Economic Integration, Monopoly Power 
and Productivity Growth without Scale Effects

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Abstract

We consider the role of monopoly power in the relationship between economic integration and economic growth in a two-country model of trade and fully endogenous productivity growth without scale effects. Firms locate production and innovation in the lowest cost countries, and trade costs and imperfect knowledge diffusion lead to the partial concentration of production and the full concentration of innovation in the larger country. If firms have strong monopoly power, improved economic integration, through a fall in trade costs or a rise in knowledge diffusion, accelerates growth while lowering product variety, as a consequence of higher industry concentration. In contrast, with weak monopoly power, the rise in industry concentration that coincides with greater economic integration has a positive effect on product variety and a negative effect on productivity growth. We show analytically that economic integration affects national welfare positively when monopoly power is strong, but may benefit or hurt national welfare when monopoly power is weak.

Key Words: Economic Integration, Fully Endogenous Productivity Growth, Monopoly Power, Industry Concentration, Scale Effect

JEL Classifications: F43; O30; O40; R12

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1 Introduction

The last several decades have witnessed dramatic trends toward greater economic integration between countries and regions. In East Asia, for example, falling information and transport costs (Dee, 2007) and unilateral tariff-cutting (Baldwin, 2008), have resulted in a significant rise in the share of intra-regional manufacturing trade from 36% in 1986 to 55% in 2006 (Athukorala and Kohpaiboon, 2010). In part, the increase in intra-regional trade has resulted from a shift of production activity out of Japan and into other East Asian countries. Japan still maintains it position as the top generator of research and development (R&D) in the region (Jaruzelski and Dehoff, 2008), however, with Japanese firms employing advanced production technologies in factories located in neighboring countries (Baldwin and Lopez-Gonzalez, 2014). Trends toward greater economic integration naturally lead to questions from policy makers concerned with the implications for economic growth and national welfare.

In this paper we investigate how monopoly power affects the relationship between economic integration and fully endogenous productivity growth in a two-country model of trade. Extending the in-house process innovation literature (Smulders and van de Klundert, 1995; Peretto, 1996), our framework focuses on monopolistically competitive manufacturing firms that produce differentiated product varieties and invest in process innovation with the aim of reducing unit production costs. Importantly, technical knowledge accumulates within the production technology of each firm generating intertemporal knowledge spillovers that lead to perpetual economic growth as current innovation efforts reduce future innovation costs (Romer, 1990). As a result, the level of product variety and the rate of productivity growth are intrinsically linked to the geographic distribution of industry through the localized nature of knowledge spillovers. With perfect capital mobility (Martin and Rogers, 1995), firms shift production and innovation independently to the lowest cost countries, and trade costs and imperfect knowledge diffusion result in the partial concentration of
production and the full concentration of innovation in the larger of the two countries, as measured by market size.

Free entry and exit in the manufacturing sector drives profits to zero, generating a direct relationship between the degree of monopoly power and the ratio of production employment to innovation employment at the firm level. Firms employ a greater share of workers in innovation, when they have strong monopoly power, but employ a greater share of workers in production, when they have weak monopoly power. Because technical knowledge is embodied within production technology, an increase in the production share of the larger country raises the level of knowledge spillovers from production to R&D and lowers the cost of process innovation, with implications for product variety and productivity growth. Specifically, with strong monopoly power, the rise in knowledge spillovers causes a greater increase in innovation employment than production employment, leading to a decrease in product variety while accelerating productivity growth. On the other hand, for weak monopoly power, innovation employment falls more than production employment, and product variety rises as productivity growth slows.

Our results for the relationship between industry concentration and economic growth differ with the standard conclusions of the theoretical new economic geography literature (Martin and Ottaviano, 1999, 2001; Baldwin and Martin, 2004), which tends to predict a positive relationship between industry concentration and economic growth in extensions of the variety expansion model of endogenous growth (Grossman and Helpman, 1991). The empirical evidence is mixed, however. Bosker (2007), Broersma and Oosterhaven (2009), and Gardiner et al. (2011) report negative relationships between industry concentration and economic growth, while Braunerhjelm and Borgman (2004) finds a positive relationship. A non-linear relationship is reported by Rizov et al. (2012), and Abdel-Rahman et al. (2006) and Brülhart and Sbergami (2009) conclude that the relationship between growth and industry
concentration depends on the level of economic development.

One possible source of the discrepancy between the mixed nature of empirical results and the conclusions of the theoretical new economic geography literature is a scale effect, whereby growth is closely linked with the size of the labor force. There is now a large body of empirical evidence rejecting the existence of a significant relationship between economic growth and population size (Jones, 1995; Dinopoulos and Thompson, 1999; Barro and Sala-i-Martin, 2004; and Laincz and Peretto, 2006). The endogenous market structure and endogenous growth framework (Smulders and van de Klundert, 1995; Peretto, 1996; Aghion and Howitt, 1998; Dinopoulos and Thompson, 1998; Etro, 2009) adopted in this paper corrects for the scale effect by shifting focus from aggregate R&D to the innovation activity associated with individual product lines. Thus, as the endogenous market structure and endogenous growth framework is supported by a large number of empirical studies (Laincz and Peretto, 2006; Ha and Howitt, 2007; Madsen et al., 2010a; Madsen et al., 2010b), this paper contributes to the literature with a simple empirically robust framework that is capable of producing mixed results for the effects of industry concentration on growth, with important implications for the relationship between economic integration and national welfare.

