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DO INCREASES IN PREFERENCE SIMILARITY (ACROSS COUNTRIES) INDUCE INCREASES IN TRADE?

An affirmative example

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We construct a simple model of trade in differentiated products, produced by a non-convex technology, where the volume and value of trade are increasing in the degree of similarity of preferences between the trading economies.

1. Introduction

Traditional theory considers dissimilarity of preferences, endowments and technologies the major reason for (international) trade. Clearly in pure exchange between individuals of the same preferences and endowments trade can not be beneficial. A similar result is true in production economies with the same convex technologies where all products are produced in all countries. However, when we enter the realm of differentiated products it is possible to envisage settings (involving non-convex technologies) where not all products are produced by all countries. Trade then ensures that all varieties are available to all consumers. When all varieties are not produced in every country (while they are demanded in all countries) trade will also occur across countries consisting of consumers of identical preferences.[1] Furthermore, it is widely believed[2] that the volume of trade will be increasing as the economies become more dissimilar. This paper establishes a counterexample to this statement. We provide an example of two countries with identical technologies and varying degree of similarity of consumers' preferences where the volume of trade is increasing in the degree of similarity between the two economies.

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[1]This has been pointed out by Krugman (1979, 1980), Lancaster (1980) and Helpman (1981).

[2]There is the exception of Linder (1961) whose main thesis was that 'the more similar the demand structures of the two countries, the more intensive, potentially, is trade between these two countries', p. 94. His formulation, however, lacked rigor, was based on the vague concept of 'representative demand' and was essentially driven by uncertainty about foreign demand. For a brief discussion and criticism of the Linder theory see Bhagwati (1965, pp. 182–184).

Section 2 describes the basic model and establishes and characterizes the equilibria in an isolated economy. Section 3 describes the two-country free trade model, its equilibrium, and the dependence of the volume and the value of trade on the degree of similarity between the two economies. In Section 4 we conclude.

2. The model

We use a variant of the model of Hotelling (1929).[3] There is a homogeneous good and an infinity of differentiated goods defined by their characteristics on a circumference of a circle of unit length.[4] Consumers are endowed with utility functions separable in money (Hicksian composite commodity) and one unit of a differentiated product. When product w is desired (by consumer w) but product x is purchased, utility is $U_w(m,x)=m+V_w(x)$. $V_w(\cdot)$ is single-peaked at $x=w$, the most desired good, and depends on p_x through $p=p_x+(w-x)^2$, which is the utility cost to consumer w of purchasing a unit of good x. Then $V_w(x,p_x)=k-p$.[5]

Let there be n firms each producing a distinct product x_j, $j=1,\dots,n$. Demand for firm j is generated by consumers located (in terms of their most preferred variety) in the interval (z_{j-1},z_j), where $z_{-1}(z_j)$ is the marginal consumer between firm $j-1\,(j)$ and firm $j\,(j+1)$. The cut-off points $z_j\,(z_{j-1})$ depend on prices p_j and $p_{j+1}\,(p_{j-1})$ since

$$U_{z_{j-1}}(m,x_{j-1})=U_{z_{j-1}}(m,x_j)\Leftrightarrow z_{j-1}=\frac{1}{2}\left[\frac{p_j-p_{j-1}}{x_j-x_{j-1}}+x_{j-1}+x_j\right].$$

Let consumers be distributed according to their most preferred good (w) with frequency $f(w)=b+v\cos(2\pi nw)$, with $b\geqq v\geqq 0$.[6] This sinusoidal distribution has peaks at i/n, $i=1,\dots,n$.[7] The generated demand for firm j is

$$D_j=\int_{z_{j-1}}^{z_j} f(w)\,\mathrm{d}w=b(z_j-z_{j-1})+\frac{v}{2\pi n}[\sin(2\pi nz_j)-\sin(2\pi nz_{j-1})].$$

[3]For a detailed exposition of Hotelling's model and its recent criticisms see Economides (1984).

[4]A circumference is not a very good representation of a space of differentiated products, except for goods differentiated by color. Here it is used for convenience and simplicity. Similar results can be obtained when the product space is a finite interval like [0, 1]. For a discussion of this issue see Economides (1982c).

[5]The reservation price k is taken sufficiently large so that all consumers buy a differentiated product.

[6]b is taken sufficiently large ($b\geqq v$) to ensure that there is a non-negative density of consumers $f(\cdot)$ everywhere in the commodity space.

[7]v is the weight parameter on the sinusoidal part of the frequency function. Its range is $[0,b]$.

