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Heterogeneous consumers and trade patterns in a monopolistically competitive setting *

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Abstract

The paper considers a two-country trade model of monopolistic competition featuring the heterogeneity of consumer preferences both within and across countries. The incorporation of heterogeneity into a traditional monopolistic competition setting is achieved by assuming different elasticities of substitution in the CES utility function for different consumers. The proposed setup expands on the traditional model of trade by demonstrating a richer set of country specific effects. The key question analysed in the paper is how consumer heterogeneity and trade liberalization affect markups and wages in different countries. Unlike the canonical CES-model of trade, where markups in different countries are constant and identical to each other, our model, by taking consumer heterogeneity into account, provides different markups across countries, incorporating both heterogeneity and trade specifics. The model also predicts that the larger of two countries engaged in costly trade may have a wage rate higher than, lower than or equal to that of the smaller one, depending on the general equilibrium conditions. This finding is in contrast to that of the canonical setting, where the larger country under costly trade always has a higher wage rate.

Keywords: heterogeneous consumers; monopolistic competition; CES utility function; international trade, markups, wages

JEL Classification: F12, D43, L13

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1 Introduction

Until recently, most of the existing contributions on international trade, following the salient papers of Krugman (Krugman, 1979; Krugman, 1980), have been focused on the production side of the economy in trying to explain trade patterns and gains from trade (Eaton and Kortum, 2002; Melitz, 2003; Melitz and Ottaviano, 2008; Eaton et al., 2011). Demand-side determinants of trade, such as preference specifics, were not ordinarily accounted for. Indeed, the number of existing contributions, encompassing many trade papers, typically postulate identical and homothetic preferences across consumers. This assumption, which is central to the canonical models of trade (Krugman, 1980; Helpman and Krugman, 1985), implies that the market demand function is symmetric across varieties and countries, i.e. the same for the same goods across different countries as well as for different goods within the country. Although at odds with reality, this assumption allows one to greatly simplify the analysis and obtain transparent analytical results. In the meantime though, there is an increasing list of publications where an attempt is made to take the heterogeneity and non-homotheticity of consumer preferences into account when explaining market outcomes and international trade patterns (Choi et al., 2009; Fieler, 2011; Markusen, 2013; Simonovska, 2010; Hepenstrick and Tarasov, 2013; Kichko et al., 2014; Di Comite et al., 2014; Wang and Gibson, 2015).

Our paper is aimed in the same direction by building a general equilibrium model of trade in which the market demand and the subsequent market outcome and trade pattern are affected by consumer taste heterogeneity. Accounting for the heterogeneity in tastes is achieved by assuming different elasticities of substitution in the CES utility function for different consumers and different countries. The modelling strategy used in this paper is similar to that applied to a closed economy case by (Osharin et al., 2014), where an attempt is made to dispense with the representative agent approach which is frequently assumed in literature on monopolistic competition.

In contrast to the modelling approach applied previously to a closed economy case in (Osharin et al., 2014), the present framework completely neglects the correlation between the income and tastes of consumers. This assumption leaves the investigation of the effects provided by the interaction between income and taste heterogeneities beyond the scope of the present setup, which can be viewed as the main shortcoming of the model. At the same time, this is done for the benefit of getting tractable expressions for the general equilibrium outcome of the model, which happens to be unachievable otherwise. In view of this, one has to take into account that by sacrificing the correlation between the tastes and incomes of consumers, we either weaken or even lose some of the potential effects provided by this correlation.

One approach which is close to ours, in terms of modelling strategy, is that of Di Comite et al. (2014). Here the authors also explore the heterogeneity of consumers to generate a new set of predictions which is more in line with existing trade patterns. Nevertheless, there is a difference between the two models. While the model of Di Comite et al. (2014) is based on the restructured quadratic utility used previously by Ottaviano et al. (2002), Melitz and Ottaviano (2008), and others, we prefer the modification of the CES utility function, which was introduced in our earlier paper (Osharin et al., 2014). In contrast to the trade models based on homogeneous consumers, an assumption of preference heterogeneity generates different demands for the same variety across destination countries when consumers within these countries have nonidentical distributions of tastes. Since there is no reason to assume a priory that the taste distributions of consumers in different countries are the same (Movshuk, 2005; Di Comite et al., 2014), we may expect that the consumer-specific CES preferences used in the present model will provide a richer set of predictions compared to that of Krugman (1980) and Helpman and Krugman (1985).

The key question to be answered by the present model of trade is how consumer heterogeneity, asymmetry in country size, and trade liberalization affect markups and wages in different countries.

In accordance with the canonical approach (Krugman, 1980) firm markups turn out to be constant and the same both within and across destination countries. This result is a natural consequence of identical consumers endowed with the CES utility function. Omitting a consumer homogeneity assumption enables one to reveal variability of markups across countries, which is observed empirically (Syverson, 2007; Feenstra and Weinstein, 2010; De Loecker and Warzynski, 2012; Bellone et al, 2014; Di Comite et al, 2014), but cannot be captured by the models of trade featuring identical and homothetic preferences. Contrary to the traditional approach, our paper shows that markups may depend upon the number of firm and wage ratios, population share of the countries, taste distributions and transportation costs.

It is worth noting that the recent research papers on trade, in trying to determine factors related to markups, has thoroughly investigated firm pricing behaviour under a wide range of assumptions. One of the first attempts to structurally estimate the impact of globalization on markups in a monopolistic competition model with non-CES preferences was taken by Feenstra and Weinstein (2010). To achieve this goal, the authors utilized the translog utility function that allows for endogenous markups. Structural estimations of the impact of globalization on markups, carried out in this paper, showed the existence of a pro-competitive effect in firm pricing behaviour: alongside the increase of U.S. imports between 1992 and 2005 markups went down, while product variety and welfare went up. Similar results were obtained by Chen et al. (2009), who used disaggregated data for EU manufacturing over the period 1989-1999 and found short-run evidence that trade openness exerts a pro-competitive effect, with prices and markups falling and productivity rising. They also found (albeit weaker) support that the long-run effects are more ambiguous and may even be anti-competitive. An investigation into the impacts of trade liberalization and market size on wages and markups was carried out in (Behrens et al, 2014) by using a full-fledged general equilibrium model with heterogeneous firms. By taking their model to the data, the authors derived a gravity equation under the general equilibrium constraints generated by the model, and structurally estimated it using a dataset on interregional trade flows between U.S. states and Canadian provinces. Consistent with the results listed above, Behrens et al. (2014) also quantify the pro-competitive effects of trade integration.

