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Endogenous Product Differentiation, Market Size and Prices

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Abstract

This paper provides a framework to understand how market size affects firms' investments in product differentiation in a model of monopolistic competition. The theory proposes that consumers' love of variety makes them more sensitive to product differentiation efforts by firms, which leads to more differentiated products in larger markets. The framework also predicts an inverted U-shaped effect of trade liberalization on product differentiation, with trade liberalization leading to more differentiated products when starting from autarky but then leading to less differentiated products as the countries approach free trade.

1. Introduction

Economists have shown that larger markets for differentiated goods often provide consumers with a greater variety of products. Less attention has been paid, however, to understand the determinants of product differentiation in the first place and how product differentiation relates to market size. Given that variety itself depends on the ability of firms to actively differentiate their products from those of rivals, one may ask what endogenous product differentiation implies for the number of goods available, prices and ultimately for consumer welfare.

Another open question is whether or not globalization leads to products that are more or less differentiated. Conventional wisdom suggests that the forces of market integration and trade liberalization produce a flat world where everyone consumes the same bland products. The framework here challenges this convention and shows the conditions under which products can in fact become more differentiated in larger markets. I achieve this in a canonical monopolistic competition framework by assuming that firms can choose how much to differentiate their products.

The basic model provides a simple tractable reduced-form general equilibrium result, with the prediction that product differentiation increases with market size. Larger markets encourage product differentiation in the model because the love-of-variety property of the utility function. Love of variety leads individual consumers to consume more varieties and less of each variety in larger markets. I show that this behavior makes them more sensitive to firms' spending on product differentiation, with the prediction that products are more differentiated in larger markets. This prediction suggests that congestion between varieties need not arise in larger markets, since firms can respond by differentiating their products.

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The theoretical model in this paper is based on monopolistic competition with endogenous technology choice. I assume that consumer utility follows a generalized constant elasticity of substitution (CES) utility function originating in Spence (1976). Following the endogenous sunk cost literature, I assume that firms can spend more on fixed costs in order to differentiate their product.[1] Firms choose their product differentiation spending from a continuum, with a more differentiated product requiring higher fixed cost spending. Firms then set prices via monopolistic competition.

The idea that love-of-variety itself encourages firms to differentiate their products is new to the literature but also very plausible for many products, such as restaurants, retail and any other markets where niche products are more common in larger markets. The theory of endogenous fixed costs and product differentiation presented here can help to explain why entry or integration does not always lead to lower price–cost markups (Ward et al., 2002; Badinger, 2007) or why prices are higher in larger markets (Tabuchi and Yoshida, 2000; Roos, 2006).

The model outlined in this paper contributes to a new literature on how market size affects the extent of endogenous product differentiation. While there are several recent papers that deal with various aspects of product quality in differentiated goods markets,[2] only a few consider the aspect of product differentiation.[3] This paper contributes to a new literature on "price-increasing competition" (Amir and Lambson, 2000; Chen and Riordan, 2007, 2008; Bertoletti et al., 2009; Lorz and Wrede, 2009; Zhelobodko et al., 2012) in two ways.[4] First, I add the feature of endogenizing fixed costs, which is not only a plausible mechanism by which product differentiation occurs but also has important implications for variety and welfare. Second, I consider the impact of trade liberalization on product differentiation.

Fixed costs in this model can be thought of as persuasive advertising or product development that differentiates one's own product or service from that of other firms.[5] For example, restaurants can spend time and effort developing new and innovative menus, which is arguably a fixed cost. Stores or restaurants can spend money on interior decorating in order to set their business apart from the competition.

A new result stemming from the assumption of costly product differentiation is that variety congestion can either increase or decrease with market size, depending on the responsiveness of consumers to firms' product differentiation spending. If consumers are sufficiently responsive to product differentiation spending then firms will be larger in larger markets, which leads simultaneously to less variety congestion and higher markups in larger markets. This prediction conflicts with previous approaches that infer a pro-competitive effect of market size when variety congestion decreases with market size. My framework suggests that market size and firm numbers alone do not provide sufficient information to make inferences about markups when product differentiation is endogenous and costly. The result that prices can increase when markets expand may provide a valuable insight for economists who study anti-competitive behavior, as this paper shows that higher prices can occur in the absence of anti-competitive activities by firms. In the mechanism described here, firms' higher prices are simply a response to consumers' preferences.

I extend the basic model to include two countries and trade costs. A new prediction regarding trade liberalization in this model is that price–cost markups and fixed cost spending is highest at an intermediate level of per-unit trade costs. The intuition behind this result is that firms' total trade costs are greatest when per-unit trade costs are at an intermediate level. Since a lower elasticity of substitution reduces the negative impact of total trade costs on export demand, firms have the strongest incentive to differentiate their product and reduce their substitution elasticity when total trade costs make up the largest proportion of firms' output. The model thus predicts an inverted-U relationship between trade liberalization and markups. When trade is already somewhat liberalized the model predicts a pro-competitive effect with lower trade costs, in line with many empirical studies in the international trade literature. Evidence for pro-competitive effects of trade liberalization may thus suggest these markets offer less differentiated products, supporting the "flat world" hypothesis. The model predicts an anti-competitive effect of trade liberalization only when departing from autarky and when variable trade costs are extremely high.

