Applied Economics, 2003, **35**, 1679–1687

Routledge
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Modelling hierarchical consumer preferences: an application to global food markets

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I. INTRODUCTION

In the literature considerable attention has been devoted to the relationship between consumer preference and a product's country of origin (Papadopoulos, 1993), and it is well established that the latter has an influence on quality perceptions (Bilkey and Nes, 1982). Whilst empirical studies have tended to concentrate on manufactured goods, there is evidence that food products exhibit strong country-of-origin characteristics (Bonnet and Simioni, 2001; Scarpa *et al.*, 2001; van der Lans *et al.*, 2001)[1] and, furthermore, that consumers typically favour *domestic* food varieties over foreign substitutes (Quagrainie *et al.*, 1998; Unterschultz *et al.*, 1998). With international trade in food expanding rapidly in global markets, and consumers facing an unprecedented level of variety, 'product-country images' are assuming greater significance (Skaggs *et al.*, 1996). More importantly, policy initiatives to promote 'regional' foods and product awareness within Europe (Peri and Gaeta, 1999), coupled with the growing antiglobalization sentiments of some sections of society, are likely to have implications for international trade by reinforcing consumer preference for domestically produced varieties and strengthening any 'preference barrier' effect.[2]

Much of the recent literature on quantitative analysis of international trade is set in the context of general equilibrium. Accordingly, against a background of continuing liberalization of world markets, and with further reforms anticipated under WTO (World Trade Organization) negotiations, a method of modelling endogenous hierarchical (ranked) consumer preferences is reported, based on region of origin, within a computable general equilibrium (CGE) framework. This extends the treatment of endogenous product differentiation in CGE models and adds an extra dimension to the exogenous, region-of-origin approach maintained under the commonly adopted Armington assumption. The first part of the paper reports technical implementation of patriotic preference in imperfectly competitive food markets. This is then followed by an empirical illustration in which the impact on trade flows is isolated.

II. PRODUCT DIFFERENTIATION AND MARKET STRUCTURE IN CGE MODELS[3]

Homogeneous goods' models are consistent with the neoclassical theory of international trade, but are not equipped to deal with intra-industry trade. A response to this problem, widely employed in the CGE literature, is use of the Armington (1969) specification. This allows for two-way

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[1] An explanation for the lack of region-of-origin based studies for food products is provided in Pecher and Tregear (2000, p. 2), who suggest that '... researchers tend to regard food purchases as low involvement/low risk items. As such they believe these purchases do not entail protracted deliberations by consumers, thereby limiting the extent to which country of origin variables are implicated'.

[2] The term 'preference barrier' is used by Torstensson, (1999, p. 29).

[3] In this paper, *horizontal* product differentiation is referred to which is associated with perceived product differences by consumers either in the form of 'love of variety' (Dixit and Stiglitz, 1977) or the 'favourite variety' approach (Lancaster, 1979). This contrasts with *vertical* product differentiation between products which is represented as actual quality differences through either comparative advantage or Research and Development (Shaked and Sutton, 1984).

Applied Economics ISSN 0003–6846 print/ISSN 1466–4283 online © 2003 Taylor & Francis Ltd
http://www.tandf.co.uk/journals
DOI: 10.1080/0003684032000128454

trade in otherwise homogeneous products by linking product differentiation with exogenous considerations related to region of origin. For example, agricultural products may have disparate physical attributes relating to differences in climate or soil, or because different varieties (e.g., soft and hard wheat) are often treated as a single commodity.

Armington import demands in multiregion CGE models are characterized by employing a two-stage ('nested') separable function:

$$Q_i = f\lfloor D_i, g(M_{i,r}, M_{i,s}, \ldots)\rfloor \tag{1}$$

In Equation 1, function f ('upper level nest') consists of domestic demand for product i, (D_i), and a 'composite' import substitute, function g. In the latter (the 'lower level nest'), imports of i are distinguished by region of origin (r,s...). Thus, the *exogenous* value of the substitution elasticity governs the association between the degree of perceived product differentiation and regional origin in both the upper and lower level nests.

The CGE literature also recognizes that product differentiation exists between firms as well as between regions. If firms produce differentiated products, then they may exercise market power, which necessitates the modelling of imperfect competition. Thus, *endogenous* product differentiation may be characterized through the treatment of production costs and utility effects resulting from changes in varietal diversity. The main approach stems from the work of Spence (1976), and Dixit and Stiglitz (1977), (SDS), where each firm is assumed to produce a given variety. At the firm level, the costs of product differentiation are traditionally represented as fixed costs (i.e., research and development, advertising), with variable costs treated within a constant returns to scale framework. The exogenous mark-up ratio of output price to marginal cost is just sufficient to cover the fixed costs of product differentiation and preserve zero profit. Increases in output per firm have the effect of reducing average total costs, referred to as the 'scale effect', while positive profits are competed away by long run entry of firms, which yields increased variety and utility in consumption – the 'love of variety' effect.