Although the pro-competitive behaviour of the firm-level markups are confirmed elsewhere (Levinsohn, 1993; Krishna and Mitra, 1998; Lundin, 2004; Noria, 2013), it should be noted that currently there is no general agreement on this point. An example of this is Fan et al. (2015) [1] , who presented evidence, using Chinese firm-product data, that trade liberalization via input tariff reductions induced an incumbent importer/exporter to increase product markups. This finding calls for a reconsideration of the established imports-as-market-discipline hypothesis, which states that a higher volume of imports intensifies competition and hence decreases the market power of a firm. An ambiguous prediction of the openness to trade influence upon the level of markups was also reported by Thompson (2002), who estimated price-marginal cost markups for Canadian manufacturing industries during the 1970s in order to assess the impact of import competition on domestic market power and found no consistent evidence that imports reduced the markups of Canadian firms during that period.

What is interesting is that our model also demonstrates mixed predictions towards this issue. In contrast to what is obtained in most of the listed papers, the final conclusion on markup behaviour in our setting crucially depends upon the relative size of the countries engaged in trade and the distribution of consumer tastes within a particular country. It can be shown, for example, that trade liberalization reduces markups in a smaller country with less dispersed preferences of consumers, and increases markups in bigger country with a greater dispersion of tastes, which is in line with the findings on China by Fan et al. (2015).

The present model also makes an interesting prediction concerning the relationship between wage rates in countries with different population sizes. As is well-known, traditional CES-models of trade show that under free trade wages are equal, while with non-zero trade costs the larger country always has the higher wage rate (Krugman, 1980). The reason for this is in the economies of scale which allow workers to be better off in larger economies because of the larger size of the corresponding market. Nevertheless, this effect, which is valid for homogeneous preferences, no longer survives with heterogeneous consumers. Our paper shows that the wage rates in different countries may no longer be equalized and, depending on the preference distribution and transportation costs, the smaller country may have a smaller, higher or equal wage rate, compared to that in the larger one. This means that the heterogeneity of preferences may outweigh the impact of increasing returns to scale. A similar result regarding wages has recently been obtained by Wang and Gibson (2015), where a somewhat different model featuring non-homothetic preferences and identical consumers within each of the trading countries was used to demonstrate this option.

The rest of the paper is organized as follows. Section 2 describes the model and obtains short-run and long-run equilibrium outcomes. In Section 3 we carry out the comparative static analysis of the model (numerically) and present the main results. Section 4 concludes.

[1] See also results of Chen et al. (2009), who documented an ambiguous and even anti-competitive impact of trade openness on the markups in the long-run period.

2 Model

Consider a world economy encompassing two different countries indexed by $r = H, F$ (Home and Foreign). We denote by L_r the mass of consumers in country r and by $L = L_H + L_F$ the total population of the world. Let $\theta = L_H/L$ be the exogenously given share of consumers residing in the domestic country. Assume that the economy of country r involves only one manufacturing sector supplying a continuum of horizontally differentiated varieties indexed by $i \in [0, N_r]$, where N_r is the mass of varieties in country r, and $N \equiv N_H + N_F$ denotes the total mass of varieties in the global economy.

Unlike standard models of monopolistic competition, consumers are supposed to be heterogeneous in their tastes. They have CES preferences but perceive varieties as being more or less differentiated, which also means that different consumers are endowed with different love for variety towards the set of varieties produced in the economy. To reflect this idea ω_r denotes an element of the country specific space of consumers Ω_r, and μ_r denotes its measure, describing the distribution of consumers' tastes. Thus, preferences of a consumer ω_r in country r can be represented by a parameter $\sigma_r(\omega_r) > 1$ which captures how this consumer perceives the differentiated varieties[2]. The distribution of $\sigma_r(\cdot)$ across (Ω_r, μ_r) may be viewed as the taste distribution. The utility function of consumer ω_r in country r is represented by

$$U_r(\omega_r) = \left(\int_{i \in N_r} (x_i^{rr}(\omega_r))^{(\sigma_r(\omega_r)-1)/\sigma_r(\omega_r)} di + \int_{j \in N_s} (x_j^{sr}(\omega_r))^{(\sigma_r(\omega_r)-1)/\sigma_r(\omega_r)} dj \right)^{\sigma_r(\omega_r)/(\sigma_r(\omega_r)-1)}, \quad (1)$$

where $x_i^{rr}(\cdot)$ and $x_j^{sr}(\cdot)$ stand for the individual consumption of domestic (i) and foreign (j) varieties, available in countries r and s correspondingly, N_r is the mass of varieties available in country r, N_s is the mass of varieties available in country s (each variety is produced by a single firm and each firm produces a single variety).

By integrating individual consumption over a continuum of firms in either of the two countries, we explore an idea of negligibility, which means that the production side of an economy is described by a continuum of firms. In the literature on monopolistic competition the usage of integrals instead of sums is accepted as a conventional approach (Combes et al., 2008). This approach formally reflects Chamberlain's idea about the negligibility of a single firm contribution into the total supply of varieties in a monopolistically competitive setting: when a firm sets price, it does not take into account the reaction of others to its choice. This means that the interaction of firms on the market is not strategic (it is mediated only through the price index). The assumption of a continuum of firms means that all magnitudes related to firms and varieties are described by continuous densities over the interval of varieties $[0, N_r]$, where N_r is the mass of varieties in

[2] Taking into account the properties of the CES utility function (Combes et al., 2008), we may alternatively consider this as a parameter driving the price elasticity of an individual demand curve of a consumer in their own country (see Appendix for details).

country r. Therefore, despite the fact that indexes i and j are integers, the formal usage of integrals enables one to more correctly capture the nature of monopolistic competition.