We use the framework to consider the effects of improved economic integration on product variety, productivity growth, and national welfare. While a rise in knowledge diffusion directly promotes greater knowledge spillovers, a fall in trade costs raises the concentration of industry in the larger country, causing an indirect increase in knowledge spillovers. Therefore, an increase in the level of economic integration influences product variety, productivity growth, and national welfare through its effect on knowledge spillovers. When monopoly power is strong, improved economic integration lowers product variety while accelerating productivity growth, and national welfare rises. In contrast, when monopoly power is weak, product variety rises and the rate of productivity growth falls. In this case, national welfare rises for a low level
of monopoly power, but falls for higher levels of monopoly power. These results also differ with those of the standard new economic geography literature, which generally finds that decreases in trade costs and increases in knowledge spillovers raise national welfare levels (Martin and Ottaviano, 1999, 2001; Baldwin and Martin, 2004).

The paper proceeds as follows. In Section 2, we develop a two-country model of trade and fully endogenous growth that corrects for scale effects and examine the relationship that arises between industry concentration and productivity growth for different levels of monopoly power. Section 3 then investigates the effects of increased economic integration through a fall in trade costs or a rise in the degree of knowledge diffusion, and considers the implications for national welfare. Section 4 concludes.

2 The Model

This section introduces our two-country model of trade and productivity growth. We refer to the countries as the North and South. Within each country labor is employed in three activities: traditional production ($Y$), manufacturing ($X$), and process innovation ($R$). The traditional sector produces a numeraire good for sale in a perfectly competitive market characterized by free trade. The manufacturing sector, on the other hand, consists of monopolistically competitive firms that produce differentiated product varieties for sale in a market that features trade costs on shipments between countries. Productivity growth arises as a result of in-house process innovation undertaken by manufacturing firms with the objective of raising profits by lowering production costs. Each manufacturing firm can relocate its production and innovation activities independently across countries. The labor endowments of the North and South are $L$ and $L^*$, where an asterisk denotes variables associated with the South. There is perfect labor mobility across sectors but no migration between countries. In the following subsections we focus on introducing the model setup for the North, but analogous conditions can also be derived for the South.
2.1 Households

The demand side of the market consists of dynastic representative households that maximize utility over an infinite time horizon. The lifetime utility of a representative Northern household is

$$U = \int_{0}^{\infty} e^{-\rho t} \left( \alpha \ln C_X(t) + (1 - \alpha) \ln C_Y(t) \right) dt,$$

(1)

where $C_X(t)$ and $C_Y(t)$ denote the consumptions of a manufacturing composite and a traditional good, $\rho$ is the subjective discount rate, and $\alpha \in (0,1)$ is the share of expenditure allocated to manufacturing goods at each moment in time $t$. The manufacturing composite has a constant elasticity of substitution (CES) form:

$$C_X(t) = \left( \int_{0}^{n(t)} c_i(t) \frac{1}{\sigma} di + \int_{0}^{n^*(t)} c_j(t) \frac{1}{\sigma} dj \right)^{\frac{1}{\sigma - 1}},$$

(2)

where $c_i(t)$ is the demand for variety $i$ of the $n(t)$ varieties produced in the North, and $c_j(t)$ is the demand for variety $j$ of the $n^*(t)$ varieties produced in the South. The elasticity of substitution between any two varieties is $\sigma > 1$.

Households choose an expenditure-saving path with the objective of maximizing (1) subject to the following intertemporal budget constraint:

$$\int_{0}^{\infty} e^{-\int_{0}^{t} r(z) dz} E(t) dt \leq \int_{0}^{\infty} e^{-\int_{0}^{t} r(z) dz} w(t) L dt + B(0),$$

where $E(t)$ is household expenditure, $r(t)$ and $w(t)$ are the interest and wage rates, and $B(0)$ is initial asset wealth.\(^1\) The solution to this optimization problem is the

\(^1\)We will show that asset wealth ($B$) has zero value in equilibrium as free entry drives the value of manufacturing firms to zero. See Section 2.5 for more details.
following Euler equation:

\[
\frac{\dot{E}(t)}{E(t)} = r(t) - \rho, \tag{3}
\]

where a dot indicates differentiation with respect to time. Southern households solve a symmetric utility maximization problem and, as we assume perfect capital mobility, interest rates equalize across countries \((r = r^*)\) leading to common motions for household expenditure: \(E/E^* = \dot{E}/E^* = r - \rho\). For the remainder of the paper, time notation is suppressed where possible in order to economize on notation.