An alternative 'preferred variety' approach, based on the seminal work of Hotelling (1929) and developed by Lancaster (1979, 1980, 1984), has not been commonly employed within the CGE literature. In this case, the notion of endogenous product differentiation and firm costs is identical to the SDS approach but individual consumers are assumed to possess a 'varietal spectrum'. Lancaster postulated that varieties are differentiated explicitly in terms of their characteristics or attributes, and are ranked with respect to an 'ideal', where varieties which are spatially closer to the ideal on the varietal spectrum are more preferred. For a given level of utility, the price that the consumer pays for a variety is inversely related to the distance of this variety from the ideal. Thus, each consumer's demand for a variety on the spectrum is a function of own price, the price of other varieties and the distance of the chosen variety from the consumer's ideal. In contrast to the SDS specification, preferences are asymmetric, where two varieties with equal price can still be ranked differently to each other.

In view of the recent empirical findings relating to consumer preferences for food, a unique CGE multiregion treatment of the preferred variety approach of Lancaster is employed. More specifically, it is assumed that consumers exhibit hierarchical preferences, with typically the domestic variety most preferred. Thus, endogenous product differentiation considerations are extended to include a region of origin component, where changes in the number of firms (product variants) has a direct impact on the positioning of a regional variety on the consumer's spectrum.[4] The endogeneity of consumer attitudes to region of origin adds an extra dimension, since the standard exogenous 'physical attributes' approach maintained under the Armington assumption neither captures the notion of a region of origin preference ranking, nor allows for changes in regional variety perceptions (and associated utilities) by consumers.

On the production side, an eclectic market structure approach employed in the literature is followed (Horn, 1984; Brown, 1987; Hertel, 1994; Harrison *et al.* 1995) which combines conditions of product differentiation and freedom of entry/exit with oligopolistic strategic (Cournot) conjecture.[5] This gives rise to 'pro-competitive' effects, defined as reductions in the mark-up distortion, as well as changes in the scale of firm output. However, here discussion is focused on the demand side of the economy to assess endogenous product differentiation and consumers' preferences, based on region of origin, and to examine whether consumer loyalty to the domestic product has a significant impact on market share and trade flows.

III. MODELLING HIERARCHICAL PREFERENCES

Assume each of say three regions produces its own 'representative variety' of a given differentiated product, characterized by a combination of attributes, e.g., after sale

[4] Firms are assumed to be indifferent to the origin of an input because, as profit maximizers, costs are paramount. Thus, *intermediate* input demands are dictated solely by technological considerations governed by the elasticity of substitution.

[5] In international (perishable) food markets, the use of quantity as a strategic variable (Cournot assumption) arguably is more appropriate than that of price (Betrand assumption). Moreover, the importance of mark-up variations by seller's market are also captured (i.e., domestic versus export market).

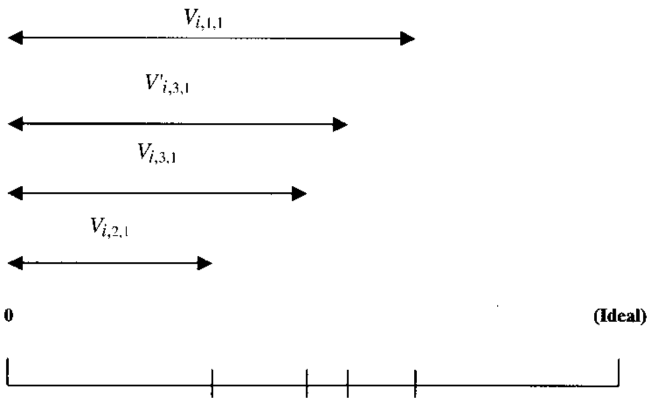

Fig. 1. *Hierarchical preferences on the varietal spectrum*

service, quality, taste, packaging. Figure 1 presents a varietal spectrum, where the 'ideal' is a variety with the perfect combination of attributes for a particular consumer.[6] On the spectrum, $V_{i,r,s}$ represents the distance from zero of representative variety *i*, in region of destination *s* produced by region *r*. It determines the preference ranking, where those varieties closer to the ideal are more preferred. Suppose that the varietal spectrum in Fig. 1 pertains to a consumer in region 1 (i.e., $s=1$). Thus, $V_{i,1,1}$ is larger than $V_{i,3,1}$ which is larger than $V_{i,2,1}$, implying that the consumer most prefers the domestic variety, followed by the variety from region 3, which in turn is preferred to the variety from region 2.

