_j \right) \right] = 0 \quad (7)$$

$$\frac{\partial \Psi_j}{\partial x_j} = \Psi_j \left[\frac{\alpha \tau}{l_j} + \frac{1 - \alpha}{\pi_j} \left(\frac{\partial p^*}{\partial x_j} x_j + p^* - \tau w_j \right) \right] = 0 \quad (8)$$

which gives

$$w_j = (1 - \alpha) + \alpha \left(p \frac{y_j}{l_j} + p^* \frac{x_j}{l_j} \right) \quad (9)$$

$$1 = \frac{\partial p}{\partial y_j} y_j + p \quad (10)$$

$$\tau = \frac{\partial p^*}{\partial x_j} x_j + p^* \quad (11)$$

According to equation (10), output for domestic consumption in firm j is determined as if the wage rate equals the competitive wage. Likewise, equation (11) states that the marginal revenue of exports must equal the competitive wage plus unit costs incurred from trade. This is so because the contract curve is vertical at the competitive employment level and, according to equation (9), the bargained wage is a weighted average of 1 and the average price of the firm's sales. The outcome on the contract curve is then determined by the bargaining power of the union. Note also that here, efficient Nash bargaining is equivalent to profit maximization, as equation (6) implies that the generalized Nash product can be written $\Psi_j = (\alpha/(1 - \alpha))^\alpha \pi_j$.

Owing to symmetry of firms subscripts can now be dropped, and due to symmetry of countries, only the Home market is considered unless stated otherwise. Equation (10) and the Foreign equivalent of (11) determine quantities in the Home market. Solving these two equations for y and x^* yields the Cournot–Nash equilibrium quantities:

$$y = \frac{1 + (\tau - 1)n^*}{n + \tau n^*} \left(\frac{\mu Y}{p} \right), \quad (12)$$

and

$$x^* = \frac{\tau - (\tau - 1)n}{n + \tau n^*} \left(\frac{\mu Y}{p} \right), \quad (13)$$

where the price is given by

$$p = \frac{n + \tau n^*}{n + n^* - 1}. \quad (14)$$

The wage rate in Home is found from (9) but there is no simple closed-form solution available. As quantities exported are non-negative, conditions for firms to engage in reciprocal dumping are obtained from (13) (and the equivalent expression for a Home firm). These conditions are

$$\tau < \frac{n}{n-1}, \quad \tau < \frac{n^*}{n^*-1}. \quad (15)$$

They are fulfilled when trade costs are low and the degree of competition in the country to which a firm exports is low.

It can be seen from (6) that $\alpha\pi = (1-\alpha)(w-1)l$. Hence, the operating profit of a representative Home firm, (1), can be rewritten by inserting equilibrium prices and quantities:

$$\pi = \mu(1-\alpha) \left[\left(\frac{1 + (\tau-1)n^*}{n + \tau n^*} \right)^2 Y + \left(\frac{\tau - (\tau-1)n^*}{n^* + \tau n} \right)^2 Y^* \right]. \quad (16)$$

Our description of the model is completed by stating labor income in Home. Total employment in the imperfectly competitive industry is $L = nl$, so that Y is given as

$$\begin{aligned} Y &= wL + (1-L) \\ &= \frac{\alpha}{1-\alpha} n\pi + 1. \end{aligned} \quad (17)$$

In stage 1, firms enter or exit the market until the operating profits equal the fixed set-up cost, i.e., $\pi - f = 0$. Such an allocation characterizes a (long-run) equilibrium of the model. Note that the integer constraint on the number of firms is ignored throughout the paper, so that n is treated as an endogenous continuous variable.⁵

If the symmetric equilibrium in which intra-industry trade takes place is disrupted by a firm that enters the Home market, there are two main effects on the operating profit. First, the new firm creates jobs with a wage greater than the wage rate in the competitive sector. This raises labor income in

⁵The main results of the paper also hold if the number of firms is fixed and exogenously given.

Home which, in turn, increases demand from Home consumers relative to that of Foreign consumers. The firms in Home now avoid trade costs for a larger fraction of total demand. Thus the profit of Home firms will, *ceteris paribus*, rise. This creates incentives for other firms to enter the Home market and, accordingly, a demand linkage effect or a force for agglomeration is formed. Note that this mechanism is close in spirit to the “market potential” concept of Harris (1954). According to Harris, concentration of production is self-reinforcing as firms choose to produce in countries with access to large markets, but markets are large in countries where many firms choose to produce.

Second, the new firm in Home increases product market competition, which lowers the price in Home and thus has an adverse effect on profits for Home firms. The entering firm also increases competition for Foreign firms but the effect is smaller due to trade costs. This competition effect constitutes a force for dispersion which works against the force for agglomeration. At the center of the analysis is the impact of economic integration on the tension between these two opposing forces.