The general equilibrium approach allows for a welfare analysis that considers the effects of product differentiation on the real wage and love for variety.[6] In the welfare analysis I show that product differentiation has two countervailing effects. While individuals like to consume varieties that are more differentiated, there is also a negative effect owing to higher price–cost markups. I am able to show, however, that the beneficial effect of product differentiation and variety outweighs the adverse effect of higher markups in larger markets. The model thus predicts that market size has a positive effect on consumer welfare under general assumptions. Endogenous product differentiation may thus be an important source of gains from economic integration.

The rest of the paper is organized as follows. The basic model in a closed economy and the effect of market size on product differentiation and entry are presented in section 2. The model is expanded to include two countries and trade costs in section 3. The welfare effects of market size are presented in section 4. Conclusions follow in section 5.

2. Autarky Model

I begin by describing the model in a closed economy. The economy is composed of a continuum of monopolistically competitive firms N indexed by $i \in [0, N]$ and there is no strategic interaction between firms. The representative consumer is endowed with one unit of labor.

Consumer Preferences

The representative consumer's utility maximization problem for differentiated goods is defined as:

$$\max_{c_i} U = \left(\int_0^N c(i)^{\theta(i)}\, di\right) \text{ s.t.} \int_0^N p(i)c(i)di = w \tag{1}$$

where $c(i)$ is the quantity of good i consumed by the representative consumer. The utility for differentiated goods is based on the generalized CES utility function (Spence, 1976), where $\theta(\mathrm{i}) \in (0, 1)$ is a firm-specific parameter that determines the price elasticity of demand for good i. I interpret $\theta(i)$ as an inverse measure of product differentiation and is endogenously determined by firm i's investment in fixed costs.[7] $p(i)$ is the price of good i and w is the representative consumer's wage. The demand for a good by a representative consumer is thus:

$$c_i(p(i), \theta(i), \lambda) = \left(\frac{\theta(i)}{\lambda p(i)}\right)^{\frac{1}{1-\theta(i)}}. \tag{2}$$

One can also derive an expression for the marginal utility of income:

$$\lambda = \frac{\theta(i)c(i)^{\theta(i)-1}}{p(i)}. \tag{3}$$

Technology

Production technology Labor is the only input in this economy, and each firm's total labor requirement $l(i)$ includes an endogenously determined fixed labor cost $F(i)$ and an exogenous variable amount of labor cost β in the production process:

$$l(i) = F(i) + \beta x(i) \tag{4}$$

where $x(i)$ is the total quantity demanded of good i.

Endogenous product differentiation The model in this paper assumes that the fixed cost, $F(i)$, is a function of the preference parameter $\theta(i)$:

$$F(\theta(i)) = \alpha\frac{1-\theta(i)}{\theta(i)}, \quad \theta(i) \in (0,1). \tag{5}$$

where $\alpha > 0$ is a parameter. This functional form imposes the assumption that fixed costs are increasing in product differentiation and convex.

The concept that fixed costs affect a consumer demand follows the work of Sutton (1991) and Dixit (1979). Differentiating one's own product from others (i.e. lowering the preference parameter, $\theta(i)$) requires higher fixed costs. These fixed costs could be persuasive advertising or product development that differentiates a firm's own product from that of other firms. Fixed costs are convex as $\theta(i)$ decreases, so that fixed cost spending exhibits decreasing returns. I refer to (5) as the "advertising function" throughout the rest of the paper.

Markup pricing Firms enter, then they choose their optimal level of product differentiation, then they set prices via monopolistic competition. The equilibrium is found by backward induction. Each firm sets its price in order to maximize profit and takes endogenous fixed costs, $F(i)$, as given:

$$\pi(i) = p(i)x(i) - w\beta x(i) - wF(\theta(i)). \tag{6}$$

Firms maximize (6) with respect to $p(i)$, yielding the following first order condition:

$$p(i) = \frac{w\beta}{\theta(i)}. \tag{7}$$

One thus obtains markup pricing, with a constant markup for a given $\theta(i)$. The markup is endogenous, however, since $\theta(i)$ is an endogenous variable chosen by the firm. Firms will take (7) into consideration when choosing $\theta(i)$.

Optimal product differentiation Each firm chooses their preference parameter $\theta(i)$ to maximize operating profits less the fixed cost to differentiate. Firm i's demand is the sum of consumer demands, $x(i) = Lc(i)$, where L is the number of consumers in the economy. Using (2), the demand for firm i's product is:

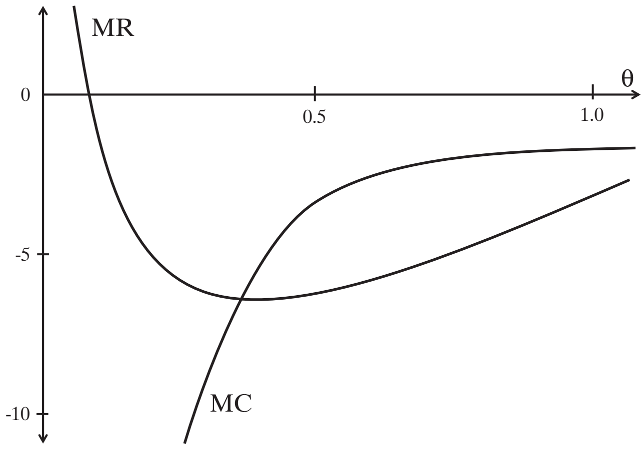

Figure 1. Graphical Illustration of Existence of Maximum Solution, $F(\theta)=\dfrac{1-\theta}{\theta}$, $L=100$, $\beta=1$

$$x_i(p(i),\theta(i),L,\lambda)=L\left(\frac{\theta(i)}{\lambda p(i)}\right)^{\frac{1}{1-\theta(i)}}. \tag{8}$$

Firms take λ, the marginal utility of income, and the denominator in (8) as given when setting their preference parameter. The first order condition for product differentiation is derived by substituting (7) and (8) into (6), then maximizing firm profits with respect to $\theta(i)$:

$$(p(i)-w\beta)x(i)\left[\frac{\ln\left(\dfrac{\theta(i)}{\lambda w\beta}\right)}{(1-\theta(i))^2}+\frac{1}{(1-\theta(i))\theta(i)}\right]=wF'(\theta(i)). \tag{9}$$

We can obtain a simpler expression describing the optimal level of product differentiation by substituting (3) into (9) and rearranging:

$$\frac{\beta x(i)}{\theta(i)}\left[\ln\left(\frac{x(i)}{L}\right)+\frac{1}{\theta(i)}\right]=F'(\theta(i)). \tag{10}$$

Equation (10) equates the marginal revenue and marginal cost of reducing product differentiation. The functional form in equation (5) imposes the assumption that the marginal cost of product differentiation increases and approaches infinity as $\theta(i)$ decreases towards zero. A graphical illustration of marginal revenue and marginal cost is given in Figure 1.

Equilibrium with identical firms The rest of this section assumes that firms are identical, meaning that they will all choose the same level of product differentiation. Firms enter until profits equal zero for each firm. Combining the markup pricing condition (7) and the zero profit condition $p=w\beta+wF(\theta)/x$, one obtains an expression for output per firm:

$$x = \frac{F(\theta)}{\beta}\frac{\theta}{1-\theta}. \tag{11}$$

The functional form of $F(\theta)$ can be chosen such that x is an increasing, decreasing, or constant function of θ.

The full employment of labor condition determines the number of firms in the manufacturing industry:

$$N = \frac{L}{F(\theta)+\beta x}. \tag{12}$$

The first order condition for optimal product differentation in the symmetric equilibrium is found by substituting (11) into (10) and using the explicit functional form for the advertising function from (5):

$$\ln\left(\frac{\alpha}{L\beta}\right)+\frac{2}{\theta}=0. \tag{13}$$

Rearranging (13) yields the following solution for the elasticity of substitution:

$$\theta = \frac{2}{\ln\left(\frac{\beta L}{\alpha}\right)}, \quad \ln\left(\frac{\beta L}{\alpha}\right) > 2, \tag{14}$$

with a unique solution for θ. There is a lower bound on the term $\ln(\beta L/\alpha)$ since θ is bounded between zero and one. The analytical solutions for the remaining endogenous variables can then be found by substituting (14) into (5), (7), (11) and (12):

$$F = \alpha\frac{\ln\left(\frac{\beta L}{\alpha}\right)-2}{2}, \tag{15}$$

$$p = \frac{w\beta}{2}\ln\left(\frac{\beta L}{\alpha}\right), \tag{16}$$

$$x = \frac{\alpha}{\beta}, \tag{17}$$

$$N = L\frac{2}{\alpha\ln\left(\frac{\beta L}{\alpha}\right)}. \tag{18}$$

Overall, equations (14)–(18) make up the autarky model. This includes the same equations as Krugman (1980) for profit maximization in price, zero profits and full employment of labor, plus (5) and (10). The unknowns are p, x, N, θ and F.

The second order condition reveals that the solution yields a unique a maximum:

$$-2\theta^{-2} < 0.$$

This particular formulation of the advertising function is tractable because it eliminates the problem of having a logged θ term in (13). The analytically solvable model is also characterized by product differentiation and markups increasing in β, the marginal cost parameter. Thus more expensive materials lead to higher markups and more product differentiation.

Market Size Effect

The model predicts that firms' spending on product differentiation is affected by market size, which has important implications for markups and entry. The next proposition describes how market size affects equilibrium product differentiation.

PROPOSITION 1. *Product differentiation is increasing in market size, i.e.:*

$$\frac{d\theta}{dL} < 0.$$

PROOF. The derivative of equation (14) with respect to θ is negative.

The intuition for this result falls directly from the love-of-variety property of the generalized CES utility function. The elasticity of substitution affects the concavity of utility for each variety and a greater concavity of utility increases consumers' marginal utility of consumption at low levels of consumption. Larger markets encourage product differentiation because consumers consume more varieties and less per variety per capita. Consumers thus move down their utility curves for each variety and become more sensitive to firms' spending on product differentiation. Firms respond by spending more on product differentiation, which makes their demand curve more inelastic. This leads firms to spend more on product differentiation via the relationship specified in equation (5). Prices rise via the markup pricing rule (7).