The approach differs from that of Lancaster (1979) who assumes that each consumer has only a single preferred variety with all others treated homogeneously (i.e., equal preference), but is a variant of the 'interleaved' type of preference structure (Lancaster, 1984), where the domestic variety is substitutable with imported varieties. It is assumed that each imperfectly competitive firm produces a unique product variant of the representative variety.[7] This approach predicts that proliferation in the number of firms (product variants) in a given region will enable that region's representative variety to come closer to the ideal (Vousden, 1990).[8] This improves the relative position (and possibly the ranking) of that representative variety in the hierarchical preference structure. For example, in Fig. 1 a proliferation of product variants in region 3, *ceteris paribus*, causes the preference value of that region's representative variety to increase to $V'_{i,3,1}$. It is this process that characterizes the 'variety effect'.

Following Lancaster (1984 and 1991), cardinal hierarchical utility from the consumption of a representative variety '*i*' from region '*r*' to the consumer in '*s*', $Z_{i,r,s}$, is given as:

$$Z_{i,r,s} = [1 + V_{i,r,s}]^{\gamma_{i,s}} \quad \gamma_{i,s} > 0 \tag{2}$$

Equation 2 is strictly increasing in V and "the effect of distance increases as products differ more and more from the ideal" (Lancaster, 1991, p. 3). Thus, varieties with higher preference values ($V_{i,r,s}$), yield higher amounts of hierarchical utility ($Z_{i,r,s}$) compared to less favoured varieties. Linearizing Equation 2 gives:[9]

$$z_{i,r,s} = \left[\frac{\gamma_{i,s} V_{i,r,s}}{[1 + V_{i,r,s}]}\right] n_{i,r} \tag{3}$$

where increases (decreases) in the number of regional firms, or product variants, ($n_{i,r}$), proxy for improvements (deteriorations) in that region's representative variety's preference value ($V_{i,r,s}$) on the varietal spectrum.

The parameter $\gamma_{i,s}$ characterizes the degree of preference heterogeneity, i.e., it measures the consumer's perception of differentiation. If $\gamma_{i,s}$ is large, the consumer identifies strongly with varietal choice, whereas with smaller values of $\gamma_{i,s}$ the consumer is less concerned with variety. In the model, larger values of $\gamma_{i,s}$ result in larger differences in hierarchical utilities between higher and lower ranked representative varieties. If $\gamma_{i,s}=0$, all representative varieties have the same hierarchical utility value ($Z_{i,r,s}=1$) which implies preference homogeneity.[10] It is assumed that marginal hierarchical utility ($\partial Z_{i,r,s}/\partial V_{i,r,s}$) falls as a representative variety moves closer to the ideal, i.e., $0<\gamma_{i,s}<1$ (Fig. 2).

Consumers' preferences are approximated in an Armington structure using a CES cost minimization procedure. However, in the case of the imperfectly competitive sectors, modified hierarchical Hicksian demands are based on a non-nested Armington structure, where domestic and foreign varieties compete *directly* with one another (Francois *et al.* 1995, Swaminathan and Hertel, 1996).

[6] Within the model, final demands are aggregated into a private household and a public household at the regional level. Disaggregation would involve arbitrary numbers of microconsumers within each market (as in the Lancaster approach), and would significantly enhance model size and complexity. For this reason, it is assumed that the preference rankings and behaviour exhibited by the aggregated households reflect those of microconsumers within each market.

[7] There are two reasons for this approach. First, from an economic point of view, a new firm is more likely to succeed in the industry by producing a new variant instead of duplicating an existing one (i.e., firms are trying to capture a niche in the product space). Secondly, a firm producing more than one variant would imply a different mark-up pricing rule for each, significantly enhancing model complexity.

[8] In Lancaster's treatment, the 'ideal' is a fictional utopia of the perfect variety, which is never realized due to a limit on the number of *available* varieties.

[9] A good review of CGE linearization techniques can be found in Horridge *et al.* (1993). Note, lowercase letters in linearized expressions are percentage change variables of their uppercase counterparts.

[10] When $\gamma_{i,s}=0$ percentage changes in hierarchical utility ($z_{i,r,s}$) are zero, so consumer (Hicksian) demands are standardized as functions of prices and subutility only, (i.e., preference homogeneity).