III. The Location of Firms

We now consider the entry and exit decisions of firms in the imperfectly competitive industry. Under certain conditions it can be shown that the agglomeration force created by demand linkages is powerful enough to outweigh the effect of increased product market competition on profits, and thus that it induces firms to concentrate in one country. The methodology used to analyze stability of equilibria in this section relies heavily on the “new economic geography” literature; see e.g. Puga (1998). The cases of identical labor market structures and differences on the labor markets are addressed in turn.

Symmetric Labor Market Structures

The location of firms is analyzed under the assumption that the bargaining power, α , is equal for all unions in both countries. We examine stability of the symmetric equilibrium (where the number of firms is equal in the two countries) as well as stability of the core–periphery equilibrium (where production is concentrated in one country). To provide an idea of how the forces for agglomeration and dispersion interact, we begin with a numerical example.

The four panels of Figure 1 are calculated with a particular level of trade costs while all other parameters are held constant. They plot the net profit

of a Home firm, $\pi - f$, against the share of industry in Home, $\lambda = n/(n + n^*)$, given that profits are zero in Foreign (i.e., the number of firms is determined from a given λ and the imposed zero-profit condition in Foreign). In the subsequent analysis, a particular location pattern, $\{n, n^*\}$ is an equilibrium if net profits are zero, i.e., $\pi - f = 0$ for all firms, and it is locally stable if $d\pi/d\lambda < 0$.⁶ In words, if, in a zero-profit equilibrium, a new firm sets up production in either country and observes a negative net profit, then this equilibrium is stable (and vice versa).

For high trade costs (top left panel), the net profit is zero for $\lambda = 0.5$, positive when less than half of industry is located in Home and negative otherwise. Since firms have incentives to enter the market until net profits are eliminated, the symmetric equilibrium is globally stable (“S” for stable). For intermediate levels of trade costs (top right and bottom left panels), the symmetric equilibrium is no longer stable; instead there are locally stable asymmetric equilibria where production moves to either Home or Foreign.

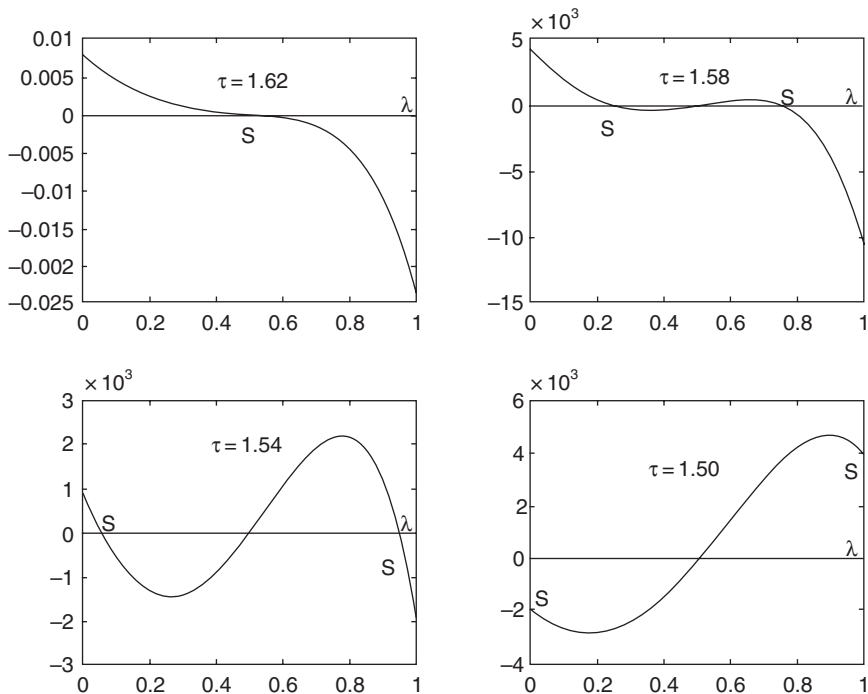


Fig. 1. Home profit as a function of industry shares; $\alpha = 0.5$, $\mu = 0.8$, $f = 0.15$

⁶If no firms locate in Home ($\lambda = 0$) then stability requires that $\pi - f < 0$ (and conversely if $\lambda = 1$ then $\pi^* - f < 0$).

In addition, as trade costs are reduced, a larger share of production is concentrated in the industry center. Finally, the bottom right panel of Figure 1 is calculated for a relatively low level of trade costs, and here all firms locate in one country. Figure 1 covers all interesting cases in the sense that the symmetric equilibrium is stable for trade costs exceeding 1.62 and the core–periphery equilibrium is stable for trade costs below 1.50.

It may be concluded that the forces for agglomeration and dispersion interact such that firms gradually relocate to the country of agglomeration as trade costs are reduced. At high levels of trade costs it is important for firms to be near final demand and to minimize product market competition. But as trade is liberalized, the demand linkage effect slowly dominates so that the periphery is gradually de-industrialized. When trade costs are reduced sufficiently, all firms choose to locate in one country. Hence, two levels of trade costs at which the structure of the equilibria changes character are identified. The level of trade costs for which the symmetric equilibrium becomes unstable is denoted τ_S , and at τ_{CP} the core–periphery equilibrium becomes stable. This is explored analytically in the following and it is shown that such critical values of trade costs indeed exist.