The intuition for the market size effect is illustrated in Figure 2. Spending on product differentiation leads to a more concave utility curve, changing from $U(c, \theta_1)$ to $U(c, \theta_2)$. The effect of more concave utility on the marginal utility of income (the slope of the utility curve) depends on consumers' level of consumption, which ultimately depends on market size since consumers purchase more varieties and less per variety in larger markets. In a small market ($L = L_2$) product differentiation does not lead to any change in the marginal utility of income, i.e. $\lambda(L_2, \theta_1) = \lambda(L_2, \theta_2)$. In other words, product differentiation does not lead to a steeper utility curve at the level of consumption that occurs in the small market. In a large market, however, ($L = L_1$) a more concave utility function leads to an increase in the marginal utility of income from $\lambda(L_1, \theta_1)$ to $\lambda(L_1, \theta_2)$. For any market size larger than L_2 product differentiation will increase with market size.

It is important to note that the connection between market size and product differentiation is not caused by firms selling more units in larger markets. The market size effect can occur when firms sell the same number of units regardless of market size.[8] Larger markets are instead characterized by a greater amount of firms owing to the free entry condition in the model. The marginal benefit of product differentiation is affected not directly by the number of units a firm can sell but rather via the indirect mechanism whereby consumers put a greater value on variety in larger markets.

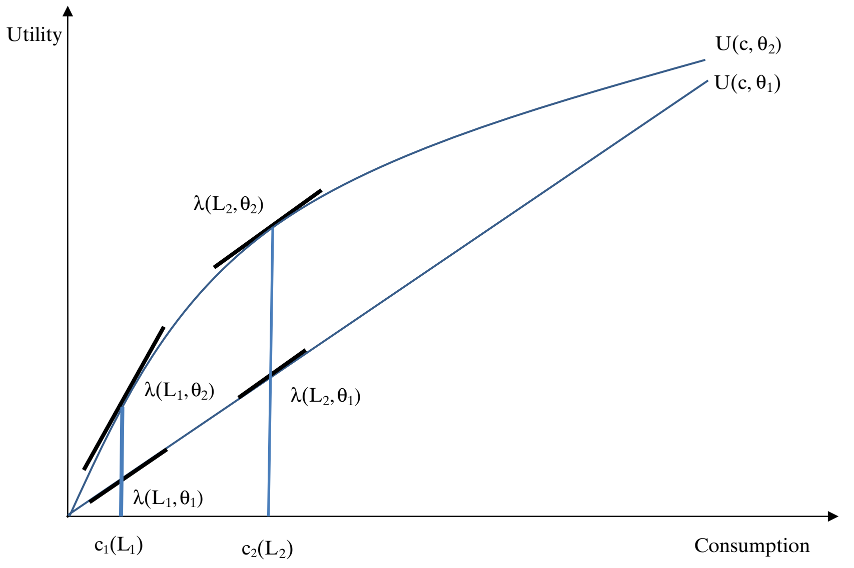

Figure 2. Effect of Product Differentiation on Marginal Utility of Income, Large vs Small Market

The market for restaurants is one plausible example of a market that satisfies these criteria. Larger markets tend not only to have more restaurants differentiated by location, but also restaurants that are highly differentiated from each other in terms of the cuisine they serve. Schiff (2013) finds that larger cities offer not only a larger number of restaurants but also a larger variety of cuisines. Moreover, he finds that rare cuisines are only found in cities with many restaurants while common cuisines can only be found in cities with few restaurants.

A prediction for an anti-competitive market size effect challenges the conventional wisdom that larger markets lead to lower price–cost markups. However, there are cases where entry does not lead to lower markups. For example, Ward et al. (2002) find that the entry of private label processed food and beverage products led brand-name firms to increase their prices. Using regional price data Tabuchi and Yoshida (2000) find that doubling city size increases nominal wages by 10% but decrease the real wage by 7–12%. Similarly, Roos (2006) finds a positive relationship between price levels and market size across German cities. Endogenous product differentiation may be one of many possible explanations for these price patterns.

Much of the evidence on pro-competitive effects relates to trade liberalization events, which I discuss after extending the basic model to include two countries and trade costs in Section 3. Some studies combine an element of market size and trade frictions, such as Hummels and Lugovskyy (2009) and Badinger (2007), which makes it difficult to relate to our theoretical result in the autarky model. Hummels and Lugovskyy (2009) study how import prices vary by importer country size and find in the trade data that 38 of 97 two-digit Harmonized System (HS) product codes display statistically significant pro-competitive effects, comprising 82% of total trade flows. Badinger (2007) finds that the EU single market led to lower price–cost markups in manufacturing, but did not affect markups in the service sector.