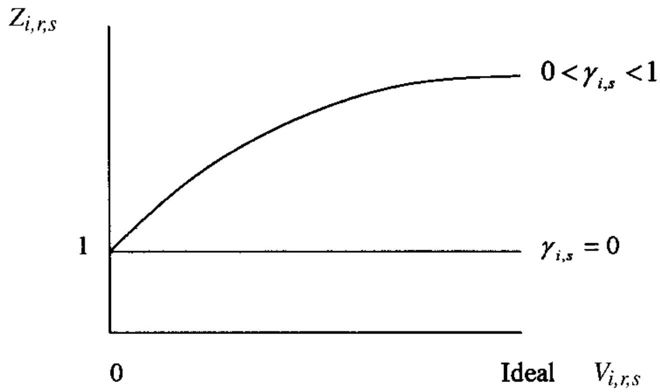

Fig. 2. *Concavity of the hierarchical utility function*

The choice of non-nested preferences supports the notion that consumers are making direct comparisons between varieties from each region on the varietal spectrum.[11] Moreover, a nested Armington structure effectively dampens the imperfectly competitive tie between regions, since firms compete only through composite goods such that variety and scale effects are limited to the regional level. The non-nested specification allows domestic and foreign firms to compete directly which enlarges the size of the market and therefore the gains from specialization, i.e., imperfect competition is 'global' (Francois *et al.*, 1995). Indeed, comparing the nested and non-nested specifications, Francois *et al.* (1995) find that the latter yields larger welfare effects.

To incorporate hierarchical preferences within this model framework, minimize expenditure on all representative varieties ($r=s$, $r\neq s$), subject to a modified non-nested CES subutility function (see Lancaster, 1984):

$$U_{i,s} = A_{i,s}\left[\sum_r \delta_{i,r,s} Q_{i,r,s}^{-\rho_i} Z_{i,r,s}\right]^{-1/\rho_i} \tag{4}$$

where $U_{i,s}$ is the level of subutility from the consumption of differentiated commodity i in region s; $Q_{i,r,s}$ is consumer demand in region s for representative variety i from region r; $Z_{i,r,s}$ is bilateral hierarchical utility associated with the consumption of the representative variety (Equation 2); $\delta_{i,r,s}$ is a CES share parameter; $A_{i,s}$ is a scale parameter; and ρ_i is an elasticity parameter. Linearizing gives:[12]

$$q_{i,r,s} = u_{i,s} - \sigma_i[p_{i,r,s} - p_{i,s}] + \sigma_i z_{i,r,s} \tag{5}$$

$$p_{i,s} = \sum_r S_{i,r,s} p_{i,r,s} + \frac{1}{\rho_i} z_{i,s} \tag{6}$$

$$z_{i,s} = \sum_r S_{i,r,s} z_{i,r,s} \tag{7}$$

$$\rho_i = \frac{1}{\sigma_i} - 1 \tag{8}$$

Linearized bilateral differentiated Hicksian demands ($q_{i,r,s}$) in Equation 5 are a function of total subutility ($u_{i,s}$), representative variety prices ($p_{i,r,s}$), composite price ($p_{i,s}$) and bilateral hierarchical utility ($z_{i,r,s}$). In this formulation, composite price is an average of representative variety prices weighted by expenditure shares ($S_{i,r,s}$) but modified by composite hierarchical utility ($z_{i,s}$) (Equation 6). Composite hierarchical utility is itself an expenditure share weighted average (Equation 7), and hence changes in bilateral hierarchical utility of the more preferred representative varieties in region s have larger effects on the composite. Finally, the elasticity parameter, ρ_i, is defined in Equation 8 in relation to the elasticity of substitution (σ_i).[13] Thus, Equations 3 and 5–8 encapsulate the treatment of hierarchical preferences within a linearized CGE model framework. With preference *homogeneity* (i.e., $\gamma_{i,s}=0$, $Z=1$, $z=0$), Equations 3 and 7 drop out and Equations 4, 5 and 6 revert to their standard Hicksian forms.[14]

Varietal effects can be discussed in the context of this framework. In region s, the effect of an increase in bilateral hierarchical utility ($z_{i,r,s}$) due to increases in product variants (firms) in region r, will always have a positive effect (*ceteris paribus*) on the demand for that representative variety, $q_{i,r,s}$. Varietal effects may also occur at constant prices ($p_{i,r,s}$) with increases in composite hierarchial utility. Thus, reference to the composite price Equation 6 shows that an increase in composite hierarchical utility ($z_{i,s}$) has the effect of reducing the per unit expenditure ($p_{i,s}$) necessary to acquire an extra unit of subutility ($u_{i,s}$). This is because increases in the level of aggregate varietal diversity enable consumers to purchase higher utility-yielding varieties with