At each moment in time households allocate constant shares of expenditure to traditional goods and the manufacturing composite:

\[
P_XC_X = \alpha E, \quad P_YC_Y = (1 - \alpha)E, \tag{4}
\]

where \(P_Y\) is the traditional good price. The price index associated with the manufacturing composite is

\[
P_X = \left(\int_0^\alpha p_i^{1-\sigma} \, di + \int_0^{\alpha^*} (\tau p_j^*)^{1-\sigma} \, dj\right)^{\frac{1}{1-\sigma}}, \tag{5}
\]

where \(p_i\) is the price of variety \(i\) produced in the North, \(p_j^*\) is the price of variety \(j\) produced in the South, and \(\tau > 1\) denotes an iceberg trade cost whereby \(\tau\) units must be shipped for every unit sold in the export market (Samuelson, 1954).

Regarding the composite price index (5) as the household’s unit expenditure function on manufacturing goods, Shephard’s Lemma yields the Northern demands for varieties produced in the North and South:

\[
c_i = \alpha p_i^{-\sigma} P_X^{\sigma-1} E, \quad c_j = \alpha (\tau p_j^*)^{-\sigma} P_X^{\sigma-1} E. \tag{6}
\]
Southern households face a similar utility maximization problem and therefore have symmetric demand conditions.

2.2 Traditional Firms

Traditional firms employ a constant returns to scale technology whereby one unit of labor is required for each unit of output. The competitive nature of the market thus ensures that the price of a traditional good equals the wage rate and, as there are no trade costs associated with international transactions, both prices and wage rates are common across countries. The traditional good is set as the model numeraire and hence \( P_Y = P^*_Y = w = 1 \) at all times.

2.3 Manufacturing Firms

Firms in the manufacturing sector produce horizontally differentiated product varieties and compete according to monopolistic competition (Dixit and Stiglitz, 1977). Although there are no costs associated with product development and market entry, incumbent firms incur labor costs in production \( (l_X) \), innovation \( (l_R) \), and a fixed per-period labor cost \( (l_F) \) related to the management of innovation.

A representative firm employs the following production technology:

\[
x = \theta l_X, \quad (7)
\]

where \( x \) is output and \( \theta \) is firm-level productivity. Each product variety is produced using a unique production technique, but we assume that the productivity level \( (\theta) \) associated with production techniques is the same for all firms, regardless of the location of production.

Under monopolistic competition, firms maximize profit on sales with a pricing strategy that set price equal to a constant markup over unit cost. Following Helpman
and Krugman (1985, p. 134), we define a firm’s degree of monopoly power as the ratio of average revenue to marginal revenue. With CES preferences over product variety, the degree of monopoly power is \( \eta \equiv \sigma/(\sigma - 1) > 1. \) Then, the optimal pricing strategy adopted by firms producing in both countries is \( p = p^* = \eta/\theta, \) given our assumption of symmetric productivity levels.

The firm level of production is set to meet the combined demands of the domestic market and the export market. For production located in the North, for example, setting supply equal to demand gives \( x = c_i + \tau c_i^* \), where the iceberg trade cost \( \tau > 1 \) captures the addition units that must be shipped for every unit sold in the export market. Substituting the demand functions (6), the production function (7), and the pricing strategy into this condition, we obtain optimal profit on sales for a firm with production based in the North:

\[
\pi = px - lX = (\eta - 1)lX = \frac{\alpha(\eta - 1)p^{1/(\eta-1)}}{\eta} \left( \frac{E}{P_X^{1/(\eta-1)}} + \frac{\varphi E^*}{P_X^*} \right) ,
\]

where \( \varphi = \tau^{1/(\eta-1)} \) describes the freeness of trade with \( \varphi = 0 \) implying prohibitively high trade costs and \( \varphi = 1 \) implying free trade. We assume that the market share of each firm is small enough that it perceives the composite price indexes \( P_X \) and \( P_X^* \) as constant when evaluating the effects of changes in its price on profit on sales (8).

In addition to production, manufacturing firms employs labor \( l_R \) in process innovation with the aim of raising firm value through productivity improvements that lower production costs and raise profit on sales (8). Following the in-house process innovation framework developed by Smulders and van de Klundert (1995) and Peretto (1996), we model the evolution of firm-level productivity as

\[
\dot{\theta} = k \theta l_R.
\]

\(^{2}\)Estimates of the elasticity of substitution (monopoly power) are provided for various industries in Broda and Weinstein (2006) and Hendel and Nevo (2006).
Importantly, technical knowledge accumulates within the production technology of each firm, as measured by $\theta$, generating an intertemporal knowledge spillover that potentially leads to perpetual economic growth in long-run equilibrium, with current innovation efforts reducing future innovation costs. In (9), $k \in (0, 1)$, regulates the strength of knowledge spillovers in the innovation process.