Our model assumes that firms follow the mill pricing policy and do not price discriminate across consumers and across destination markets. Hence, the delivered price of a variety i (p_i^{rs}), produced in country r and sold in country s ($s \neq r$) is given by $p_i^{rs} = \tau p_i^r \geq p_i^r$, where p_i^r is the price of a domestic variety sold in a domestic country, and $\tau \geq 1$ is the iceberg-type transportation cost. Assume further that each consumer is also a worker who is endowed with one unit of labor in both countries. In other words, we treat the labor market as homogeneous across countries in order to intentionally highlight effects provided solely by heterogeneity in consumer tastes. Let w_r be the basic wage rate in country r, determined endogenously, then the individual income of consumer ω_r in country r will be equal to his/her wage rate: $y_r = w_r$. Taking this into account, the budget constraint of consumer ω_r in country r becomes

$$\int_{i \in N_r} p_i^r x_i^{rr}(\omega_r) di + \int_{j \in N_s} \tau p_j^s x_j^{sr}(\omega_r) dj = y_r, \tag{2}$$

where p_i^r and p_j^s are the prices of varieties i and j produced and sold in countries r and s correspondingly.

Maximizing utility function (1) subject to the budget constraint (2), the individual demand function of consumer ω_r in country r for variety i produced by a domestic firm is given by

$$x_i^{rr}(\omega_r) = \frac{y_r}{P_r(\omega_r)} (p_i^r)^{-\sigma_r(\omega_r)}. \tag{3}$$

The corresponding individual demand function of consumer ω_r in country r for variety j produced in country s is

$$x_j^{sr}(\omega_r) = \frac{y_r}{P_r(\omega_r)} (\tau p_j^s)^{-\sigma_r(\omega_r)}. \tag{4}$$

In both cases the price aggregate in country r common to the consumers sharing the same sigma parameter equals

$$P_r(\omega_r) = \int_{i \in N_r} (p_i^r)^{1-\sigma_r(\omega_r)} di + \int_{j \in N_s} (\tau p_j^s)^{1-\sigma_r(\omega_r)} dj. \tag{5}$$

Note that this price aggregate is dependent on the prices of varieties produced both in domestic and foreign countries.

The technology in our framework is represented through the cost function, which is of the unique-factor type. Firms produce under increasing returns and share identical technology in both countries with $f > 0$ and $c > 0$ denoting the fixed and the marginal labor requirements needed to produce q_i^r units of variety i in country r. Taking this into account, the profit of firm i in country r is given by

$$\pi_i^r = (p_i^r - c w_r) q_i^r - f w_r, \tag{6}$$

where w_r is the wage rate of workers/consumers in country r, $q^r \equiv q_i^{rr} + \tau q_i^{rs}$ is the total market demand, faced by firm i in this country, and q_i^{rr} and q_i^{rs} are the components of the total demand. The first component represents the domestic demand for variety i by domestic consumers:

$$q_i^{rr} = \int_{\Omega_r} x_i^{rr}(\omega_r) d\mu_r = y_r \int_{\Omega_r} \frac{(p_i^r)^{-\sigma_r(\omega_r)}}{P_r(\omega_r)} d\mu_r, \tag{7}$$

the second component represents the market demand for variety i by foreign consumers:

$$q_i^{rs} = \int_{\Omega_s} x_i^{rs}(\omega_s) d\mu_s = y_s \int_{\Omega_s} \frac{(\tau p_i^r)^{-\sigma_s(\omega_s)}}{P_s(\omega_s)} d\mu_s. \tag{8}$$

Unlike the individual demands, the market demands in our model are not isoelastic because taste parameters $\sigma_r(\cdot)$ and $\sigma_s(\cdot)$ vary across consumers and countries and depend upon consumer taste distribution.

2.1 Short-run equilibrium and price elasticity coefficients of the market demand

Inserting market demands (7) and (8) into (6) and maximizing profits with respect to p_i^r for every firm in each of the two countries, given the firm distribution (N_H, N_F) and wages (w_H, w_F) in the global economy, yields the following system of equations for equilibrium prices p_i^H and p_j^F:

$$\begin{cases} p_i^H = \frac{\bar{\varepsilon}_i^H}{\bar{\varepsilon}_i^H - 1} c w_H \\ p_j^F = \frac{\bar{\varepsilon}_j^F}{\bar{\varepsilon}_j^F - 1} c w_F \end{cases}, \tag{9}$$

where $\bar{\varepsilon}_i^H \equiv -(p_i^H/q_i^H)(\partial q_i^H/\partial p_i^H)$ and $\bar{\varepsilon}_j^F \equiv -(p_j^F/q_j^F)(\partial q_j^F/\partial p_j^F)$ are the price elasticity coefficients of the market demand for varieties i, j in home and foreign countries, correspondingly, given by

$$\bar{\varepsilon}_i^H = \frac{y_H \int_{\Omega_H} \frac{\sigma_H(\omega_H)\left(p_i^H\right)^{-\sigma_H(\omega_H)}}{P_H(\omega_H)} d\mu_H + \tau y_F \int_{\Omega_F} \frac{\sigma_F(\omega_F)\left(\tau p_i^H\right)^{-\sigma_F(\omega_F)}}{P_F(\omega_F)} d\mu_F}{y_H \int_{\Omega_H} \frac{\left(p_i^H\right)^{-\sigma_H(\omega_H)}}{P_H(\omega_H)} d\mu_H + \tau y_F \int_{\Omega_F} \frac{\left(\tau p_i^H\right)^{-\sigma_F(\omega_F)}}{P_F(\omega_F)} d\mu_F}, \tag{10}$$

$$\bar{\varepsilon}_j^F = \frac{y_F \int_{\Omega_F} \frac{\sigma_F(\omega_F)\left(p_j^F\right)^{-\sigma_F(\omega_F)}}{P_F(\omega_F)} d\mu_F + \tau y_H \int_{\Omega_H} \frac{\sigma_H(\omega_H)\left(\tau p_j^F\right)^{-\sigma_H(\omega_H)}}{P_H(\omega_H)} d\mu_H}{y_F \int_{\Omega_F} \frac{\left(p_j^F\right)^{-\sigma_F(\omega_F)}}{P_F(\omega_F)} d\mu_F + \tau y_H \int_{\Omega_H} \frac{\left(\tau p_j^F\right)^{-\sigma_H(\omega_H)}}{P_H(\omega_H)} d\mu_H}. \tag{11}$$

Note that the elasticity coefficients $\bar{\varepsilon}_i^H$ and $\bar{\varepsilon}_j^F$ depend upon the taste distributions of both domestic and foreign consumers.