The differentiated goods are produced by a non-convex technology which is summarized by a cost function of a fixed cost F and marginal cost c. Let there be $j=1,\dots,n$ firms in the market producing products $x_1,\dots,x_n$. Then, the profit function of firm j is $\Pi_j=(p_j-c)D_j-F$. We seek non-cooperative (Nash) equilibria when firms use (non-negative) prices as strategies.

Letting $k=2\pi n$, the first and second partial derivatives of the profit function of firm j with respect to its own price are:

$$\frac{\partial \Pi_j}{\partial p_j}=b(z_j-z_{j-1})+b(p_j-c)\left(\frac{\mathrm{d}z_j}{\mathrm{d}p_j}-\frac{\mathrm{d}z_{j-1}}{\mathrm{d}p_j}\right)$$
$$+\frac{v}{k}[\sin(kz_j)-\sin(kz_{j-1})]$$
$$+v(p_j-c)\left[\cos(kz_j)\frac{\mathrm{d}z_j}{\mathrm{d}p_j}-\cos(kz_{j-1})\frac{\mathrm{d}z_{j-1}}{\mathrm{d}p_j}\right],$$

$$\frac{\partial^2 \Pi_j}{\partial p_j^2}=2b\left(\frac{\mathrm{d}z_j}{\mathrm{d}p_j}-\frac{\mathrm{d}z_{j-1}}{\mathrm{d}p_j}\right)+2v\left[\cos(kz_j)\frac{\mathrm{d}z_j}{\mathrm{d}p_j}-\cos(kz_{j-1})\frac{\mathrm{d}z_{j-1}}{\mathrm{d}p_j}\right]$$
$$+vk(p_j-c)\left[-\sin(kz_j)\left(\frac{\mathrm{d}z_j}{\mathrm{d}p_j}\right)^2+\sin(kz_{j-1})\left(\frac{\mathrm{d}z_{j-1}}{\mathrm{d}p_j}\right)^2\right],$$

because

$$\frac{\mathrm{d}^2z_j}{\mathrm{d}p_j^2}=\frac{\mathrm{d}^2z_{j-1}}{\mathrm{d}p_j^2}=0.$$

In the expression of the second derivative the coefficient of b is negative since $\mathrm{d}z_j/\mathrm{d}p_j<0$, $\mathrm{d}z_{j-1}/\mathrm{d}p_j>0$. b can be taken sufficiently large so that Π_j is concave in p_j. Then the common solution of $\partial\Pi_j/\partial p_j=0$, $j=1,\dots,n$, defines a Nash equilibrium $(p_1^*,\dots,p_n^*)$. The following proposition is a straightforward implication of the quasi-concavity of the profit functions.[8]

Proposition 1. Given any varieties $x_1,\dots,x_n$ a Nash equilibrium in prices exists for b sufficiently large.

If varieties are located at the peaks of the demand, i.e. $x_j=j/n$, then $z_j=(2j+1)/2n$, $z_j-z_{j-1}=1/n$, $\mathrm{d}z_j/\mathrm{d}p_j=-\mathrm{d}z_{j-1}/\mathrm{d}p_j=-n/2$, $\sin(kz_j)=\sin(kz_{j-1})=0$, $\cos(kz_j)=\cos(kz_{j-1})=\cos(\pi)=-1$. Therefore, $\partial\Pi_j/\partial p_j=(1/n)[b-(p_j-c)n^2(b-v)]$ and $p_j^*=b/[n^2(b-v)]+c$.

[8]For the well-known proof see Friedman (1977).

Corollary 1. For b sufficiently large and symmetric locations $x_j = j/n$, $j=1,\dots,n$, a symmetric Nash equilibrium exists at equal prices for all firms, $p_j^* = b/[(b-v)n^2]+c$, for all j.

3. Free trade

Now let there be two economies like the one described in section 2, identical in all respects except for the distribution of consumers' preferences. Assume that the distribution of consumers in country 1 is $f_1(w)=b+v\cos(2\pi nw)$, while the distribution of consumers in country 2 is $f_2(w)=b+v\cos(2\pi nw+\pi)$. These distributions differ only in the cosine term.[9] They are less alike the higher the value of v. For the world economy with free trade we shall compute the Nash equilibrium prices, the volume and value of trade and ascertain their variation with v.