In particular, knowledge spillovers are modeled as the weighted-average productivity of technical knowledge observable by the R&D department of each firm:

$$k = s + \delta s^*, \quad (10)$$

where $s \equiv n/(n+n^*)$ and $s^* \equiv n^*/(n+n^*)$ are the shares of firms locating production in the North and South. The parameter $\delta \in (0, 1)$ describes the imperfect nature of spatial knowledge diffusion; technical knowledge includes both codifiable aspects that are conveyed easily across large distances and tacit aspects that are only transferable through face-to-face communication (Keller, 2004). Under this specification, completely localized knowledge spillovers occur for $\delta = 0$, while perfect international knowledge diffusion arises for $\delta = 1$.

The total per-period profit of a firm equals operating profit on sales less the cost of investment in process innovation and the per-period fixed labor cost:

$$\Pi = \pi - l_R - l_F. \quad (11)$$

Each firm sets its level of employment in process innovation ($l_R$) with the objective of maximizing firm value, $V = \int_0^\infty \Pi(t) e^{-\int_0^t r(\tau) d\tau} dt$, subject to the technological constraint (9). We solve this optimization problem using the following current value

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3While Ang and Madsen (2013) provide strong evidence for the influence of knowledge spillovers in the productivity growth of China, India, Japan, Korea, Singapore, and Taiwan, the imperfect nature of knowledge spillovers has been well documented by a number of empirical studies, for example, Jaffe et al. (1993), Mancusi (2008), and Coe et al. (2009). Our theoretical formulation for imperfect spillovers is adapted from Baldwin and Forslid (2000).
Hamiltonian function: \( H = \Pi + \mu k \theta l_R \), where \( \mu \) denotes the current shadow value of an improvement in the technology of the firm. The optimal level of innovation employment then equates both the value of a marginal improvement in technology with the marginal cost of process innovation \( \mu = 1/(k\theta) \), and the internal rate of return to process innovation with the risk-free rate of return \( \partial \pi / \partial \theta = r \mu - \dot{\mu} \). Combining these conditions, we derive a no-arbitrage condition for in-house R&D investment:

\[
 r \geq \frac{k\pi}{(\eta - 1)} - \frac{\dot{k}}{k} - \frac{\dot{\theta}}{\theta} \tag{12}
\]

The no-arbitrage condition binds whenever there is active process innovation.

### 2.4 Equilibrium

Long-run equilibrium is characterized by the levels of knowledge spillovers resulting from the production shares of each country. With no costs incurred in product development, free entry drives total per-period profits (11) to zero (\( \Pi = 0 \)), ensuring that household income derives from wages alone. Accordingly, given our choice of labor as the model numeraire, \( E = L \) and \( E^* = L^* \), and from the Euler condition (3), we have \( r = \rho \) at all moments in time.

Manufacturing firms are free to shift their production and innovation activities independently between countries at negligible cost (Martin and Rogers, 1995). As firms relocate production with the aim of increasing profit on the margin, profit on sales equalizes between the North and South, whenever there is active production in both countries: \( \pi = \pi^* \). Combining this condition with the pricing rule, \( p = \eta / \theta \), we

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4The solution to the firm's intertemporal optimization problem must also satisfy the following transversality condition \( \lim_{t \to \infty} e^{-\rho t} \mu \theta = 0 \), where with free entry \( r = \rho \) at all moments in time as discussed in Section 2.5.

5In particular, total household wealth is zero in equilibrium, \( B = 0 \), as free entry drives firm value to zero, \( V = 0 \).
solve for the share of firms locating production in the North:

\[ s(\varphi, L/L^*) = \frac{L/L^* - \varphi}{(1 - \varphi)(1 + L/L^*)}. \]  

Equilibrium production shares exhibit a home market effect (Krugman, 1980), whereby the country with the larger market, represented here by labor endowment, hosts the larger share of manufacturing activity, that is \( \partial s / \partial (L/L^*) > 0 \). Moreover, the production share of the larger country is increasing in \( \varphi \). For example, for \( L/L^* > 1 \), \( ds/d\varphi = (L/L^* - 1)/[(1 - \varphi)^2(1 + L/L^*)] > 0 \). A closer examination of (13) shows, however, that increases in \( \varphi \) beyond the threshold \( L^* / L \) have no further impact on patterns of production activity since \( s = 1 \).

With production shares fixed at each moment in time, knowledge spillovers (10) jump immediately to their equilibrium levels: \( \dot{k} = \dot{k^*} = 0 \). In addition, substituting (13) into (8), and reorganizing the result, we obtain equilibrium employment in as

\[ l_X = l_X^* = \frac{\alpha(L + L^*)}{\eta N}, \]  

where \( N = n + n^* \) is the total number of incumbent firms. Therefore, the scale of production is the same for all firms, regardless of the location of production.