Stability of the Symmetric Equilibrium

The countries are identical with respect to preferences and size so there is always a symmetric equilibrium where the number of firms and labor incomes are identical, i.e., $n = n^*$ and $Y = Y^*$. The question is whether this equilibrium is locally stable. When trade costs prohibit trade ($\tau n/(n - 1)$), the equilibrium is stable since no firm has incentives to relocate to the other country and face a higher level of competition. When trade costs admit intra-industry trade, minimization of competition may no longer be sufficient to ensure stability because of the agglomeration force. Thus, to analyze stability in this case, we consider the effect on profits of a perturbation of the symmetric equilibrium configuration that raises the share of firms in Home, λ . In other words, to find the point at which symmetry is broken, the operating profit in (16) is differentiated around the symmetric equilibrium and, with $dn = -dn^* = 2nd\lambda$, we obtain

$$\frac{d\pi}{d\lambda} = \frac{2(\tau^2 - 1)(2n - 1) \left[(\tau + 1) \frac{\alpha}{1-\alpha} nf - 2(\tau - 1)(n - 1)Y \right]}{\frac{(\tau + 1)n}{1-\alpha} \left(\frac{(\tau + 1)^2 n}{\mu} - (1 + (\tau - 1)n) \right)}. \quad (18)$$

Recall that firms in Home stand to gain if $d\pi/d\lambda > 0$, in which case the equilibrium is no longer locally stable. For $\tau = 1$, (18) is zero (i.e., location

does not matter), but the term in square brackets is positive, so that $d\pi/d\lambda$ must approach zero from above as τ tends to one.⁷ At the trade prohibitive level, $\tau = n/(n-1)$, the term is negative when the number of firms is sufficiently large and the fixed set-up cost is assumed to be low enough to ensure this.⁸ There thus exists a level of trade costs, $\tau_S \in]1, n/(n-1)[$, above which the symmetric equilibrium with intra-industry trade is stable ($d\pi/d\lambda$ is negative) and below which it is unstable ($d\pi/d\lambda$ is positive). Therefore, as is now a standard result in models of economic geography, the demand linkages dominate both the effect of increased product market competition and the need to be near final demand when trade costs are reduced below a certain level, τ_S .

Asymmetric Equilibria

We non-investigate the conditions under which the equilibrium where all firms have located in one of the countries is stable, in the sense that no firm would gain by setting up production in the de-industrialized periphery. The number of firms in equilibrium is determined from the zero-profit condition for firms in the center, and local stability requires that a firm in the periphery cannot make a positive net profit. The operating profit of a firm in the core is found by evaluating (16) with $n^* = 0$, with income given by (17):

$$\pi^C = \frac{\mu(1-\alpha)}{n^2} \left[\frac{\alpha}{1-\alpha} nf + 2 \right]. \quad (19)$$

The obtainable operating profit in the periphery is found by evaluating the Foreign equivalent of (16) with $n^* = 0$:

$$\pi^P = \frac{\mu(1-\alpha)}{n^2} \left[\tau^{-2}(1 + (\tau-1)n)^2 + (\tau - (\tau-1)n)^2 \left(1 + \frac{\alpha}{1-\alpha} nf \right) \right]. \quad (20)$$

The zero-profit condition, $\pi^C = f$, implies that $nf(n - \alpha\mu) = 2\mu(1 - \alpha)$, from which the number of firms in the core is determined. Clearly, this number is not influenced by trade costs which are fully paid for by consumers in the

⁷By using the fact that $n < \tau/(\tau-1)$, the denominator is seen to be positive, so that the sign of the derivative depends on the term in square brackets in the numerator.

⁸The term in square brackets in $d\pi/d\lambda$ is negative for $\tau = n/(n-1)$ if and only if $\mu\alpha < 2n(n-1)/(2n-1)$, where n is the number of firms in symmetry. This inequality corresponds to the “no-black-hole” condition in Fujita *et al.* (1999), and it is satisfied for low enough values of f . When the condition is not satisfied, the force for agglomeration dominates the force for dispersion to such an extent that the symmetric equilibrium is unstable for all relevant values of trade costs.

periphery. Now, the core–periphery equilibrium is locally stable if and only if $\pi^P < f$ or

$$\phi(\tau) \equiv \tau^{-2}(1 + (\tau - 1)n)^2 \frac{n - \alpha\mu}{2n} + (\tau - (\tau - 1)n)^2 \frac{n + \alpha\mu}{2n} < 1. \quad (21)$$

In order to determine whether this condition is satisfied, we explore the properties of $\phi(\tau)$. First, it is evident that $\phi(1) = 1$. Second, the first-order derivative is given by:

$$\begin{aligned} \phi'(\tau) = & \tau^{-2}(1 + (\tau - 1)n)(n - \alpha\mu) \\ & - \tau^{-3}n(1 + (\tau - 1)n)^2(n - \alpha\mu) \\ & - (\tau - (\tau - 1)n)(n - 1)(n + \alpha\mu). \end{aligned} \quad (22)$$

Hence, it can be seen that $\phi'(1) = -2n(n - 1) < 0$. Next, if the force for agglomeration is not extraordinarily strong relative to the force for dispersion, then it is profitable for a firm to set up production in the periphery at the trade prohibitive level of transport costs, i.e., $\phi(n/(n - 1)) > 1$.⁹ Therefore $\phi(\tau)$ is first decreasing from $\phi(1) = 1$ and later increasing such that $\phi(n/(n - 1)) > 1$, as shown in Figure 2 for a specific parameter combination.