Each of the two price equations in (9) is intentionally written in a form similar to that in Krugman's model of trade (Krugman, 1980) to demonstrate the key difference between the present (heterogeneous) and traditional (homogenous) frameworks. To see this difference more clearly, we assume identical preferences for consumers in both of the two countries, i.e. set $\sigma_H(\omega_H) = \sigma_F(\omega_F) = \sigma$ irrespective of the consumer type in in (10) and (11). It is easily verified that in such a case we get $\bar{\varepsilon}_i^H = \bar{\varepsilon}_j^F = \sigma$ and, hence, the system of price equations simplifies to

$$\begin{cases} p_i^H = \frac{\sigma}{\sigma-1} c w_H, \\ p_j^F = \frac{\sigma}{\sigma-1} c w_F \end{cases} \tag{12}$$

for any i and j.

First, note that this is exactly what we have in Krugman's model with identical consumers having the CES utility function. Second, and more importantly, it means that the potential dependence of prices p_i^H and p_j^F upon the number of parameters, which is present in (9), immediately drops out of the model once we get rid of the heterogeneity in consumer preferences. This clearly highlights the role played by consumer heterogeneity in the trade model of monopolistic competition. Third, the same observation is true for the markups $m_i^H \equiv (p_i^H - cw_H)/p_i^H$ and $m_j^F \equiv (p_j^F - cw_F)/p_j^F$, which turn out to be equal the inverse sigma in the Krugman framework, $m_i^H = m_j^F = 1/\sigma$, pointing out that notwithstanding the presence of the trade interaction between the two countries, everything looks like these countries are in autarky, which is strange. Contrarily, it would be natural to expect that the trade model purposefully developed to reflect trade interaction should contain corresponding effects in markups. Nevertheless, the traditional models of trade lack such an opportunity. In accordance with our point of view, this could be due to the homogeneity assumption which is central to these models. In trying to dispense with consumer heterogeneity, the traditional models of trade lose a number of important elements of trade interaction. Fortunately, the aforementioned shortcoming can be circumvented by applying the modified CES utility function incorporating consumer heterogeneity in tastes. Our point of view is that the heterogeneity assumption may be viewed as the one of the key ingredients of any workable model of trade.

In order to further simplify our analysis we assume identical firms within each of the two countries providing symmetric price equilibrium. By doing so and renaming price and elasticity coefficients ($p_i^r \equiv p_r$, $p_j^s \equiv p_s$, $\bar{\varepsilon}_i^H \equiv \bar{\varepsilon}_H$, $\bar{\varepsilon}_j^F \equiv \bar{\varepsilon}_F$), the system (9) reduces to

$$\begin{cases} p_H = \frac{\bar{\varepsilon}_H}{\bar{\varepsilon}_H-1} c w_H \\ p_F = \frac{\bar{\varepsilon}_F}{\bar{\varepsilon}_F-1} c w_F \end{cases} . \tag{13}$$

Elasticity coefficients appearing in (13) are given by

$$\bar{\varepsilon}_H = \frac{\alpha \int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{g_H(\sigma_H)\sigma_H d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} + (1-\alpha)\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{g_F(\sigma_F)\sigma_F d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}}}{\alpha \int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{g_H(\sigma_H) d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} + (1-\alpha)\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{g_F(\sigma_F) d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}}}, \tag{14}$$

$$\bar{\varepsilon}_F = \frac{(1-\alpha) \int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{g_F(\sigma_F)\sigma_F d\sigma_F}{1+\tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F-1)}} + \alpha\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{g_H(\sigma_H)\sigma_H d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}}}{(1-\alpha) \int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{g_F(\sigma_F) d\sigma_F}{1+\tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F-1)}} + \alpha\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{g_H(\sigma_H) d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}}}. \tag{15}$$

where $\alpha \equiv Y_H/Y$ is the share of the total income of the home country in the total income of the global economy, $g_H(\cdot)$ and $g_F(\cdot)$ stand for the distributions of the taste parameters in home and foreign countries, σ_{H1}, σ_{H2}, σ_{F1}, and σ_{F2} are the lower and upper limits in the distributions of the taste parameters, and $\tilde{p} \equiv p_H/p_F$, $\tilde{N} \equiv N_F/N_H$ and $\tilde{w} \equiv w_H/w_F$ denote price, mass of firm and wage ratios, respectively.

Integrals in (14) and (15) can be evaluated explicitly by assuming homogeneous distribution of the taste parameters in either of the two countries by letting

$$g_r(\sigma_r) = \begin{cases} \frac{1}{\sigma_{r2}-\sigma_{r1}}, & if \quad \sigma_{r1} < \sigma_r < \sigma_{r2} \\ 0, & if \quad \sigma_r \le \sigma_{r1} \quad or \quad \sigma_r \ge \sigma_{r2} \end{cases}, \tag{16}$$

where $r = H, F$. Inserting distribution (16) in (14)-(15) yields

$$\bar{\varepsilon}_H = \frac{\alpha\gamma_{HH}\bar{\sigma}_H + (1-\alpha)\gamma_{HF}\bar{\sigma}_F}{\alpha\beta_{HH} + (1-\alpha)\beta_{HF}}, \tag{17}$$

$$\bar{\varepsilon}_F = \frac{(1-\alpha)\gamma_{FF}\bar{\sigma}_F + \alpha\gamma_{FH}\bar{\sigma}_H}{(1-\alpha)\beta_{FF} + \alpha\beta_{FH}}, \tag{18}$$

where $\beta_{HH} \equiv \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}}$, $\beta_{FH} \equiv \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}}$, $\beta_{FF} \equiv \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1+\tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F-1)}}$, $\beta_{HF} \equiv \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}}$, $\gamma_{HH} \equiv \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}}$, $\gamma_{FH} \equiv \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}}$, $\gamma_{FF} \equiv \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F d\sigma_F}{1+\tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F-1)}}$, $\gamma_{HF} \equiv \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}}$ are integrals which can be expressed through standard and special functions (see Appendix), $\bar{\sigma}_H = (\sigma_{H1}+\sigma_{H2})/2$, $\bar{\sigma}_F = (\sigma_{F1}+\sigma_{F2})/2$. By inspecting β-integrals one can derive the following identities (see Appendix):