Turning next to innovation activity, we now show that all process innovation takes place in the country with the larger market and thus the greater share of industry. First, we set (11) equal to zero and use (8) in the result to obtain free entry conditions for the manufacturing industry:

\[ l_X = \frac{l_R + l_F}{\eta - 1}, \quad l_X^* = \frac{l_R^* + l_F}{\eta - 1}. \]  

These conditions show that if there is active R&D in both countries, firm-level employment in innovation must also be the same for all firms regardless of location as
it is determined proportionally with the scale of production \( (l_R = l_R^*) \). Returning to (12), however, we use \( r = \rho \) with (8), (9), (10), and (15) to rewrite the no-arbitrage conditions for process innovation in the North and South:

\[
\rho \geq k(\delta, s(\varphi, L/L^*))(l_X - l_R), \quad \rho \geq k^*(\delta, s(\varphi, L/L^*))(l_X - l_R). \tag{16}
\]

With asymmetric market sizes \( (L \neq L^*) \), the no-arbitrage condition only binds for innovation located in the larger country, given that it hosts the larger share of industry from (13), and that its firms therefore enjoy a larger level of knowledge spillovers, ensuring that the larger country hosts all innovation activity.

Before concluding this section, we discuss the requirements necessary for positive levels of production and innovation activity. In order to pin down the location patterns for production and innovation, without loss of generality, we assume that the North has a larger market: \( L > L^* \). Then, the North will have the greater share of production \( (s > 1/2 \text{ and } k > k^*) \), and all innovation will concentrate in the North. Now, combining the free-entry conditions (15) and the Northern no-arbitrage condition (16), firm-level employment in production and innovation are solved for as

\[
l_X = \frac{k(\delta, \varphi, L/L^*)l_F - \rho}{(\eta - 2)k(\delta, \varphi, L/L^*)}, \quad l_R = \frac{k(\delta, \varphi, L/L^*)l_F - (\eta - 1)\rho}{(\eta - 2)k(\delta, \varphi, L/L^*)}. \tag{17}
\]

These employment conditions lead to the following lemma outlining the requirements on knowledge spillovers, \( k \in ((1 + \delta)/2, 1) \), for active production and innovation:

**Lemma 1** *(Knowledge spillovers, production, and innovation):* An equilibrium with positive employment in both manufacturing and process innovation requires either (i) \( k \in ((\eta - 1)\rho/l_F, 1) \) for \( \eta > 2 \), or (ii) \( k \in ((1 + \delta)/2, (\eta - 1)\rho/l_F) \) for \( \eta < 2 \).

The degree of monopoly power determines the ratio of production employment to innovation employment that is consistent with free market entry and exit (15),
at the firm level. In particular, when firms have strong monopoly power \((\eta > 2)\),
free entry requires that firms employ a greater share of labor in innovation than
in production; that is, \(l_X/(l_R + l_F) < 1\). Returning to the Northern no-arbitrage
condition, we can see therefore that innovation employment will only satisfy free entry
when knowledge spillovers are sufficiently large and labor productivity in innovation
is high: \(k > (\eta - 1)\rho/l_F\). Alternatively, with weak monopoly power \((\eta < 2)\), the
employment share is greater for production, and sufficiently small knowledge spillovers
are required for positive employment in innovation: \(k < (\eta - 1)\rho/l_F\). Interestingly,
firm-level employment in innovation is increasing in monopoly power when monopoly
power is weak, and decreasing in monopoly power when monopoly power is strong, a
result that matches piecewise with the inverted-U relationship between competition
and innovation reported by Aghion et al. (2005) and Askenazy et al. (2013).\(^6\)

3 Product Variety and Productivity Growth

The proceeding section introduced a simple model in which geographic patterns of
production and innovation were determined endogenously according to national la-
bor endowments, trade costs, the degree of knowledge diffusion, and the degree of
monopoly power. In this section, we investigate the implications of these patterns
for the overall level of product variety and the pace of productivity growth. We also
consider the growth effects of greater economic integration through lower trade costs
and greater knowledge diffusion. The section ends with an examination of the welfare
effects of greater economic integration. To simplify our discussion, we continue to fo-
cus on the case where the North is larger than the South \((L > L^*)\), and all innovation
occurs in the North.

\(^6\)The partial derivation of firm-level employment in innovation with respect to monopoly power
is \(\partial l_R/\partial \eta = -(kl_F - \rho)/(k(\delta - 2)^2),\) and can be signed using Lemma 1.
3.1 Industry Concentration

Beginning with the overall level of product variety, equating the first equations in (15) and (17) yields the total number of manufacturing firms:

\[ N = \frac{\alpha(\eta - 2)(L + L^*)k(\delta, \varphi, L/L^*)}{\eta(k(\delta, \varphi, L/L^*)l_F - \rho)}. \tag{18} \]