It has now been verified that there exists a level of trade costs, τ_{CP} , below which the core–periphery equilibrium is stable and above which it is unstable. Furthermore, Figure 1 suggests that $\tau_{CP} < \tau_S$,¹⁰ implying that there is a range of trade costs between τ_{CP} and τ_S where neither the symmetric equilibrium nor the core–periphery equilibrium is stable and that there must be asymmetric equilibria without complete de-industrialization of the periphery in this range of trade costs. Figure 3 plots equilibrium shares of industry in Home against trade costs. On the basis of this example, it may be concluded that integration leads to gradual movement of production from the periphery to the core.

Taken together the results imply four distinct stages of integration. In the first stage there are high trade costs, symmetry among countries and no cross-hauling of goods. Second, reducing trade costs makes it profitable for firms to engage in reciprocal dumping, although the symmetric equilibrium is still locally stable. In the third stage firms gradually start to relocate into the industry center (which could be either country) if trade costs are reduced further. Fourth, in the case of low trade costs, the demand linkages are so

⁹This condition is equivalent to $\alpha\mu < n - 2n^3/(2n - 1)^2$, and again it is satisfied when the number of firms is sufficiently large, or for a low enough value of f .

¹⁰It has not been possible to verify the inequality analytically, but it can be proved in a version of the model with a fixed number of firms.

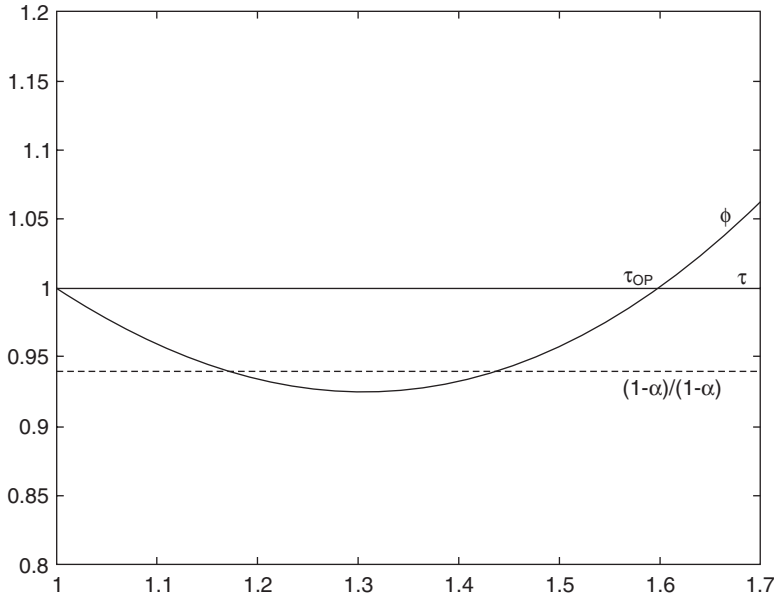


Fig. 2. ϕ as a function of trade costs; $\alpha = 0.53$, $\alpha^* = 0.5$, $\mu = 0.8$, $f = 0.15$

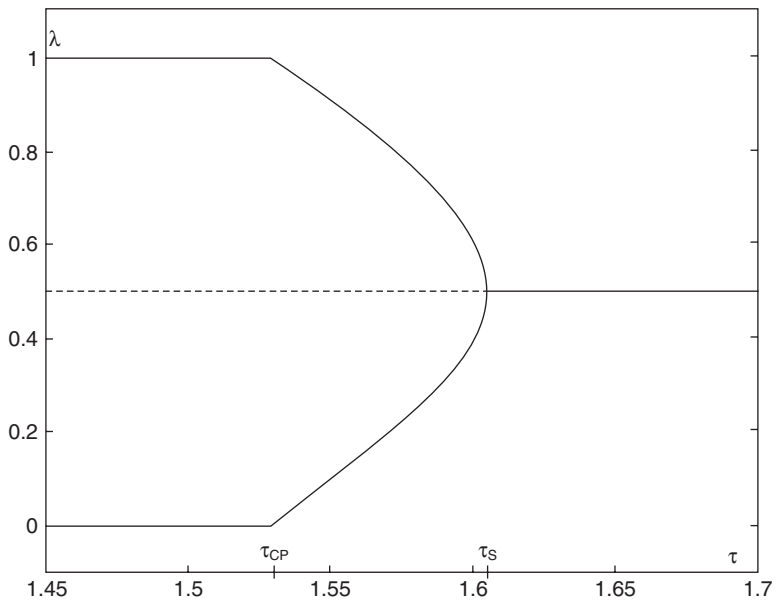


Fig. 3. Industry shares as a function of trade costs; $\alpha = \alpha^* = 0.5$, $\mu = 0.8$, $f = 0.15$

powerful that the core–periphery equilibrium is locally stable and economic activity is completely concentrated in one of the countries.