$$\beta_{HH} + \beta_{FH} = 1, \tag{19}$$

$$\beta_{FF} + \beta_{HF} = 1. \tag{20}$$

The latter relationships have clear economic meaning: both of them reflect the division of the total spending of each country's consumers on domestic and foreign goods (see Appendix for details). Taking this into account, we may interpret β_{HH} as the share of domestic spending on domestic goods, β_{FH} as the share of domestic spending on imported goods, β_{FF} as the share of foreign spending on goods, produced locally, and β_{HF} as the share of foreign spending on imports. The sum of shares in both cases is equal to unity, as the total income of domestic and foreign consumers must be completely exhausted by purchasing domestic and foreign varieties. In addition to identities (19)-(20), β-integrals also satisfy the following equation (see Appendix):

$$(1-\alpha)\beta_{HF} = \alpha\beta_{FH}, \tag{21}$$

which reflects the balance of trade between home and foreign countries [3]. The following relationships, similar to those for β-integrals, can also be derived for γ-integrals (see Appendix):

$$\gamma_{HH} + \gamma_{FH} = 1, \tag{22}$$

$$\gamma_{FF} + \gamma_{HF} = 1. \tag{23}$$

Taking into account above relationships connecting β- and γ-integrals, we get the final expressions for the price elasticity coefficients:

$$\bar{\varepsilon}_H = \gamma_{HH}\bar{\sigma}_H + \frac{1-\alpha}{\alpha}(1-\gamma_{FF})\bar{\sigma}_F, \tag{24}$$

$$\bar{\varepsilon}_F = \gamma_{FF}\bar{\sigma}_F + \frac{\alpha}{1-\alpha}(1-\gamma_{HH})\bar{\sigma}_H. \tag{25}$$

In accordance with these expressions, the price elasticity coefficient in a particular country is a weighted sum of the average values of the taste parameters in either of the two trading countries with weights being determined by the relative size of the countries' economy in the global economy. For example, when the relative size of the home country economy substantially exceeds the size of the foreign one ($\alpha >> 1-\alpha$), we have $\bar{\varepsilon}_H \approx \gamma_{HH}\bar{\sigma}_H$, $\bar{\varepsilon}_F \approx \frac{\alpha}{1-\alpha}(1-\gamma_{HH})\bar{\sigma}_H$. This means that in such a case the properties of an aggregate demand and trade pattern in both countries are dominated by the contribution of the home country economy having a larger relative size. The opposite is true for $\alpha << 1-\alpha$, when the home country contribution into the global economy is substantially smaller compared to the foreign one.

Comparing (17)-(18) with (24)-(25), we may conclude that by using relationships, connecting β- and γ-integrals, the original formulas for the price elasticity coefficients turned out to be substantially simplified. Actually, in contrast to (17) and (18), only two integrals instead of eight

[3] Strictly speaking, this relationship only holds in the long-run equilibrium of the model, which is considered in the next section. Nevertheless, we decided to use it here in order to save space in getting the final expressions for the price elasticity coefficients.

should now be calculated to get price elasticity coefficients (24)-(25) of the aggregate domestic and foreign demand.

In order to obtain markups and relative wages which are of interest here, we need to close our setup by deriving the system of equations for three unknown ratios ($\tilde{w}$, $\tilde{p}$, $\tilde{N}$) appearing in the price elasticity coefficients. This can be done by addressing the long-run equilibrium of the model.

2.2 Long-run equilibrium of the model

Assuming free entry and exit in each of the two countries, the long-run equilibrium of the model can be defined as a state where prices satisfy profit maximization conditions, national factor markets are clear, trade is balanced, and firms earn zero profits. By plugging the price $p_r = (\bar{\varepsilon}_r/(\bar{\varepsilon}_r - 1))cw_r$ of a particular variety in country r into the zero profit condition $(p_r - cw_r)q_r - fw_r = 0$, one can get the equilibrium output of a firm (firm size) in country r:

$$q_r = \frac{(\bar{\varepsilon}_r - 1)f}{c}. \tag{26}$$

Rewriting the zero profit condition as $p_r q_r = (cq_r + f)w_r = l_r w_r$, where l_r is the employment of a firm in country r, and multiplying both sides of this relation by mass of firms (taking into account $N_r l_r = L_r$) yields

$$N_r = \frac{L_r}{\bar{\varepsilon}_r f}. \tag{27}$$

Dividing the equilibrium price of a firm in country H by the equilibrium price of a firm in country F, we have

$$\tilde{p} = \frac{\bar{\varepsilon}_H}{\bar{\varepsilon}_F}\frac{\bar{\varepsilon}_F - 1}{\bar{\varepsilon}_H - 1}\tilde{w}. \tag{28}$$

Similarly, dividing an equilibrium mass of firms in country F by an equilibrium mass of firms in country H, we get

$$\tilde{N} = \frac{\bar{\varepsilon}_H}{\bar{\varepsilon}_F}\frac{1-\theta}{\theta}, \tag{29}$$

where $(1-\theta)/\theta \equiv L_F/L_H$.

Combining (28) and (29) with the balance of payments condition (21), we get the following system of three equations, describing the general equilibrium of the model:

$$\begin{cases} \tilde{p} = A\tilde{w} \\ \tilde{N} = B(1-\theta)/\theta \\ (1-\alpha)\beta_{HF} = \alpha\beta_{FH} \end{cases}. \tag{30}$$

Coefficients A and B appearing in (30) are expressed trough γ-integrals and exogenously given parameters of the model:

$$A \equiv \frac{\bar{\varepsilon}_H}{\bar{\varepsilon}_F}\frac{\bar{\varepsilon}_F - 1}{\bar{\varepsilon}_H - 1} = \frac{1 - \left[\gamma_{FF}\bar{\sigma}_F + \frac{\alpha}{1-\alpha}(1-\gamma_{HH})\bar{\sigma}_H\right]^{-1}}{1 - \left[\gamma_{HH}\bar{\sigma}_H + \frac{1-\alpha}{\alpha}(1-\gamma_{FF})\bar{\sigma}_F\right]^{-1}}, \tag{31}$$

$$B \equiv \frac{\bar{\varepsilon}_H}{\bar{\varepsilon}_F} = \frac{\left[\gamma_{HH}\bar{\sigma}_H + \frac{1-\alpha}{\alpha}(1-\gamma_{FF})\bar{\sigma}_F\right]}{\left[\gamma_{FF}\bar{\sigma}_F + \frac{\alpha}{1-\alpha}(1-\gamma_{HH})\bar{\sigma}_H\right]}. \tag{32}$$