First observe that aggregate (world) demand does not depend on v and w: $f(w)=f_1(w)+f_2(w)=2b$. Firm j faces a uniform distribution of consumers so that $D_j=\int_{z_{j-1}}^{z_j} f(w)\,dw = 2b(z_j - z_{j-1})$. Since $\Pi_j=(p_j-c)D_j-F$, it follows that the first-order condition for firm j is equivalent to

$$p_j^* = \frac{(x_{j+1}-x_j)(x_j-x_{j-1})}{2(x_{j+1}-x_{j-1})}\left[\frac{p_{j+1}}{x_{j+1}-x_j}+\frac{p_{j-1}}{x_j-x_{j-1}} + x_{j+1}-x_{j-1}+\frac{c(x_{j+1}-x_{j-1})}{(x_{j+1}-x_j)(x_j-x_{j-1})}\right].$$

It is also easily checked that Π_j is concave in p_j. The common solution of the first-order conditions defines a Nash equilibrium in prices. In the world economy there are $2n$ firms and under symmetry:

$$x_{j+1}-x_j=\frac{1}{2n},\qquad z_j=\frac{2j+1}{4n},\qquad p_{j-1}=p_j=p_{j+1},$$

so that $p_j^*=c+1/(4n^2)$.

Proposition 2. Given symmetric varieties $x_1,\dots,x_{2n}$ a Nash equilibrium in prices exists for the combined economy of countries 1 and 2 at $p_j^*=c+1/(2n)^2$, for all j.

Up to this point the use of symmetric patterns of varieties in the price game was arbitrary. However, it can be justified in the context of a non-

[9]The cosine terms have a phase difference of π so that the peaks of f_1 coincide with the troughs of f_2, and vice versa

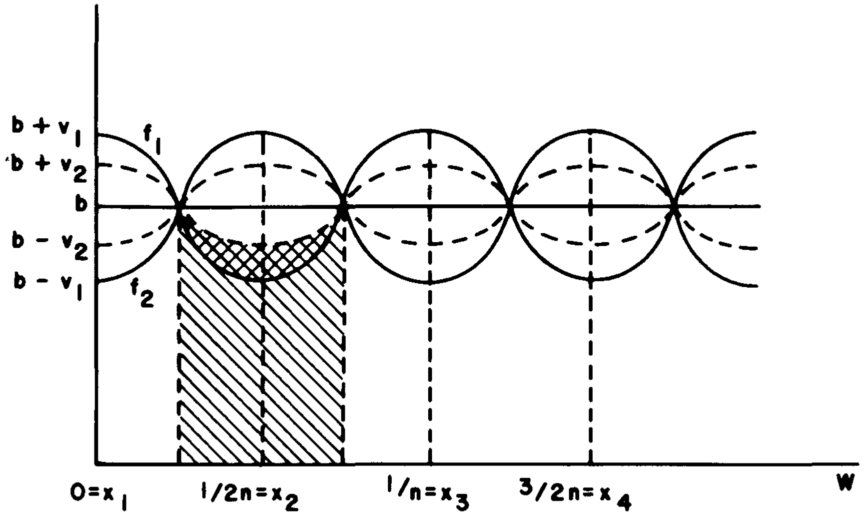

Fig 1 The frequency distributions for varying similarity of preferences across countries Similarity is decreasing in $v(v_1>v_2)$. The shaded area represents exports of firm 2 (which is in country 2) The area shaded twice represents the increase in the exports of firm 2 when preferences become more similar.

cooperative game in varieties which contains the price game as a sub-game. Suppose that there is the following two-stage structure. There are two games: a short-run, price game, and a long-run, variety game. In the last stage (short-run) game firms choose prices non-cooperatively given the (already chosen) varieties. Suppose that for any choice of varieties there exists a unique (given the variety choice) non-cooperative (Nash) equilibrium in the price game. In the previous stage (long-run) game firms choose varieties non-cooperatively expecting to receive the Nash equilibrium profits of the price game to be played with the chosen varieties.[10] Now the assumption of a symmetric pattern of varieties in the price game can be justified if such a pattern is a perfect equilibrium in the long-run game in varieties. This is indeed true:

Proposition 3 [Economides (1983)]. *Under the assumptions of section 3, there exist (perfect) symmetric Nash equilibria in varieties where $x_j - x_{j-1}=d$ for all j. They correspond to equilibria of the price sub-game at prices $p_j^*=d^2+c$, for all j.*[11]

[10]The two-stage structure as a model of oligopolistic competition in differentiated products was introduced by Hotelling (1929). In modern terminology the varieties equilibrium is a 'perfect' (or 'sub-game perfect') equilibrium, with reference to the price sub-game, which occurs further out in the game tree

[11]This is proposition 4 in Economides (1983) Here $d=1/(2n)$

The question now is which symmetric pattern of varieties production will emerge in the free trade equilibrium. If there were no frictions and no costs of change of the variety produced, firms could produce any product in a symmetric configuration and the pattern of trade would be undetermined. But if there is even the slightest cost of changing the variety currently produced, then all firms will keep producing their autarky varieties at the free trade equilibrium. Then the pattern of trade is determined and, as we show next, the volume of trade increases as the two economies become more similar.