The economic geography literature based on Dixit and Stiglitz (1977) has also found that high trade costs lead to an equal division of production between countries, whereas for sufficiently low trade costs, all firms choose to locate in one country. In this sense the structure of equilibria in our model is consistent with that obtained in different frameworks, but it works according to very different mechanisms that incorporate strategic interactions among firms and imperfectly competitive labor markets.¹¹

Asymmetric Labor Market Structures

Let us now turn to equilibria in which unions in Home and Foreign have different bargaining strengths, assuming that $\alpha > \alpha^*$. Again, before deriving the analytical results, we illustrate the forces at work by a numerical example. The top left panel of Figure 4 shows that for high levels of trade costs, more than half of industry is located in Foreign. This share increases gradually (λ falls) as τ is reduced until it is a locally stable equilibrium for all firms to locate in Foreign, as shown in the top right panel of Figure 4. When τ is reduced further, as in the bottom left panel, there are two locally stable equilibria where all firms are located either in Home, the country with relatively strong labor unions, or Foreign. For τ close to 1 (bottom right panel), the equilibrium involving concentration of firms in Home ceases to be stable due to the difference in union bargaining power. Clearly, in the limiting case without any trade frictions, no firms would choose to locate in Home as they can export to Home from Foreign without any costs.

Figure 5 plots the equilibrium shares of industry in Home, λ , against trade costs, τ . It can be seen that there is a range of intermediate levels of trade costs for which it is an equilibrium outcome for all firms to locate in Home. Here, the demand linkages are strongest for intermediate levels of trade costs, so that the agglomeration advantages from clustering in the country with strong unions are sufficient to outweigh the disadvantage from paying higher wages. Figure 5 implies that if trade costs are reduced

¹¹Models based on the Dixit and Stiglitz (1977) monopolistically competitive framework often find “catastrophic” change in location once the critical level of trade costs that breaks the symmetric equilibrium is reached; cf. Krugman and Venables (1995). In addition, multiple equilibria are possible in the sense that both the symmetric and core–periphery equilibria can be stable for a range of trade costs. Our model exhibits gradual but “locally catastrophic” change in the sense that the slope at the bifurcation point in Figure 4, τ_S , is infinite. Other studies, such as Puga (1998) and Baldwin, Martin and Ottaviano (2001), also find gradual change.

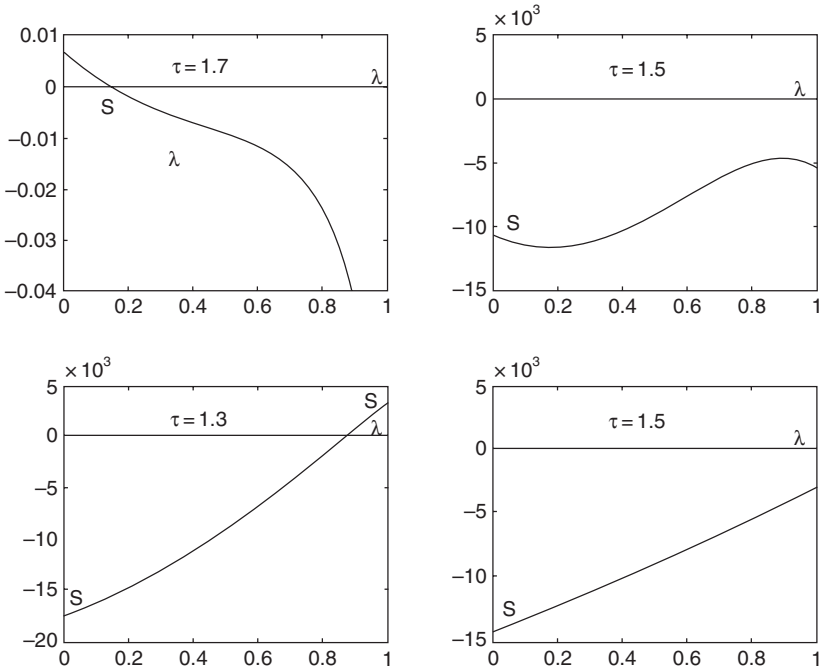


Fig. 4. Home profit as a function of industry shares; $\alpha = 0.53$, $\alpha^* = 0.5$, $\mu = 0.8$, $f = 0.15$