The system of equations (30) is highly non-linear and does not provide an explicit solution. Nevertheless, it can be resolved numerically at a given set of exogenous parameters of the model. Using the numerical solution of this system, one can get the specific values of the price elasticity coefficients and obtain the general equilibrium outcome of the model. This makes it possible to compare nominal wages, prices, markups, mass of firms and other key variables of the model in each of the two countries at different values of transportation costs τ, population shares θ, and parameters σ_{H1}, σ_{H2}, σ_{F1}, σ_{F2} of the homogeneous taste distributions. Our major interest here is in the wage and markups behavior as functions of the exogenous parameters of the model listed above.

In order to more clearly see the key difference between the canonical and present models of trade, consider the limiting case of identical consumers by letting $\sigma_{H1} = \sigma_{H2} = \sigma_{F1} = \sigma_{F2} = \sigma$ in (30) . In doing so, we get $A = B = 1$, $\beta_{HF} = \bar{\beta}_{HF} \equiv \left[1 + \tilde{N}(\tau\tilde{p})^{\sigma-1}\right]^{-1}$, $\beta_{FH} = \bar{\beta}_{FH} \equiv \left[1 + \tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma-1)}\right]^{-1}$, where $\bar{\beta}_{HF}$ and $\bar{\beta}_{FH}$ are the reduced forms of the β-integrals appearing in the balance of trade equation (21). As a result, the system (30) boils down to

$$\begin{cases} \tilde{p} = A\tilde{w} \\ \tilde{N} = \frac{1-\theta}{\theta} \\ (1-\alpha)\bar{\beta}_{HF} = \alpha\bar{\beta}_{FH} \end{cases}. \tag{33}$$

This set of equations, representing the long-run equilibrium of the canonical model of trade, is much simpler than (30), and can be reduced to just one equation (see below). It has been analyzed in Krugman (1980), where it was concluded that, in contrast to the present model of trade, neither the taste parameter, nor transportation costs affect the equilibrium mass of firms. Indeed, as (33) shows, the mass of firm ratio is determined from the second equation (independently of the first and the third equations) and is equal to the exogenously given ratio of population shares of the two countries.

The key parameter which depends upon transportation costs and asymmetry in country size in both models of trade is the wage ratio $\tilde{w} \equiv w_H/w_F$ implying the wages may be different in the two countries able to trade at a cost. To show how wages behave in the canonical model of trade, let us take into account that the income share of the domestic country in the total income of the world for the homogenous case is equal to $\alpha = (\theta\tilde{w})/(1+\theta(\tilde{w}-1))$ and insert $\tilde{p} = \tilde{w}$ and $\tilde{N} = (1-\theta)/\theta$ into the third equation of the system (33). This provides the following balance of trade condition:

$$\frac{1}{\theta + (1-\theta)\tau^{\sigma-1}(\tilde{w})^{\sigma-1}} = \frac{\tilde{w}}{\theta\tau^{\sigma-1}(\tilde{w})^{-(\sigma-1)} + (1-\theta)}, \tag{34}$$

which displays the main result of the canonical model of trade - that the lager country, all other things being equal, has the higher wage rate (Krugman, 1980). Most clearly this can be seen in the limiting case of a very large transportation cost ($\tau >> 1$), where (34) converts to $\theta\tilde{w}^{1-\sigma} = (1-\theta)\tilde{w}^{\sigma}$, which, in turn, can be rewritten as

$$\tilde{w} \equiv \frac{w_H}{w_F} = \left(\frac{L_H}{L_F}\right)^{\frac{1}{2\sigma-1}}. \tag{35}$$

Since $1/(2\sigma-1) > 0$, the relative wage in (35)is greater than one if $L_H/L_F > 1$ and less than one if $L_H/L_F < 1$. This result, being the natural consequence of economies of scale and homogeneity of preferences, may not hold in our model of trade. The reason for this is in the country specific demand for varieties which is provided by the consumers' taste heterogeneity across countries.

Comparing (30) and (33), one can notice that unlike the traditional model of trade (Krugman, 1980), the equilibrium price ratio in the present setup shouldn't necessarily coincide with the corresponding wage ratio; similarly, the mass of firm ratio shouldn't be equal to the ratio of population shares of the destination countries. Indeed, in accordance with (30), the discrepancy between price and wage ratios is provided by the magnitude of the coefficient A, while the difference between the mass of firm and population ratios is provided by the magnitude of the coefficient B. Either of these two coefficients may exceed or be less than unity, depending on the asymmetry in country sizes, differences in taste distributions and transportation costs. This means that the price ratio in our model, in contrast to the canonical one, may well exceed or may be less than the corresponding wage ratio. Similarly, the mass of firm ratio may be greater or less than the corresponding ratio of country sizes in population.

Besides the wage rates, our interest here is in the markups behavior in either of the two countries. Using the Lerner index as the measure of firm-level markups in home and foreign country yields:

$$\begin{cases} m_H \equiv \frac{p_H - cw_H}{p_H} = \frac{1}{\bar{\varepsilon}_H} \\ m_F \equiv \frac{p_F - cw_F}{p_F} = \frac{1}{\bar{\varepsilon}_F} \end{cases}. \tag{36}$$

The latter shows that the markups are inversely related with the price elasticity coefficients of the market demand (which is in line with what we know from industrial organization theory) and depend on the same set of parameters as elasticity coefficients do. When consumers are less sensitive to price considerations, firms are able to charge higher markups. Conversely, in the limiting case of very high elasticities we come to the perfect competition case: an equilibrium price turns out to be equal the marginal cost.

The preliminary comparative analysis of the two models of trade we have just gone through clearly shows that their predictions can be different. In such a case the key question is how large can this difference be? To see this in more detail, we present some results of the numerical calculations in the next section, starting with the simplest case of identical taste distributions across destination countries. This option is the natural starting point at which to begin our numerical analysis, which is chosen intentionally. First, it allows one to make close parallels between the present and the more conventional models of trade. Second, it provides a rather intuitive but not evident result which deserves further consideration.