Figure 1 illustrates the relationship that arises between product variety and knowledge spillovers for each of the cases outlined in Lemma 1. As firms may respond to a rise in the labor productivity of innovation, stemming from improved knowledge spillovers, by either expanding or reducing their investment in process innovation, an increase in the level of knowledge spillovers may raise or lower per-period innovation costs \((l_R + l_F)\), with important implications for the level of firm entry, since firm-level production is determined by per-period fixed costs through free market entry and exit:

\[ \frac{\partial N}{\partial k} = -\frac{\rho N}{k(l_F l - \rho)}. \]

Figure 1(a) shows the case when firms have strong monopoly power \((\eta > 2)\), and an improvement in knowledge spillovers generates increased investment in innovation, a greater firm-level scale of production, and consequently, a lower level of market entry \((k > \rho/l_F)\).\(^7\) In contrast, when the monopoly power of firms is weak \((\eta < 2)\), improved knowledge spillovers cause a reduction in investment in process innovation, resulting in a decrease in the firm-level scale of production and an increase in product variety \((k < \rho/l_F)\), as shown in Figure 1(b). These cases highlight how changes in knowledge spillovers affect the tradeoff between the level of market entry and firm scale that arises with free market entry and exit.

Next, we derive the equilibrium rate of productivity growth by combining (9),

\(^7\)The second-order derivative of (18) with respect to \(k\) is \(\partial^2 N/\partial k^2 = 2\rho l_F N/(k(\rho - kl_F)^2) > 0\). Thus, \(N\) is a convex function of \(k\) as depicted in Figure 1.
Figure 1: Product Variety

\[ N \]
\[ N(k) \]
\[ \frac{(\eta-1)\rho}{l_F} \]
\[ 1 \]
\[ k(\delta, \varphi, L/L^*) \]
\[ 1+\frac{\delta}{2} \]
\[ \frac{(\eta-1)\rho}{l_F} \]
\[ k(\delta, \varphi, L/L^*) \]

(a) Strong Monopoly Power (\( \eta > 2 \))
(b) Weak Monopoly Power (\( \eta < 2 \))

(14), (15), and (17):

\[ g \equiv \frac{\dot{\theta}}{\theta} = kl_R = \frac{\alpha k(L + L^*)}{\eta N} - \rho = \frac{k(\delta, \varphi, L/L^*)l_F - (\eta - 1)\rho}{\eta - 2}. \]  \hspace{1cm} (19)

From (18), an increase in the overall labor endowment \( (L + L^*) \) is fully absorbed by a rise in the number of manufacturing firms, thus ensuring that the productivity growth rate is not biased by a scale effect. In addition, we find a negative relationship between the degree of monopoly power and productivity growth when firms have strong monopoly power, and a positive relationship when monopoly power is weak; that is, \( \frac{dg}{d\eta} = -kl_X/(\eta - 2) \).

A rise in the level of knowledge spillovers influences the rate of productivity growth through two channels:

\[ \frac{\partial g}{\partial k} = l_R + k \frac{\partial l_R}{\partial k} = \frac{l_F}{\eta - 2}. \]

The first direct channel is the positive effect of an increase in the productivity of labor in innovation. This direct channel is always dominated, however, by the second indirect channel that may be positive or negative depending on the direction of the
firm-level adjustment in investment in process innovation. With strong monopoly power ($\eta > 2$), innovation employment increases, accelerating productivity growth, as shown in Figure 2(a). Alternatively, for weak monopoly power ($\eta < 2$), innovation employment falls, dampening productivity growth, as depicted in Figure 2(b).

We are particularly interested in the relationship between industry concentration and the rate of productivity growth:

**Proposition 1 (Industry concentration, product variety, and productivity growth):** An increase in industry concentration ($s$) has the following effects: (i) lower product variety ($N$) but faster productivity growth ($g$), when monopoly power is strong $\eta > 2$ and $k \in ((\eta - 1)\rho/l_F, 1)$; and (ii) greater product variety but slower productivity growth, when monopoly power is weak $\eta < 2$ and $k \in ((1 + \delta)/2, (\eta - 1)\rho/l_F)$.

An increase in the Northern share of industry unambiguously raises the weighed-average productivity of knowledge observable by researchers in the North, $\partial k/\partial s = 1 - \delta > 0$. Accordingly, the direct effect of greater industry concentration is a rise in labor productivity that parallels the mechanism generating a positive relationship between industry concentration and economic growth in the standard new economic geography literature (Martin and Baldwin, 2004). Within our framework, however, this direct
productivity effect is always dominated by the indirect adjustment in investment in innovation at the firm level. When firms have strong monopoly power ($\eta > 2$), increased industry concentration leads to a rise in firm-level employment in innovation, a fall in the level of product variety, and a rise in the productivity growth rate. When firms have weak monopoly power ($\eta < 2$), on the other hand, firm-level employment in innovation falls, the level of market entry rises, and the rate of productivity growth falls, as a result of the increase in industry concentration. These results are shown by the arrows indicating movements along the $N(k)$ and $g(k)$ curves in Figures 1 and 2.