The prediction that markups increase in market size is the opposite conclusion of the "ideal variety" approach to modeling monopolistic competition, whether product differentiation is exogenous as in Lancaster (1979, 1980) or endogenously determined as in Weitzman (1994). The reason for this discrepancy is that product differentiation imposes a disutility on consumers in the ideal variety approach, while it enhances consumers' utility in the "love of variety" approach. Adding endogenous product differentation in the manner described above provides a very different result compared with workhorse models of monopolistic competition in the international trade and new economic geography literature.[9] The anti-competitive prediction is, however, related to recent theoretical contributions in the industrial organization literature, such as Amir and Lambson (2000) and Chen and Riordan (2007, 2008). The predictions here are relevant for goods with a propensity for endogenous product differentiation, which explains why it conflicts with the evidence from the market for ready-mixed concrete (Syverson, 2004). Ready-mixed concrete is a homogeneous product, which makes switching between suppliers easier when markets are more dense. In contrast, my framework deals with markets for differentiated products and going without a particular good is more difficult in larger markets because goods are more differentiated.

Product Differentiation and Variety Congestion

It is also worthwhile to analyze the implications of endogenous product differentiation on variety congestion as markets expand. I focus on the ratio of varieties to consumers N/L, which can be thought of as a measure of variety congestion, or alternatively, an inverse measure of market concentration. I derive this measure by substituting (11) into (12) and dividing by L:

$$n \equiv \frac{N}{L} = \frac{1-\theta}{F(\theta)}. \tag{19}$$

Equation (19) illustrates that the number of varieties per consumer depends on fixed cost spending and the degree of differentiation between products. In Krugman (1980) this ratio is a constant regardless of market size. In my framework, however, this ratio may either increase or decrease as markets grow. The impact of market size on variety congestion can be more clearly seen by totally differentiating (19) with respect to L:

$$\frac{dn}{dL} = -\frac{1}{F(\theta)}\frac{d\theta}{dL} - \frac{1-\theta}{(F(\theta))^2}\frac{dF(\theta)}{d\theta}\frac{d\theta}{dL}. \tag{20}$$

One can see in (20) that market size affects congestion via two distinct channels. The first channel is the effect of market size on congestion via product differentiation, which is positive since Proposition 1 showed that $d\theta/dL$ is negative. The second channel is the effect of market size on congestion owing to fixed cost spending, which depends on the elasticity of the advertising function and the market size effect on product differentiation. The second channel is negative since $dF(\theta)/d\theta$ is negative by the assumptions on the shape of the advertising function given in equation (5). These two channels capture the two countervailing effects of product differentiation on congestion. On the one hand, product differentiation on its own has positive effects on variety, but on the other, the fixed costs associated with increasing product differentiation reduces variety by leading to fewer larger firms.

The net effect of product differentiation on variety congestion is not clear from equation (20). One can show, however, that the evolution of congestion as the market expands depends critically on the elasticity of the advertising function. I summarize this result in the following proposition:

PROPOSITION 2. *If the advertising function is sufficiently elastic then variety congestion is decreasing with market size.*

$$\frac{dF(\theta)}{d\theta}\frac{\theta}{F(\theta)} < -\frac{\theta}{1-\theta} \Rightarrow \frac{dn}{dL}\frac{L}{n} < 0.$$

PROOF. See Appendix.

An advertising function that leads to decreasing congestion as the market expands is one where fixed cost spending must increase by at least $\theta/(1-\theta)\%$ in order to reduce θ by 1%. Firms are induced to spend more on product differentiation as the market grows to such an extent that they increase in size, leading to less variety congestion. In other words, entry increases with market size but at a decreasing rate when the advertising function is sufficiently elastic. The elasticity of the explicit functional form of the advertising function from equation (5) is $-1/(1-\theta)$ and thus has the property that variety congestion is decreasing in market size.

This result contrasts with the oligopoly framework of Bresnahan and Reiss (1991) that infers increased competition and lower markups when entry is increasing and concave in market size. For example, Campbell and Hopenhayn (2005) found that retailing firms are larger in larger cities, and concluded that firms were larger owing to falling markups in larger markets, although the authors had no direct evidence on markups. My framework suggests, however, that market size and firm numbers or firm size alone do not provide sufficient information to make inferences about competition. The endogenous sunk cost literature argues a similar point. In contrast to Sutton (1991), however, my framework predicts an anti-competitive market size effect without requiring a high concentration of firms. This result differs from the model of Zhelobodko et al. (2012), which predicts that firm size increases with market size only in the pro-competitive case. Including a fixed cost to differentiate means that firm size is increasing with market size even in the anti-competitive case.

3. Two Countries and Trade Costs

Setting, Preferences and Technology

Extending the basic model to a two country model with trade costs yields new results regarding how trade liberalization affects product differentiation. Preferences and the firms' problem are identical to the basic model. I assume iceberg trade costs between the two countries, whereby τ units must be shipped in order for one unit to arrive at its destination. I assume that the markets are of equal size and that firms are identical. These simplifications allow us to more easily see the effect of trade costs on equilibrium product differentiation.