Indeed, the next question which immediately arises when tastes are identically distributed is whether the price elasticity coefficients $\bar{\varepsilon}_H$ and $\bar{\varepsilon}_F$, representing the "collective" preferences of the domestic and foreign consumers, coincide (or not) with each other? While the answer to this question is rather obvious when countries, equal in population size, are engaged in free trade, it is less so when they are asymmetric and trade at nonzero transportation costs. In other words, we are interested in whether consumers in different countries will demonstrate a similarity in "collective" preferences if their individual tastes are identically distributed. If such a similarity in preference structure takes place, then our model should generate a range of predictions very close to those of the canonical model of trade. For example, as it stems from (30)-(32) the price ratio in such a case will be equal to the wage ratio exactly as in Krugman's model of trade. Taking this into account, it would be quite natural to find out an approximation to the proposed heterogeneous model, which would be simpler than the original one, but, nevertheless, would be capable of representing the outcome of the original model with admissible precision. In doing so, we demonstrate that the solution of (33), calculated at the average values of the taste parameters (i.e. by substituting $\sigma = \bar{\sigma}_H = \bar{\sigma}_H$ in the balance of payments condition) is very close to that of the present (heterogeneous) model of trade.

In view of this, in the next section we proceed as follows. First, we consider the situation with equally distributed consumer tastes across countries in order to confirm or reject the hypothesis concerning possible identity in their price elasticity coefficients and to verify the existence of the approximation to the heterogeneous model of trade. Second, we investigate the case with a mean preserving spread in taste distributions having unequal differences in sigma-parameters ($\Delta\sigma_H \neq \Delta\sigma_F$) and equal values of their averages ($\bar{\sigma}_F = \bar{\sigma}_H = \bar{\sigma}$). Third, we analyze the case where differences in the sigma-parameters are kept equal ($\Delta\sigma_H = \Delta\sigma_H = \Delta\sigma$) but their averages may differ ($\bar{\sigma}_F \neq \bar{\sigma}_H$). Notice that while the second case can be potentially imitated by a "representative" model of trade similar to that of the conventional one as it implies identical average values of sigmas in different countries, the third option cannot be treated as such due to the difference in average values of the taste parameters.

3 Results

3.1 Identical taste distributions in trading countries

We start our investigation with identical homogenous taste distributions in each of the two trading countries by letting $\bar{\sigma}_H = \bar{\sigma}_F = \bar{\sigma}$ and $\Delta\sigma_F = \Delta\sigma_H = \Delta\sigma$ in (30). Performing massive calculations at different values of the population shares (θ) and transportation costs (τ), we didn't reveal any noticeable differences in the price elasticity coefficients, characterizing "collective" preferences in these countries, which used to be the same within the accuracy of the numerical calculations.

Intuitively, it may seem rather obvious that consumers in different countries should exhibit "collective" preferences, coinciding with each other, if their individual tastes are identically distributed, but, looking at the complicated structure of the elasticities (14)-(15), it is not easy *a priory* to expect such an outcome, except for two symmetric countries equal in size. Nevertheless, as our calculations show, it is this option that is realized. It means that notwithstanding the sophisticated structure of the elasticities $\bar{\varepsilon}_H$ and $\bar{\varepsilon}_F$, which depend upon the specific combinations of firm, price and wage ratios, these ratios, due to the change in the exogenous parameters of the model, acquire the magnitudes, making these elasticities equalized in both countries.

Equalization of the price elasticity coefficients drives A and B coefficients in (30) to unity and reduces the first and the second equations of the system (30) to those of Krugman's (33). As a consequence, the price ratio in (30) exactly coincides with the corresponding wage ratio, while the mass of firm ratio coincides with the ratio of country sizes in population [4].

Table 1 reports wage ratios $\tilde{w} \equiv w_H/w_F$ (equal to the corresponding price ratios $\tilde{p} = p_H/p_F$) calculated for the different values of the population share θ and transportation costs τ ($\bar{\sigma}_H = \bar{\sigma}_F = 2$; $\Delta\sigma_F = \Delta\sigma_H = 2$).

It shows that each of the two ratios gradually converge to unity at zero transportation costs ($\tau = 1$), indicating wage and price equalization in destination countries. For all of the treated values of the population shares θ and transportation costs τ, except for under free trade conditions ($\tau = 1$), the wage rate turns out to be higher in the larger country (and so does the price). Symmetric countries equal in population size ($\theta = 0.5$) demonstrate equal nominal wages and prices at all the treated values of transportation costs. These findings are in full accordance with Krugman's model of trade, signifying that economies in scale make consumers/workers better off in larger economies because of the larger size of the local market.

The difference in wage rates between the countries increases along with transportation costs and asymmetry in country size. Fig.1 shows that an increase in the average values of the taste parameters $\bar{\sigma}_H = \bar{\sigma}_F = \bar{\sigma}$ (all other things being equal) provides non-monotonic behavior of the wage ratio in destination countries.

This ratio initially increases along with increase in $\bar{\sigma}$ (curves 1 and 2 correspond to $\bar{\sigma} = 2$

[4] The latter makes the home-market effect unrealizable within our setting with only one monopolistically competitive sector in each of the two trading countries, exactly like in the canonical model of trade (Krugman, 1980).

θ	$\tau = 2.0$	$\tau = 1.8$	$\tau = 1.6$	$\tau = 1.4$	$\tau = 1.2$	$\tau = 1.0$
0.1	0.792	0.815	0.844	0.882	0.932	1.00
0.2	0.849	0.866	0.886	0.913	0.949	1.00
0.3	0.901	0.911	0.925	0.942	0.966	1.00
0.4	0.950	0.955	0.962	0.971	0.983	1.00
0.5	1.000	1.000	1.000	1.000	1.000	1.00
0.6	1.052	1.046	1.038	1.029	1.017	1.00
0.7	1.109	1.096	1.080	1.060	1.034	1.00
0.8	1.176	1.154	1.127	1.094	1.053	1.00
0.9	1.262	1.226	1.183	1.133	1.072	1.00

Table 1: Wage ratios $\tilde{w} \equiv w_H/w_F$ (equal to the corresponding price ratios $\tilde{p} = p_H/p_F$) calculated for the different values of the population share θ and transportation costs τ ($\bar{\sigma}_H = \bar{\sigma}_F = 2$; $\Delta\sigma_F = \Delta\sigma_H = 2$).