3.2 Economic Integration

This section briefly considers greater economic integration between the North and the South because of either a fall in trade costs or a rise in the degree of knowledge diffusion. Both of these mechanisms for improved economic integration affect the level of market entry and the rate of productivity growth through adjustments in the level of knowledge spillovers. Beginning with a decrease in trade costs, we obtain the following results:

**Proposition 2** *(Trade costs, product variety, and productivity growth):* A decrease in trade costs (an increase in $\varphi$) has the following effects: (i) lower product variety ($N$) but faster productivity growth ($g$), when monopoly power is strong $\eta > 2$ and $k \in ((\eta - 1)\rho/l_F, 1)$; and (ii) greater product variety but slower productivity growth, when monopoly power is weak $\eta < 2$ and $k \in ((1 + \delta)/2, (\eta - 1)\rho/l_F)$.

An increase in the freeness of trade makes the larger Northern market more attractive as a production base, since firms gain better access to the Northern market while incurring lower trade costs on exports to the smaller Southern market. The rise in industry concentration increases the level of knowledge spillovers in the North, leading to adjustments in the level of product variety and the rate of productivity growth, as introduced in Proposition 1 and shown by the arrows in Figures 1 and 2.
We obtain similar results with a rise in the degree of knowledge diffusion:

**Proposition 3** (Knowledge diffusion, product variety, and productivity growth): A increase in the degree of knowledge diffusion \( \delta \) has the following effects: (i) lower product variety \( N \) but faster productivity growth \( g \), when monopoly power is strong \( \eta > 2 \) and \( k \in ((\eta - 1)\rho/l_F, 1) \); and (ii) greater product variety but slower productivity growth, when monopoly power is weak \( \eta < 2 \) and \( k \in ((1 + \delta)/2, (\eta - 1)\rho/l_F) \).

An increase in the degree of knowledge diffusion raises the weighted-average productivity of knowledge observable by Northern researchers. This change in knowledge spillovers induces adjustments in firm-level investment in innovation, the overall effect and direction of which depend on the strength of monopoly power, as illustrated by the arrows for each of case in Figures 1 and 2.

### 3.3 National Welfare

In this last section, we discuss the welfare implications of greater economic integration. With both traditional and manufacturing firms earning zero profits, national welfare levels can be obtained by substituting (2), (5), (9), and (13) into lifetime utility (1):

\[
U_0 = \frac{\ln (\theta(0)^\alpha A_1 L)}{\rho} + \frac{\alpha(\eta - 1)}{\rho} \ln \frac{L}{L + L^*} + \frac{\alpha}{\rho} \left( (\eta - 1) \ln ((1 + \varphi)N) + \frac{g}{\rho} \right),
\]

\[
U_0^* = \frac{\ln (\theta(0)^\alpha A_1 L^*)}{\rho} + \frac{\alpha(\eta - 1)}{\rho} \ln \frac{L^*}{L + L^*} + \frac{\alpha}{\rho} \left( (\eta - 1) \ln ((1 + \varphi)N) + \frac{g}{\rho} \right),
\]

where \( A_1 = (\alpha/\eta)^\alpha (1 - \alpha)^{1 - \alpha} \) is a constant. As we are interested in the effects of improved economic integration corresponding with an increase in \( \varphi \) or \( \delta \), the third term on the right-hand side of each of these conditions will be our main focus. Moreover, given the symmetric nature of the marginal impacts of greater integration for residents of both countries, we focus on Northern households in what follows.

Beginning with the effects of greater economic integration due to a reduction in
trade costs, we have

\[
\frac{1}{A_2} \frac{dU_0}{d\varphi} = \frac{1 - \varphi}{2k - (1 + \delta)} - \frac{\rho}{k(l_F - \rho)} + \frac{l_F}{\rho(\eta - 1)(\eta - 2)},
\]

where \( A_2 = \alpha(\eta - 1)(dk/d\varphi)/\rho > 0 \), since \((dk/ds)(ds/d\varphi) > 0\), and \(2k - (1 + \delta) > 0\) from Lemma 1. The first term on the right-hand side captures the positive impact of lower prices when trade costs fall. The second term describes the love of variety effect associated with changes in the range of product variety in household consumption. The third term denotes the effect of changes in the rate of productivity growth.

Given that freer trade coincides with an increase in the concentration of industry that raises the weighted-average productivity of knowledge spillovers, the opposing love of variety and productivity growth effects suggest a trade-off between welfare level and welfare growth. We find that the degree of monopoly power is key in determining the balance between these level and growth effects:

**Proposition 4** *(Trade costs, monopoly power, and national welfare)*: A decrease in trade costs (i) raises national welfare when monopoly power is strong \((\eta > 2)\); but (ii) raises national welfare for \(\eta < \eta_F\) and lowers it for \(\eta > \eta_F\), when monopoly power is weak \((\eta < 2)\), where \(\eta_F \in (1, 2)\).

Proof: See the Appendix.