[11] All perfectly competitive sectors in the model retain the standard (Hicksian) nested Armington framework, where regional varieties compete through a composite foreign variety.
[12] The mathematical derivation is given in the Appendix.
[13] The elasticity of substitution (σ_i) in Equation 7 needs to be greater than 1, implying that ρ_i is negative. If $\sigma_i \leq 1$, then ρ_i is zero or positive. In the former case, $1/\rho_i$ in the composite price equation prevents a model solution. In the latter case, a positive value for ρ_i would be counter intuitive with respect to changes in composite hierarchial utility in Equation 6. Moreover, values of σ_i less than 2 yield foreign mark-ups which are larger than the domestic mark-up, implying that firms always have a better 'foothold' abroad than at home, which is also counter intuitive.
[14] Equation 4 is expressed in a form that makes clear the relationship with the standard Hicksian form. However, Equation 4 can also be expressed as Equation A11 in the appendix, the third term of which emphasizes that changes in hierarchical utility are governed by changes in $z_{i,r,s}$ *relative* to changes in the composite, $z_{i,s}$. This is of particular relevance with respect to the empirical application reported later in the paper.

the same per unit cost, which is equivalent to accruing equal amounts of utility at lower cost.

Price effects are captured through relative movements in representative variety prices ($p_{i,r,s}$) and composite price ($p_{i,s}$) determining movements in demand ($q_{i,r,s}$). Thus, in this structure there are varietal and price effects contained within the Hicksian demands. Moreover, following Lancaster (1984), it is possible to have the same level of demand for two representative varieties, where one variety has a lower preference value, ($V_{i,r,s}$), but also a lower price, ($p_{i,r,s}$).

Finally, in the imperfectly competitive sectors, the number of firms, or product variants, ($n_{i,r}$), is determined by changes in output per firm ($qofm_{i,r}$) and industry output ($qo_{i,r}$), which are related by the linearized condition:

$$qo_{i,r} = qofm_{i,r} + n_{i,r} \tag{8}$$

Given a change in industry output, the change in output per firm is determined by the change in mark-up (i.e., pro-competitive effect), with the number of firms changing to ensure that condition (8) is satisfied. Moreover, any change in the number of firms influences the position of the representative variety on the varietal spectrum and thus the consumer preference value ($V_{i,r,s}$).

IV. EMPIRICAL APPLICATION

To isolate the potential impact of patriotic preference in international food markets, a CGE application is presented in which a comparison is made between two counterfactual equilibria – one under strong preference heterogeneity ($\gamma_{i,s} = 0.95$), the other under preference homogeneity ($\gamma_{i,s} = 0$). To test the notion of a 'preference barrier', focus is on the impact on market share and trade flows. The simulations are run using the GTAP (Global Trade Analysis Project) version 4 database for 1995 (McDougall *et al.* 1998), aggregated to 17 commodities[15] and 3 regions, namely the EU, the USA and a rest of the world aggregate (ROW). The database is projected through to the year 2000, using forecasted growth rates in capital, skilled and unskilled labour endowments, real GDP and agricultural total factor productivity, after Frandsen *et al.* (1998).[16] Capital and both types of labour are treated as perfectly mobile. The natural resource and land factors are 'sluggish' and specific to certain sectors.[17] Imperfect competition is introduced into the six food processing sectors, with all remaining sectors characterized as perfectly competitive.[18] Given the sizes of the three regions and the level of sectoral aggregation, the number of firms in each imperfectly competitive sector is set to 100 in the benchmark data set.[19]

The production technology in both perfectly and imperfectly competitive sectors is similar, with the top level in the nested structure governing substitution possibilities between composite value added and composite inputs.[20] In the second level of the nest, composite value added demands are split into primary factors, and composite input demands are disaggregated into domestic and composite imported inputs. The latter are further disaggregated by region of origin in a third level of the nest.

On the demand side, a homothetic utility function is used in the top level of the nest to allocate regional income over three forms of final demands (private and public households, and savings). In the lower levels, final demands for homogeneous goods are treated using a standard nested structure, while for differentiated products (i.e., representative varieties), the non-nested model structure detailed in Section III is employed.

In wishing to highlight the effects of patriotic purchasing behaviour, the domestic representative variety is characterized as being most favoured on the varietal spectrum. Benchmark preference values, $V_{i,r,s}$, are calibrated from expenditure shares on each representative variety (Table 1). Expenditure shares may not be the best measure to characterize preference hierarchies. Values for V could be based on stated preference choice experiments, a method that has been employed to identify country of origin effects (see for example, Unterschultz *et al.*, 1998; Kim *et al.*, 2000).

[15] The commodities are wheat, other grains, oilseeds, sugar, raw milk, cattle and sheep, pigs and poultry, other agriculture, meat processing, other meat processing, vegetable oils and fats, milk processing, sugar processing, other food processing, other primary, manufacturing and services.

[16] Land and natural resource endowments remain unchanged under the projections.