The volume of exports of a typical firm $j=2i$ (i integer) of country 1 located at $x_{2i}=i/n$ is [using the facts that $z_{2i}=i/n+1/(4n)$, $z_{2i-1}=i/n-1/(4n)$]:

$$E_j=E_{2i}=\int_{z_{j-1}}^{z_j}[b+v\cos(2\pi nw+\pi)]\mathrm{d}w$$

$$=b(z_{2i}-z_{2i-1})+\frac{v}{2n\pi}[\sin(2nz_{2i}\pi+\pi)-\sin(2nz_{2i-1}\pi+\pi)]$$

$$=\frac{b}{2n}+\frac{v}{2n\pi}\left[\sin\left(2i\pi+\frac{3\pi}{2}\right)-\sin\left(2i\pi+\frac{\pi}{2}\right)\right]=\frac{b}{2n}-\frac{v}{n\pi}.$$

The total volume of exports of country 1 is $E=(b/2)-(v/\pi)$. Thus, the volume of trade is decreasing in v, the degree of dissimilarity between the two economies, for all v in $[0,b]$. Since equilibrium prices are independent of v, the value of trade is also decreasing in v. The more similar the economies become (as $v\to 0$), the larger the volume and value of trade between them. The largest volume and value of trade occurs when the economies are identical.

Thus, we have established:

Proposition 4. The volume and value of trade are increasing in the degree of similarity between the two economies.

Intuitively, this result is better understood when we remember that each country specializes in the products for which it faces high domestic demand. More diverse tastes across countries mean lower demand for the product produced abroad, and this means less trade.

4. Summary and conclusion

We have analyzed a simple model of trade in differentiated products between two countries with identical non-convex production technologies and preferences of varying similarity. Contrary to the results of the usual

models of convex technologies we prove that trade in differentiated products *decreases* as preferences across countries become more *dissimilar*, and trade *increases* as preferences across countries become more *similar*. Each country specializes in the differentiated products for which it faces high domestic demand. As preferences across countries become more dissimilar, foreign demand for the product drops, and this causes overall trade to drop. On the other hand, as preferences become more similar export demand increases and therefore trade increases.

References

Bhagwati, Jagdish, 1965, The pure theory of international trade A survey, Economic Journal

Economides, Nicholas, 1984, The principle of minimum differentiation revisited, European Economic Review, forthcoming

Economides, Nicholas, 1983, A simple model of trade in differentiated products, International Economics Research Center Discussion Paper no 26 (195), Columbia University, Department of Economics

Economides, Nicholas, 1982a, Nash equilibrium in oligopolistic competition in prices and varieties, Discussion Paper no 150, Columbia University, Department of Economics, revised February 1984

Economides, Nicholas, 1982b, Nash equilibrium existence in duopoly with products defined by two characteristics, Discussion Paper no 152, Columbia University, Department of Economics

Economides, Nicholas, 1982c, Oligopoly in differentiated products with three or more competitors, Discussion Paper no 153, Columbia University, Department of Economics, revised June 1984

Economides, Nicholas, 1981, Oligopoly in markets for products differentiated by their characteristics, Ph D dissertation, University of California at Berkeley

Friedman, James, 1977, Oligopoly and the theory of games (North-Holland, Amsterdam)

Helpman, Elchanan, 1981, International trade in the presence of product differentiation, economies of scale and monopolistic competition A Chamberlin–Heckscher–Ohlin approach, Journal of International Economics 11, 305–340

Hotelling, Harold, 1929, Stability in competition, Economic Journal 39, 41–57

Krugman, Paul, 1979, Increasing returns, monopolistic competition, and international trade, Journal of International Economics 9, 4, 469–479

Krugman, Paul, 1980, Scale economies, product differentiation and the pattern of trade, American Economic Review 70, 5, 950–959.

Lancaster, Kelvin, 1979, Variety, equity and efficiency (Columbia University Press, New York)

Lancaster, Kelvin, 1980, Intra-industry trade under perfect monopolistic competition, Journal of International Economics 10, 151–175

Linder, Stephan, 1961, An essay on trade and transformation (John Wiley & Sons, New York).

Novshek, William, 1980, Equilibrium in simple spatial (or differentiated product) models, Journal of Economic Theory 22, 2, 313–326

Salop, Steven, 1979, Monopolistic competition with outside goods, Bell Journal of Economics