In the first case, firms have strong monopoly power, and the increase in knowledge spillovers caused by freer trade lowers market entry while accelerating economic growth. We find, however, that in an equilibrium with active investment in process innovation, the positive growth effect always dominates the negative level effect and improved economic integration raises national welfare. In the second case, with weak monopoly power, improved economic integration leads to greater market entry, but dampens economic growth. In this case, the positive level effect dominates and national welfare rises for a low degree of monopoly power. Otherwise, the negative
growth effect dominates and welfare deteriorates with greater economic integration.

Next, we examine the effects of greater economic integration resulting from an improvement in the degree of knowledge diffusion between countries:

\[
\frac{1}{A_3} \frac{dU_0}{d\delta} = \frac{\rho}{k(l_F - \rho)} + \frac{l_F}{\rho(\eta - 1)(\eta - 2)},
\]

where \(A_3 = \alpha(\eta - 1)(dk/d\delta)/\rho > 0\) and \(dk/d\delta > 0\). Once again, the first term on the right-hand side captures the love of variety effect and the second term describes the productivity growth effect.

**Proposition 5** (Knowledge diffusion, monopoly power, and national welfare): An increase in the degree of knowledge diffusion (i) raises national welfare when monopoly power is strong (\(\eta > 2\)); but (ii) raises national welfare for \(\eta < \eta_b\) and lowers it for \(\eta > \eta_b\), when monopoly power is weak (\(\eta < 2\)), where \(\eta_b \in (1, 2)\).

Proof: See the Appendix.

An improvement in the level of economic integration, through an increase in the degree of knowledge diffusion, raises knowledge spillovers into Northern process innovation. When firms have strong monopoly power, the increase in knowledge spillovers leads to a rise in the rate of economic growth that dominates the negative effect of a fall in product variety, ensuring an improvement in national welfare. Conversely, if firms have weak monopoly power, the rise in product variety dominates the fall in economic growth and national welfare improves for low values of the degree of monopoly power. If the degree of monopoly power is high, however, the negative growth effect dominates and welfare is adversely affected by greater economic integration.

4 Conclusion

We have developed a two-country model of trade and fully endogenous productivity growth that corrects for scale effects. Productivity growth arises from investments
by firms in process innovation with the objective of lowering production costs. With perfect capital mobility, firms are free to locate production and innovation activities independently in the lowest cost countries. Trade costs and imperfect knowledge diffusion then result in the partial concentration of production and the full agglomeration of innovation in the larger of the two countries, as measured by market size.

We use the framework to consider how monopoly power affects the relationship between economic integration and the pace of economic growth. In particular, defining two ranges for the degree of monopoly power, we find that when firms have strong monopoly power, an improvement in the level of economic integration between the two countries, through either decreased trade costs or increased knowledge diffusion, raises the concentration of industry in the larger country, leading to faster productivity growth, but lower product variety. In contrast, when monopoly power is weak, increased industry concentration in the larger country, caused by greater economic integration, induces a fall in productivity growth and a rise in product variety. Finally, examining the balance between the opposing level and growth effects associated with product variety and productivity growth, we show analytically that improved economic integration affects national welfare positively when firms have strong monopoly power, but may benefit or hurt national welfare when monopoly power is weak.

Appendix

Beginning with Proposition 4, we use (17) to rewrite (22) as follows:

\[
\frac{1}{A_2} \frac{dU_0}{d\varphi} = \frac{1 - \varphi}{2k - (1 + \delta)} + \frac{((\eta - 2)\rho + kl_F) l_R}{(\eta - 1)(\eta - 2)\rho k l_X},
\]

(A1)

where \(2k - (1 + \delta) > 0\). Clearly, \(dU_0/d\varphi > 0\) for \(\eta > 2\). When \(\eta \in (1, 2)\), however, the second term in (A1) is positive for \(\eta < \tilde{\eta} \equiv 1 + (\rho - kl_F)/\rho\) and negative for \(\eta > \tilde{\eta}\). As such, there is one threshold value \(\eta_\varphi \in (1, 2)\) for which \(dU_0/d\varphi = 0\). Therefore, we
conclude that \( dU_0/d\varphi > 0 \) for \( \eta < \eta_\varphi \) and \( dU_0/d\varphi < 0 \) for \( \eta > \eta_\varphi \) when \( \eta \in (1, 2) \).

Turning next to Proposition 5, we use (17) to rewrite (23) as follows:

\[
\frac{1}{A_3} \frac{dU_0}{d\delta} = \frac{(\eta - 2)\rho + kl_F}{(\eta - 1)(\eta - 2)\rho k l_x} l_R, \tag{A2}
\]

where once again \( 2k - (1 + \delta) > 0 \). We confirm that \( dU_0/d\delta > 0 \) for \( \eta > 2 \). When \( \eta \in (1, 2) \), however, \( dU_0/d\delta > 0 \) for \( \eta < \eta_\delta = \tilde{\eta} \) and \( dU_0/d\delta < 0 \) for \( \eta > \eta_\delta \).

References