[17] The land factor is confined to the primary agricultural sectors, and the natural resource factor is specific to the 'other primary' sector.

[18] The chosen aggregation of the database highlights food processing to allow an imperfectly competitive treatment of these sectors. Conversely, the manufacturing and services sectors comprise a large number of disparate subsectors and, as such, are considered to be too aggregated to be charaterized as imperfectly competitive.

[19] Within the model, the relationship between number of firms, mark-up and market elasticity of demand is such that setting the number of firms to more than the chosen ceiling level of 100 has only a *marginal* effect on simulation results.

[20] Following Swaminathan and Hertel (1996), the imperfectly competitive sectors' primary value added nest is disaggregated into fixed and variable value added according to the mark-ups. The fixed component of value added accounts for all fixed costs in the model. Thus, the overheads of new product development (i.e., salaries of marketing staff and innovation engineers) are solely primary factor costs. Whilst this assumption is open to criticism (lack of detail pertaining to capital–labour intensities across fixed and variable costs in all regions, and lack of detail on the specific composition of fixed and variable cost at the chosen sectoral aggregation), 'it lends itself to easy analysis and simple interpretation' (Swaminathan and Hertel, 1996, p. 21).

However, this is beyond the scope of the present paper and in the absence of a more appropriate, readily available alternative, expenditure shares are used as an indication of consumers' purchasing predilections.

Although the number of product variants, or firms, ($n_{i,s}$), tends to increase under the projection simulations, the effect of preference heterogeneity alone is to reduce $n_{i,s}$ in all cases. However, it is *relative* movement in product variant diversity ($n_{i,s} - n_{i,r}$) that determines changes in consumers' hierarchical utility (Table 2).[21] For example, in other meat processing, diversity in the EU improves relative to the USA, but worsens with respect to the ROW. Inspection of Table 2 shows that, in these projection simulations, relative improvements in product variant diversity are most evident in the ROW and least evident in the USA.

Changes in the value of sectoral exports and imports under preference heterogeneity, relative to their levels under preference homogeneity, in each of the three regions, are shown in Table 3. Of note is that most are negative. This suggests, as might be expected *a priori*, that trade suffers as a result of consumer preferences favouring domestically produced varieties. Relative improvements in diversity

Table 1. *Consumers' domestic preferences* ($V_{i,r,s}$)*

Representative variety (*i*)	EU	USA	ROW
Meat processing	0.93	0.97	0.96
Other meat processing	0.98	0.98	0.96
Vegetable oils and fats	0.97	0.85	0.95
Milk processing	0.98	0.99	0.93
Sugar processing	0.98	0.84	0.97
Other food processing	0.96	0.95	0.97

Note: *Benchmark values based on expenditure shares.

Table 2. *Changes and relative movements in product variants* (n) *under preference heterogeneity*

				Relative directional movements in $n_{i,s}$					
				EU vs.		US vs.		ROW vs.	
Representative variety (*i*)	$n_{i,EU}$ %Δ*	$n_{i,US}$ %Δ*	$n_{i,ROW}$ %Δ*	US	ROW	EU	ROW	EU	US
Meat processing	−0.15	−0.58	−0.23	+	+	−	−	−	+
Other meat processing	−0.34	−0.41	−0.30	+	−	−	−	+	+
Vegetable oils and fats	−0.34	−0.42	−0.28	+	−	−	−	+	+
Milk processing	−0.56	−0.37	−0.13	−	−	+	−	+	+
Sugar processing	−0.56	−0.24	−0.45	−	−	+	+	+	−
Other food processing	−0.25	−0.28	−0.34	+	+	−	+	−	−

Note: *Percentage changes over levels under preference homogeneity.

Table 3. *Percentage changes in relative trade values under preference heterogeneity**

	EU		US		ROW	
Sector	exports	imports	exports	imports	exports	imports
Wheat	−1.1	−0.7	−0.7	−1.4	−1.1	−0.8
Other grains	−1.7	−0.9	−1.0	−1.6	−1.5	−1.1
Oilseeds	−1.4	−1.0	−0.8	−1.2	−1.3	−0.7
Sugar	−1.0	−0.9	0.1	−1.2	−1.0	−0.9
Cattle and sheep	−0.6	−0.6	0.1	−1.8	−1.6	−0.3
Pigs and poultry	−0.5	−0.5	0.0	−0.9	−0.6	−0.2
Other agriculture	−0.7	−0.4	−0.1	−0.7	−0.5	−0.3
Meat processing	−3.1	−3.5	−2.2	−8.3	−5.0	−2.3
Other meat processing	−6.3	−3.9	−6.0	−5.3	−4.3	−6.2
Vegetable oils and fats	−6.2	−1.4	−5.5	−3.8	−1.8	−6.1
Milk processing	−5.5	−3.9	−5.7	−4.5	−4.0	−5.6
Sugar processing	−6.1	−1.6	−5.4	−3.0	−2.1	−6.1
Other food processing	−6.7	−4.3	−6.6	−5.8	−4.9	−6.9
Other primary	0.1	0.0	0.0	0.1	0.1	0.0
Manufacturing	0.2	−0.1	0.1	−0.1	−0.2	0.2
Services	0.1	−0.1	0.1	0.0	−0.2	0.2
Total	−0.1	−0.2	−0.1	−0.2	−0.3	−0.2