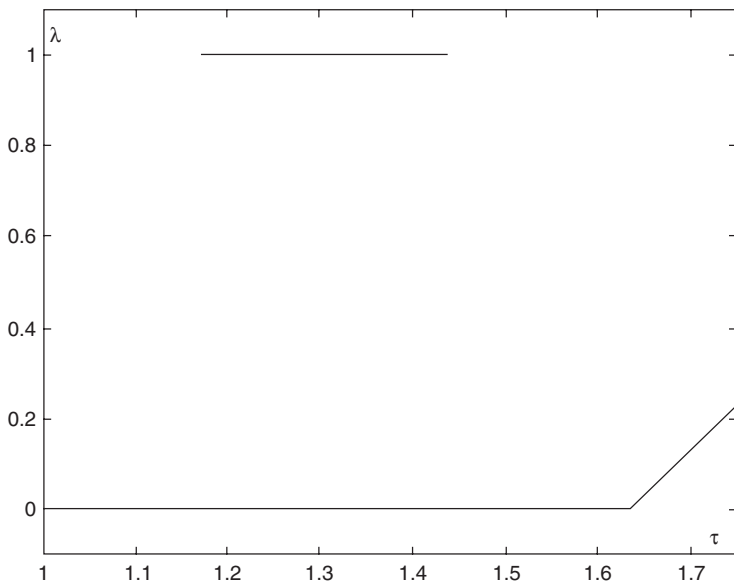


Fig. 5. Industry shares as a function of trade costs; $\alpha = 0.53$, $\alpha^* = 0.5$, $\mu = 0.8$, $f = 0.15$

continually from a high level, then at some point the country with relatively weak unions ends up with all firms in the imperfectly competitive industries. This seems to dismiss the possibility of equilibria with all firms located in Home. However, a realistic scenario is that trade unions do not come into existence until industrialization has occurred, implying that equilibria with concentration of firms in countries with relatively strong unions cannot be ruled out on this account.

Compared to the panels of Figure 1, where unions are identical in the two countries, Figure 4 indicates that the profit curves are pushed down due to the stronger unions in Home. This suggests the existence of a limit as to how different bargaining powers can be in order for there to be stable equilibria with firms located in Home.

Stability of the Core–Periphery Equilibrium in Home

Let us now explore the conditions under which it is a locally stable equilibrium for all firms to concentrate in Home, i.e., in the country which gives firms an inherent competitive disadvantage due to higher bargaining power of unions. It was previously shown that the core–periphery equilibrium is stable for values of τ satisfying $\phi(\tau) < 1$. Taking into account that the bargaining powers in the two countries are different, the condition now becomes

$$\phi(\tau) < \frac{1 - \alpha}{1 - \alpha^*}, \tag{23}$$

where $(1 - \alpha)/(1 - \alpha^*) \in [0, 1]$, i.e., the condition is now stronger. Recall that $\phi(1) = 1$, $\phi(\tau)$ has a negative slope for low values of τ and that $\phi(\tau) > 1$ for high values of τ . Thus it may be concluded that if α is sufficiently close to α^* ($(1 - \alpha)/(1 - \alpha^*)$ close to 1), then there must be a subset of trade costs in the interval $[1, n/(n - 1)]$ for which it is a stable equilibrium for all firms to locate in the country with relatively strong unions (see Figure 2).¹²

Comparative Static Results

How, then, is stability of the core–periphery equilibrium affected by changes in parameters of the model? Comparative static results for τ_{CP} are not

¹²The fact that $\phi(\tau)$ has negative slope for low values of trade costs ensures that $\phi(\tau)$ at some point is smaller than $(1 - \alpha)/(1 - \alpha^*)$ (for α close to α^*), and $\phi(n/(n - 1)) > 1$ implies that there exists (at least) one closed interval of trade costs where (23) is satisfied (due to continuity of $\phi(\tau)$).

readily available, but we may recall that stability of equilibria depends on the relative strength of the force for agglomeration and the force for dispersion. The former was identified earlier as consisting of a demand linkage effect which is closely connected to changes in income. The latter is the competition effect which is influenced by changes in the number of firms. Hence, if we can assess how the number of firms and income in the center are affected by changes in the parameters, then it is possible to predict how τ_{CP} changes.

From the zero profit condition, $\pi^C = f$, the number of firms is affected by changes in parameters in the following way:

$$\frac{dn}{d\alpha} < 0, \quad \frac{dn}{d\mu} > 0. \quad (24)$$

Higher bargaining power of unions makes it less profitable for firms to operate and some firms have to exit the market, whereas a higher share of income spent on goods produced in imperfectly competitive industries, μ , increases profitability and thus leads to entry of firms.

In a zero-profit equilibrium, labor income in the center can be written as

$$Y = \frac{n + \alpha\mu}{n - \alpha\mu}, \quad (25)$$

and the signs of the derivatives for Y are

$$\frac{dY}{d\alpha} > 0, \quad \frac{dY}{d\mu} > 0. \quad (26)$$

If the bargaining power of unions rises, then there are both direct and indirect effects on income. Stronger unions increase wages directly, but at the same time the number of firms falls. Due to increasing returns to scale, this indirectly tends to increase income as well (i.e., $dY/dn < 0$). That is, greater union bargaining power squeezes profits and drives out some firms, so that the remaining firms can operate on a more efficient scale.