The Trade Friction Effect

The effect of trade costs on the equilibrium level of product differentiation is a unique property of the model. The first order condition for product differentiation under the special case where country sizes are identical (i.e. $L = L^*$) is:[10]

$$\underbrace{\frac{F(\theta)}{1-\theta}\left[\ln\left(\frac{\frac{F(\theta)}{\beta}\frac{\theta}{1-\theta}}{\mu L\left(1+\tau^{\frac{-\theta}{1-\theta}}\right)}\right)+\frac{1}{\theta}\right]}_{\text{"market size effect"}}-\underbrace{\frac{F(\theta)}{(1-\theta)^2}\left[\frac{\tau^{\frac{-\theta}{1-\theta}}\ln\tau}{1+\tau^{\frac{-\theta}{1-\theta}}}\right]}_{\text{"trade friction effect"}}=F'(\theta). \tag{21}$$

This equation effectively divides the first order condition into two parts, a "market size effect" and a "trade friction effect". The "market size effect" is almost identical to the left-hand side of the first order condition in the basic model given in equation (13), except for the additional term $1 + \tau^{-\theta/(1-\theta)}$ multiplying L in the denominator. This term equals 1 under infinite trade costs and 2 under free trade, since free trade between two countries of equal size effectively doubles the market.

The "trade friction effect" is an additional term that is not present in the first order condition under autarky. It can be shown that if trade costs per unit are zero or approach infinity (using L'Hôpital's rule, see Appendix) then no trade occurs and the trade friction effect equals zero.

The nonlinear nature of (21) makes it difficult to find a closed form solution for equilibrium production differentiation as a function of trade costs. A graphical illustration of the numerical solution of the two-country model with trade costs and symmetric country size under various levels of trade costs is shown in Figure 3. The numerical solution illustrates that product differentiation increases when moving either from autarky or free trade and is maximized at some intermediate level of trade costs. Trade frictions thus affect more than just market potential in the model; the friction itself enhances the marginal revenue of product differentiation. The intuition is that lowering θ abates the loss of demand owing to "melting" and the marginal benefit from this activity is greatest when "melting" is greatest (i.e. intermediate trade costs).

It can be helpful to analyze this result within a trade liberalization context. If trade costs are gradually lowered from autarky to free trade, θ first decreases, then increases as trade costs approach zero. Similarly, F and p first increase to a maximum at some intermediate level of trade costs, then decrease as trade costs approach zero. This contrasts with the monotonic market size effects that one observes in the basic closed economy model. The result that product differentiation effects are strongest at intermediate trade costs is akin to new economic geography literature, where agglomeration forces are strongest at intermediate trade costs.

The model predicts an inverted-U relationship between trade liberalization and markups. When trade costs are at an intermediate level and trade is liberalized further, the model predicts a pro-competitive effect, in line with many empirical studies in the international trade literature. For example, Roberts and Tybout (1996) find that higher industry-wide exposure to foreign competition results in lower (price–cost) margins in Mexico, Columbia, Chile and Morocco.[11] The model predicts an anti-competitive effect of trade liberalization only when departing from autarky and when variable trade costs are extremely high. In the numerical simulation in Figure 3 one

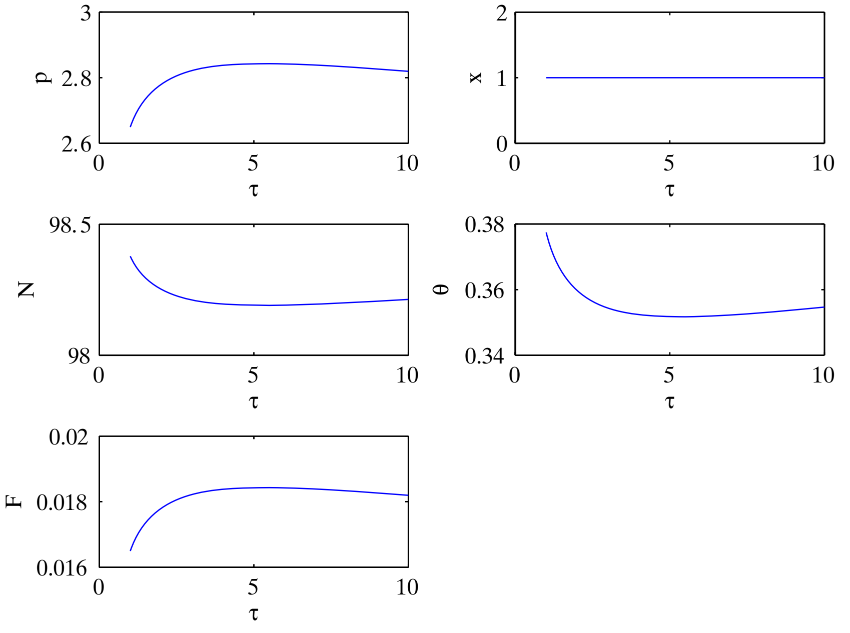

Figure 3. Two Country Simulation, Varying Trade Costs, $L = L^* = 100$, $F(\theta) = \dfrac{1}{100}\dfrac{1-\theta}{\theta}$, $\beta = 1$

can see that trade costs must exceed $\tau = 5$ for trade liberalization to have a markup-widening effect.