Note: *Changes over levels under preference homogeneity.

[21] See footnote 12.

Table 4. *Percentage changes in relative foreign trade share**

	Foreign trade share in:		
Representative variety (*i*)	EU	USA	ROW
Meat processing	−4.5	−8.3	−7.3
Other meat processing	−4.7	−5.6	−13.0
Vegetable oils and fats	−3.7	−5.9	−11.4
Milk processing	−4.4	−6.8	−8.8
Sugar processing	−4.8	−4.7	−11.8
Other food processing	−6.0	−8.2	−11.6

Note: *Changes over levels under preference homogeneity.

of domestic product variants, and thus in the preference value of the domestic representative variety, have the effect of diverting on to the domestic market output which otherwise would be destined for export, displacing less favoured imported varieties.[22] Thus, in the food processing sectors, both exports and imports fall significantly in relative terms. This trade-reducing effect also spills over into other parts of the economy, with the upstream agricultural sectors suffering similar, though less severe, reductions. Manufacturing, services and other primary show some relative increases in trade, but not sufficient to prevent the overall impact from being negative in all three regions (Table 3).

The net effect on foreign trade shares in the food processing sectors of each of the regions is shown in Table 4. These shares experience relative falls in all cases, between 4 and 13%. Notwithstanding the generally negative relative trade effects associated with patriotic preferences, the impact on welfare of introducing preference heterogeneity into the simulations is a small (<1%) increase in equivalent variation in each region.

V. SUMMARY AND CONCLUSIONS

Unprecedented levels of variety in global markets is becoming a hallmark of international trade in food products. 'Product-country' images and preferences are likely to have implications for trade flows. It has been shown how hierarchical consumer preferences, based on region of origin, can be endogenized in a standard, multiregion CGE model of the type commonly used to quantify the impacts of trade liberalization. In an empirical application, focus is on one specific type of country of origin preference, namely patriotic purchasing behaviour, and how increases in trade volumes can be muted though not necessarily to the detriment of welfare. That welfare increases under preference heterogeneity is perhaps not too surprising, given that preferences feed directly into the utility function, but of more interest and possible concern to trade analysts is likely to be the juxtaposition of this welfare outcome with the generally negative trade impacts of patriotic purchasing behaviour.

These impacts are conditional on the level of consumers' preference heterogeneity, i.e., the extent to which consumers identify with variety and varietal changes, and the strength of country of origin preferences. Crucial in this modelling approach, therefore, are estimates of consumer preference heterogeneity (γ) and benchmark preference values (V). A value of the former has been specified close to its upper bound, so as to highlight the contrast with preference homogeneity. In choosing to model patriotic purchasing behaviour benchmark preference values have been calibrated to expenditure shares. However, there is need for research to derive estimated values, with perhaps the most promising approach being that of stated preference analysis.

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[22] However, industry output in the directly affected sectors actually falls as a result of preference heterogeneity alone, because gains in the domestic market are outweighed by losses in export markets. This results in falls in output per firm and in the number of firms (as observed in the main text).

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APPENDIX: DERIVING LINEARIZED CES HICKSIAN HIERARCHICAL DIFFERENTIATED DEMAND FUNCTIONS

Following Lancaster (1984, p. 139), demand for differentiated commodities is of the CES form. Thus:

$$U_{i,s} = A_{i,s}\left[\sum_r \delta_{i,r,s} Q_{i,r,s}^{-\rho_i} Z_{i,r,s}\right]^{-1/\rho_i} \tag{A1}$$

where $U_{i,s}$ is the level of subutility from the consumption of differentiated commodity i in region s; $Q_{i,r,s}$ is consumer demand in region s for representative variety i from region r; $Z_{i,r,s}$ is bilateral hierarchical utility associated with the consumption of the representative variety; $A_{i,s}$ is a scale parameter; $\delta_{i,r,s}$ is a CES share parameter; and ρ_i is an elasticity parameter. Minimizing cost subject to Equation A1 gives first order conditions:

$$P_{i,r,s} = \Lambda A_{i,s}\left[\sum_r \delta_{i,r,s} Q_{i,r,s}^{-\rho_i} Z_{i,r,s}\right]^{-(1+\rho_i)/\rho_i} \delta_{i,r,s} Q_{i,r,s}^{-(1+\rho_i)} Z_{i,r,s} \tag{A2}$$

$$U_{i,s} = A_{i,s}\left[\sum_r \delta_{i,r,s} Q_{i,r,s}^{-\rho} Z_{i,r,s}\right]^{-1/\rho_i} \tag{A3}$$

where $P_{i,r,s}$ is the price of representative varieties. Substituting Equation A3 into Equation A2:

$$P_{i,r,s} = \Lambda A_{i,s}^{-\rho_i} U_{i,s}^{(1+\rho_i)} \delta_{i,r,s} Q_{i,r,s}^{-(1+\rho)} Z_{i,r,s} \tag{A4}$$

Following the approach of Dixon *et al.* (1992), linearization of Equation A3 gives:

$$u_{i,s} = \sum_r S_{i,r,s}\left[q_{i,r,s} - \frac{1}{\rho_i} z_{i,s}\right] \tag{A5}$$

where lower case letters are percentage changes in the corresponding upper case variables, and $z_{i,s}$ is a linearized expenditure share weighted average of bilateral hierarchical utilities, with expenditure shares given as:

$$S_{i,r,s} = \frac{P_{i,r,s} Q_{i,r,s}}{\sum_r \left[P_{i,r,s} Q_{i,r,s}\right]} \tag{A6}$$

Linearization of (A4) gives:

$$p_{i,r,s} = \lambda + (1+\rho_i)u_{i,s} - (1+\rho_i)q_{i,r,s} + z_{i,r,s} \tag{A7}$$

where λ is a lagrangian variable. Thus, Equations A5 and A7 are linearized first order conditions. Rearranging Equation A7 in terms of $q_{i,r,s}$ gives:

$$q_{i,r,s} = -\sigma_i p_{i,r,s} + \sigma_i \lambda + u_{i,s} + \sigma_i z_{i,r,s} \tag{A8}$$

where σ_i is the elasticity of substitution between all pair-wise types of representative varieties in the nest:

$$\sigma_i = \frac{1}{1+\rho_i} \tag{A9}$$

Substituting Equation A8 into Equation A5 and rearranging in terms of $\sigma_i\lambda$ yields:

$$\sigma_i \lambda = \sigma_i \sum_r S_{i,r,s} p_{i,r,s} - \sigma_i \sum_r S_{i,r,s} z_{i,r,s} + \left[\frac{1}{\rho_i}\right] \sum_r S_{i,r,s} z_{i,r,s} \tag{A10}$$

Substituting Equation A10 into Equation A8 eliminates λ. Factorizing the resulting expression gives linearized CES Hicksian primary factor demands:

$$q_{i,r,s} = u_{i,s} - \sigma_i \left[p_{i,r,s} - \left[\sum_r S_{i,r,s} p_{i,r,s} \right] \right] + \sigma_i [z_{i,r,s} - z_{i,s}] + \frac{1}{\rho_i} z_{i,s} \tag{A11}$$

where

$$z_{i,s} = \sum_r S_{i,r,s} z_{i,r,s} \tag{A12}$$

For consistent aggregation:

$$P_{i,s} U_{i,s} = \sum_r P_{i,r,s} Q_{i,r,s} \tag{A13}$$

By linearizing Equation A13, substituting Equation A5 and rearranging:

$$p_{i,s} = \sum_r S_{i,r,s} \left[p_{i,r,s} + \left[\frac{1}{\rho_i}\right] z_{i,r,s} \right] \tag{A14}$$

Using the weighted composite hierarchical utility variable expression Equation A12 and rearranging gives:

$$\sum_r S_{i,r,s} p_{i,r,s} = p_{i,s} - \left[\frac{1}{\rho_i}\right] z_{i,s} \tag{A15}$$

Substitution of Equation A15 into Equation A11, expanding the brackets and collecting terms gives:

$$q_{i,r,s} = u_{i,s} - \sigma_i [p_{i,r,s} - p_{i,s}] + \sigma_i [z_{i,r,s} - z_{i,s}] - \sigma_i \left[\frac{1}{\rho_i} z_{i,s} - \frac{\sigma_i}{\rho_i} z_{i,s} \right] \tag{A16}$$

Rearranging Equation A9 in terms of ρ_i and substituting the result into Equation A16:

$$q_{i,r,s} = u_{i,s} - \sigma_i \left[p_{i,r,s} - p_{i,s} \right] + \sigma_i z_{i,r,s} \tag{A17}$$