With respect to changes in μ , the signs of the direct and indirect effects are no longer the same. The direct effect of a rise in μ is positive and the indirect effect is negative since n increases, but the overall effect remains positive.

In the case where unions are identical across countries, the force for agglomeration is strengthened and the force for dispersion is weakened if α increases because income in the center rises and the level of competition

falls. It follows that the core–periphery equilibrium is more likely to be stable for higher α 's. Clearly, in the limit, τ_{CP} must approach 1 for $\alpha \rightarrow 0$ because no extra income is generated and hence there is no force for agglomeration. Simulations indeed indicate that $d\tau_{CP}/d\alpha > 0$.

If, on the other hand, a unilateral increase in bargaining power is observed in a country with agglomeration of industry, then there are two opposing effects. The forces for agglomeration and dispersion both reinforce concentration of firms in the center (the force for agglomeration is strengthened and the force for dispersion is weakened), but firms have incentives to move to countries with weaker unions. In this case, simulations suggest that the latter effect dominates (i.e., the range of trade costs for which it is a stable equilibrium for firms to locate in the center shrinks).

The effect of changes in μ is less straightforward because income and the number of firms change in the same direction, so that both forces are either weakened or strengthened. A rise in μ has a positive effect on both the number of firms and income, but simulations indicate that τ_{CP} falls (i.e., $d\tau_{CP}/d\mu < 0$). Therefore a higher μ strengthens the force for dispersion more than the force for agglomeration, so that agglomeration of economic activity in the center is less likely to be a stable equilibrium.

IV. Conclusion

While there are many reasons for different wage levels across countries, the framework of this paper has abstracted from reasons other than differences in the bargaining strength of trade unions. By itself, agglomeration of economic activity tends to widen the wage gap between countries due to increased demand for labor, but our analysis is taken a step further by asking whether such concentrations of firms can be sustained even if there are inherent competitive disadvantages from locating in the industrial center.

Provided that unions are not too different with respect to bargaining strength across countries, the model explains why and how it is an equilibrium for firms to concentrate in a country with relatively strong labor unions. This concurs with observations from several European countries. The basic mechanism behind this result is that concentration of wage income creates externalities that more than outweigh the disadvantages from bargaining with relatively strong unions. Firms do not move to the country with weak unions because in so doing they would incur higher costs from transporting their goods to the country where the major share of world income is located.

Appendix*Extension to Several Industries*

Suppose there are m symmetric industries with Cournot competition. The consumer preferences can then be specified as follows:

$$U = Z^\mu z_0^{1-\mu}, \quad (\text{A1})$$

where Z is a CES consumption index over the m different goods:

$$Z = m^{1/(1-\epsilon)} \left(\sum_{i=1}^m z_i^{(\epsilon-1)/\epsilon} \right)^{\epsilon/(\epsilon-1)}, \quad \epsilon > 1. \quad (\text{A2})$$

The price index corresponding to the consumption index is given by

$$P = \left(\frac{1}{m} \sum_{i=1}^m p_i^{1-\epsilon} \right)^{1/(1-\epsilon)}, \quad (\text{A3})$$

and the demand for good i in Home can now be found to be

$$z_i = \frac{\mu Y}{m} P^{\epsilon-1} p_i^{-\epsilon}, \quad i = 1, \dots, m, \quad (\text{A4})$$

With these changes, equilibrium quantities and prices in a representative industry become

$$y = \frac{1 + (\tau - 1)\epsilon n^*}{n + \tau n^*} \left(\frac{\mu Y}{mp} \right), \quad (\text{A5})$$

$$x^* = \frac{\tau - (\tau - 1)\epsilon n}{n + \tau n^*} \left(\frac{\mu Y}{mp} \right) \quad (\text{A6})$$

and

$$p = \frac{\epsilon(n + \tau n^*)}{\epsilon(n + n^*) - 1}. \quad (\text{A7})$$

Therefore the new condition for firms to engage in reciprocal dumping is

$$\tau < \frac{\epsilon n}{\epsilon n - 1}. \quad (\text{A8})$$

The operating profit of a representative Home firm in the representative industry is

$$\pi = \frac{\mu(1-\alpha)}{\epsilon m} \left[\left(\frac{1 + (\tau - 1)\epsilon n^*}{n + \tau n^*} \right)^2 Y \left(\frac{P}{p} \right)^{\epsilon - 1} + \left(\frac{\tau - (\tau - 1)\epsilon n^*}{n^* + \tau n} \right)^2 Y^* \left(\frac{P^*}{p^*} \right)^{\epsilon - 1} \right], \quad (\text{A9})$$

and income takes the following form:

$$Y = \frac{\alpha}{1 - \alpha} mnf + 1. \quad (\text{A10})$$

Stability of the Symmetric Equilibrium

Total differentiation of the operating profit in (A9) and using the fact that $dn = -dn^* = 2nd\lambda$ gives

$$\frac{d\pi}{d\lambda} = \frac{2(\tau^2 - 1)(2\epsilon n - 1) \left[(\tau + 1) \frac{\alpha}{1 - \alpha} mnf - 2(\tau - 1)(\epsilon n - 1) Y \right]}{\frac{\tau + 1}{1 - \alpha} mn \left(\frac{(\tau + 1)^2 \epsilon n}{\mu} - (1 + (\tau - 1)\epsilon n) \right)}. \quad (\text{A11})$$