4. Product Differentiation and Welfare

An important question is whether or not the forces of endogenous product differentiation lead to higher or lower welfare as markets expand. I use the direct utility function defined in equation (1) to examine the welfare effects of market size. Substituting (11) and (12) into (1), assuming symmetric firms and using $c = x/L$ provides an expression of utility in terms of market size and product differentiation:

$$U(L,\theta) = \left(\frac{L\theta}{\alpha}\right)^{\frac{1-\theta}{\theta}} \frac{\theta}{\beta}. \tag{22}$$

The total differential of the utility function with respect to market size is:

$$\frac{dU}{dL} = \frac{\partial U}{\partial L} + \frac{\partial U}{\partial \theta}\frac{d\theta}{dL}.$$

The direct effect of L on utility is positive. The effect of product differentation on utility, however, is unclear without further derivations because reductions in θ have two countervailing effects: utility becomes more concave in consumption, but prices increase as markups widen. This contrasts with Krugman (1980) that assumes exogenous technology, where markups are constant and welfare effects occur exclusively via increased variety.

It is clear from (22) that $\partial U/\partial L > 0$. $\partial\theta/\partial L < 0$ as a result of Proposition 1. The partial derivative of equation (22) with respect to θ is:

$$\frac{\partial}{\partial\theta}\left(\left(\frac{L\theta}{\alpha}\right)^{\frac{1-\theta}{\theta}}\frac{\theta}{\beta}\right) = -\frac{1}{L\theta^2}\frac{\alpha}{\beta}\left(\ln L\frac{\theta}{\alpha}-1\right)\left(L\frac{\theta}{\alpha}\right)^{\frac{1}{\theta}}. \tag{23}$$

The sign of this derivative depends on the term $\ln(L\theta/\alpha) - 1$ in (23). Plugging in the solutions for $\partial U/\partial L$, $\partial U/\partial\theta$ and $d\theta/dL$ into the total differential and using the solution for θ from (14) provides a condition under which utility per capita is increasing in market size:

$$\frac{\partial U}{\partial L} \geq 0 \Leftrightarrow \left(\frac{\frac{2}{\ln\left(\frac{\beta L}{\alpha}\right)}}{\alpha}\right)^{\frac{1-\theta}{\theta}} L^{\frac{1-2\theta}{\theta}} + \left[\frac{1}{2L^2}\frac{\alpha}{\beta}\left(\ln\frac{L}{\alpha}\frac{2}{\ln\left(\frac{\beta L}{\alpha}\right)}-1\right)\left(\frac{L}{\alpha}\frac{2}{\ln\left(\frac{\beta L}{\alpha}\right)}\right)^{\frac{1}{\theta}}\right] \geq 0.$$

This condition imposes a parameter restriction on $\ln(\beta L/\alpha)$, similar to the existence condition required in (14). Endogenous product differentiation modeled in this way thus has a net positive effect on welfare when the market expands, despite the adverse effect of higher markups.

5. Conclusion

I take a new look at the determinants of product differentiation using a monopolistic competition framework. The model allows for firms to endogenously choose from a continuous set of technologies by creating a trade-off between fixed costs and product differentiation. This assumption is consistent with fixed costs that represent persuasive advertising or product development that differentiate one's own product from others in the eyes of consumers. Fixed costs, markups, and output per firm are increasing functions of market size. The model thus generates "endogenous markups" that are a direct result of firms' optimizing behavior.

This reduced-form approach to modeling endogenous product differentiation may provide a useful policy insight to economists who analyze the anti-competitive effects of trade liberalization and economic integration. In particular, this paper illustrates that larger markets can lead to an upward pressure on markups that are not caused by firms' anti-competitive behavior.

The theoretical model suggests that endogenous product differentiation contributes positively to the welfare gains from economic integration. Endogenous product differentiation thus yields gains from trade that the international trade and economic geography literature have thus far overlooked. The prediction that markups increase with market size follows a new literature exploring a more nuanced approach to adressing the effect of intregration on markups. While pro-competitive effects are commonly found and their causes are clearly understood, evidence and intuition suggests that the forces of product differentiation may also be at play. As Jean Tirole (1988, p. 289) puts it, "Though it will be argued that advertising may foster competition by increasing the elasticity of demand (reducing 'differentiation'), it is easy to find cases in which the reverse is true". It is hoped that this paper has given some theoretical foundation to this argument.

Appendix

Proof of Proposition 2.

The result is obtained by multiplying both sides of (20) by $n/L = (1 - \theta)/F(\theta)$, then rearranging, to obtain the following expression:

$$\frac{dn}{dL}\frac{L}{n} = -\frac{d\theta}{dL}\frac{L}{\theta}\left[\frac{dF(\theta)}{d\theta}\frac{\theta}{F(\theta)} + \frac{\theta}{1-\theta}\right].$$

The sign of $(dn/dL)/(L/n)$ will be negative (i.e. variety congestion decreasing with market size) if the term in brackets is negative. This parameter restriction can be expressed as the following:

$$\frac{dn}{dL}\frac{L}{n} < 0 \Leftrightarrow \frac{dF(\theta)}{d\theta}\frac{\theta}{F(\theta)} < -\frac{\theta}{1-\theta}.$$

Deriving the First Order Condition, Two Countries and Trade Costs

This section shows the calculations for deriving equation (21). The demand for firm i's product with two countries of equal size and trade costs is:

$$x(i)(p(i), \theta(i), N, L, \lambda) = \left(1 + \tau^{\frac{-\theta(i)}{1-\theta(i)}}\right)\mu L\left(\frac{\theta(i)}{\lambda p(i)}\right)^{\frac{1}{1-\theta(i)}}. \tag{A1}$$

As in autarky, firms take λ, the marginal utility of income and the denominator in (A1) as given when setting their preference parameter. The first order condition for product differentiation is derived by substituting (7) and (A1) into (6), then maximizing firm profits with respect to θ (suppressing the i index):

$$(p(\theta) - w\beta)x(p,\theta)\left[\begin{array}{c}\dfrac{1}{(1-\theta)^2}\ln\left(\dfrac{1}{\lambda w\beta}\right) + \dfrac{2}{(1-\theta)^2}\ln\theta \\ + \dfrac{1}{(1-\theta)\theta} - \dfrac{\tau^{\frac{-\theta}{1-\theta}}\ln\tau}{(1-\theta)^2\left(1+\tau^{\frac{-\theta}{1-\theta}}\right)}\end{array}\right] = wF'(\theta). \tag{A2}$$

One can obtain a simpler expression describing the optimum level of product differentiation by substituting (3) into (A2) and rearranging:

$$\frac{\beta x(p,\theta)}{\theta}\left[\ln\left(\frac{x}{\mu L\left(1+\tau^{\frac{1}{1-\theta}}\right)}\right) + \frac{1}{\theta} - \frac{1}{1-\theta}\frac{\tau^{\frac{-\theta}{1-\theta}}\ln\tau}{\left(1+\tau^{\frac{-\theta}{1-\theta}}\right)}\right] = F'(\theta). \tag{A3}$$

Finally, we obtain equation (21) by substituting (11) into (A3).

Properties of the Trade Friction Effect

Use L'Hopitals rule to solve for $\tau = 0$ and $\tau = \infty$:

$$\lim_{\tau \to 1^+} \frac{\tau^{\frac{-\theta}{1-\theta}} \ln \tau}{1+\tau^{\frac{-\theta}{1-\theta}}} = \lim_{\tau \to 1^+} \frac{\frac{\partial}{\partial \tau}(\ln \tau)}{\frac{\partial}{\partial \tau}\left(\frac{1+\tau^{\frac{-\theta}{1-\theta}}}{\tau^{\frac{-\theta}{1-\theta}}}\right)} \lim_{\tau \to 1^+} \tau^{-\frac{\theta}{1-\theta}} \frac{1-\theta}{\theta} = 0,$$

$$\lim_{\tau \to \infty} \frac{\tau^{\frac{-\theta}{1-\theta}} \ln \tau}{1+\tau^{\frac{-\theta}{1-\theta}}} = \lim_{\tau \to \infty} \frac{\frac{\partial}{\partial \tau}(\ln \tau)}{\frac{\partial}{\partial \tau}\left(\frac{1+\tau^{\frac{-\theta}{1-\theta}}}{\tau^{\frac{-\theta}{1-\theta}}}\right)} = \lim_{\tau \to \infty} \tau^{-\frac{\theta}{1-\theta}} \frac{1-\theta}{\theta} = 0.$$

The trade friction effect equals zero when $\tau = 1$ or when $\tau = \infty$.

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Notes

1. This contrasts with most of the previous literature on trade and endogenous technology, such as Markusen and Venables (1997), Ekholm and Midelfart (2005) and Bustos (2011) that assume a trade-off between lower marginal costs and higher fixed costs.
2. Prominent examples include Lin and Saggi (2002), Baldwin and Harrigan (2011), Simonovska (2010) and Khandelwal (2010).
3. The model in this paper describes endogenous horizontal product differentiation, in contrast to the models of vertical product differentiation in the Industrial Organization literature. Prominent examples include Shaked and Sutton (1987), Mazzeo (2002) and Berry and Waldfogel (2010).
4. Analyzing the implications of endgenous fixed costs on variety also relates to the new literature on optimal industrial allocations and trade under endogenous markups, such as Dhingra and Morrow (2013).
5. The idea that firms can actively differentiate their products dates as as far back as Hotelling (1929) and its use as a marketing strategy was formally documented by Smith (1956).
6. The welfare analysis complements existing studies that evaluate the welfare implications of globalization on variety, such as Broda and Weinstein (2006), Arkolakis et al. (2008) and Cole and Davies (2014).
7. Since $\theta(i)$ is a parameter in the consumer's utility function it may be argued that it is not observable. I assume that firms are able to invest in product differentiation, which is assumed to have a mapping into $\theta(i)$.
8. The functional form of the advertising function in (5) has the property that the quantity sold is independent of market size.
9. The intra-industry trade models of Krugman (1980) and Helpman and Krugman (1987) employ Dixit and Stiglitz (1977) preferences and exhibit no market size or distance effect on prices. The heterogeneous firm model by Melitz (2003) exhibits no market size effects and average export prices that are decreasing in distance. Models based on Melitz and Ottaviano (2008) assume quadratic utility and exhibit "pro-competitive effects", whereby markups and hence prices are lower in larger markets owing to greater competition. Models based on Baldwin and Harrigan (2011) exhibit the desired characteristic that higher-priced goods are sold to more distant countries, but lack any market size effect.
10. A detailed description of the steps required to obtain equation (21) is given in the Appendix.
11. See Tybout (2003) for a comprehensive review of the literature on earlier studies of trade liberalization and markups.