It is easily checked that the denominator is positive since $\epsilon n < \tau/(\tau - 1)$. As before, the numerator is zero and increasing for $\tau = 1$, and negative at the trade prohibitive level, $\tau = \epsilon n/(\epsilon n - 1)$, if $\mu\alpha < 2\epsilon n(\epsilon n - 1)/(2\epsilon n - 1)$ which, for instance, is satisfied for $n = 2$. Thus, there exists a level of trade costs, $\tau_S \in]1, \epsilon n/(\epsilon n - 1)[$, above which the symmetric equilibrium with intra-industry trade is stable ($d\pi/d\lambda$ is negative) and below which it is unstable ($d\pi/d\lambda$ is positive).

Asymmetric Equilibria in Asymmetric Labor Markets

Assume now that $\alpha > \alpha^*$, and the core-periphery equilibrium where $n^* = 0$ may be analyzed as follows. The operating profit of a firm in the core is

$$\pi^C = \frac{\mu(1-\alpha)}{\epsilon mn^2} \left[\frac{\alpha}{1-\alpha} mnf + 2 \right], \quad (\text{A12})$$

whereas the obtainable operating profit in the periphery is

$$\pi^P = \frac{\mu(1-\alpha^*)}{\epsilon mn^2} \left[\tau^{-2}(1 + (\tau - 1)\epsilon n)^2 + (\tau - (\tau - 1)\epsilon n)^2 \left(1 + \frac{\alpha}{1 - \alpha} mnf \right) \right]. \quad (\text{A13})$$

The zero-profit condition, $\pi^C = f$, implies that $mnf = 2\mu(1 - \alpha)/(\epsilon n - \alpha\mu)$, so the core-periphery equilibrium is locally stable ($\pi^P < f$) if and only if

$$\phi(\tau) = \tau^{-2}(1 + (\tau - 1)\epsilon n)^2 \frac{\epsilon n - \alpha\mu}{2\epsilon n} + (\tau - (\tau - 1)\epsilon n)^2 \frac{\epsilon n + \alpha\mu}{2\epsilon n} < \frac{1 - \alpha}{1 - \alpha^*}. \quad (\text{A14})$$

Again note that $\phi(1) = 1$, and that the first-order derivative is given by:

$$\begin{aligned}\phi'(\tau) &= \tau^{-2}(1 + (\tau - 1)\epsilon n)(\epsilon n - \alpha\mu) \\ &\quad - \tau^{-3}\epsilon n(1 + (\tau - 1)\epsilon n)^2(\epsilon n - \alpha\mu) \\ &\quad - (\tau - (\tau - 1)\epsilon n)(\epsilon n - 1)(\epsilon n + \alpha\mu).\end{aligned}\tag{A15}$$

As in the text, it is seen that $\phi'(1) = -2\epsilon n(\epsilon n - 1) < 0$. If it is assumed that $2(\epsilon n)^3 < (2\epsilon n - 1)^2(\epsilon n - \alpha\mu)$ (which is satisfied for a sufficiently low level of f), then $\phi(\epsilon n/(\epsilon n - 1)) > 1$. The results concerning stability of the core-periphery equilibrium thus carry through to the extended model.

Comparative Static Results

It is easily found from $mnf = 2\mu(1 - \alpha)/(\epsilon n - \alpha\mu)$ that the number of firms in a zero-profit equilibrium reacts to changes in parameters in the following way:

$$\frac{dn}{d\alpha} < 0, \quad \frac{dn}{d\mu} > 0, \quad \frac{dn}{d\epsilon} < 0.\tag{A16}$$

Income in the center can be written as

$$Y = \frac{\epsilon n + \alpha\mu}{\epsilon n - \alpha\mu},\tag{A17}$$

and the signs of the derivatives for Y are

$$\frac{dY}{d\alpha} > 0, \quad \frac{dY}{d\mu} > 0, \quad \frac{dY}{d\epsilon} < 0.\tag{A18}$$

Hence, the comparative static results are not changed, but now there is another effect when the elasticity of demand, ϵ , is changed. A lower ϵ means a higher price (see (A7)) which leads to entry of firms and higher income. Simulations suggest that $d\tau_{CP}/d\epsilon < 0$, so in this case the force for agglomeration is strengthened more than the force for dispersion (contrary to the result for μ).

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First version submitted January 2001;
final version received May 2002.