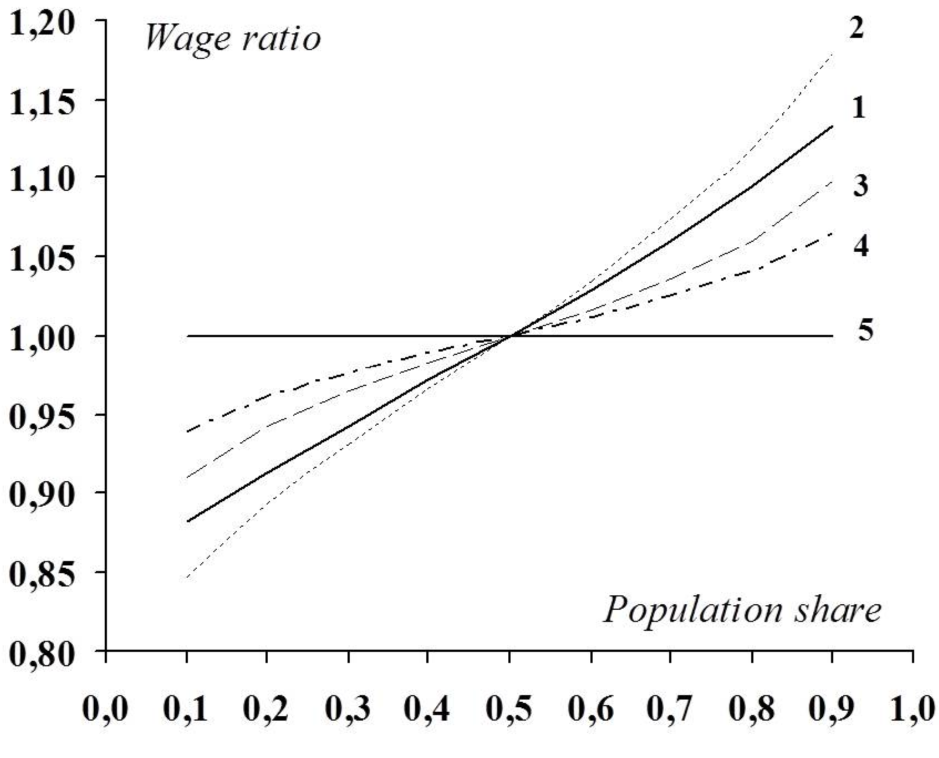

Figure 1: Wage ratios at different values of the average sigma ($\tau = 1.4$)

and $\bar{\sigma} = 4$) and then decreases to unity at all values of the population share (curves 3, 4 and 5 correspond to $\bar{\sigma} = 12$, $\bar{\sigma} = 18$ and $\bar{\sigma} \to \infty$).

Our calculations suggest that the trade pattern generated by the proposed setup with identical taste distributions across countries can be accurately imitated by the appropriately adjusted canonical model of trade. This adjustment can be done by replacing the taste parameter σ appearing in equation (34) representing the trade balance condition of the traditional model, with the common average value of the taste parameters in countries H and F: $\sigma \to \bar{\sigma} = \bar{\sigma}_H = \bar{\sigma}_F$. In such a case the percentage difference in wage ratios, calculated on the basis of the present and canonical model of trade, so adjusted, remains very small for all combinations of population share and transportation cost.

The percentage difference in wage ratios increases along with the increase in transportation costs and asymmetry in country size and achieves its maximum value at the maximum value of the transportation costs ($\tau = 2$), as in Table 1. The maximum percentage difference in wage rates between the two models amounts to 2.17% for $\theta = 0.1$ and 2.22 % for $\theta = 0.9$. A similar conclusion is valid for all other endogenous parameters of the model. For example, the corresponding difference between mass of firm and country size ratios never exceeds 3.4% for the same values of exogenous parameters as in Table 1. This finding shows that the heterogeneous model of trade can be represented by the Krugman setup without any sufficient loss of accuracy when consumer tastes in the two destination countries are identically distributed.

3.2 Mean preserving spread in taste distributions

Turning to the second step in our investigation of the impact of consumer heterogeneity upon the pattern of trade, the average values of the sigma parameters in trading countries remain untouched, but we assume unequal values for the intervals $\Delta\sigma_H$ and $\Delta\sigma_F$ ($\Delta\sigma_F \neq \Delta\sigma_H$) reflecting dispersions in consumer tastes. This is the case of mean preserving spread in the distribution of consumer taste parameters, where averages of the taste parameters are kept equal in both countries, but their variances may differ. By assuming different spreads in taste distributions we introduce an asymmetry in consumers' "collective" preferences between domestic and foreign countries and make firms face a country specific demand curve. In contrast to the previously investigated case, this asymmetry provokes some differences in the elasticity coefficients $\bar{\varepsilon}_H$, $\bar{\varepsilon}_F$, and, as a consequence, provides a significant discrepancy between the corresponding mass of firm, price and wage ratios and markup values in different countries. It enables one to go beyond the Krugman model's predictions. Let us illustrate this through a numerical example.

Assume that the domestic country is larger than (or equal to) the foreign one ($\theta \geq 0.5$) and has more dispersed consumer tastes ($\Delta\sigma_H > \Delta\sigma_F$) [5] . Table 2 below presents the wage and

[5] For countries sharing a similar institutional structure, it is quite reasonable to expect more dispersed tastes from consumers residing in a larger country because the larger the number of people, the more diversity of consumer tastes there should be. This assumption may be incorrect when countries differ in their institutional characteristics.

θ	w_H/w_F	p_H/p_F	$m_H(\%)$	$m_F(\%)$	w_H/p_H	w_F/p_F
0.5	0.877	0.854	18.93	21.03	0.810	0.789
0.6	0.917	0.893	19.16	21.28	0.808	0.787
0.7	0.966	0.939	19.37	21.57	0.806	0.784
0.8	1.031	1.000	19.57	21.97	0.804	0.780
0.9	1.139	1.098	19.77	22.65	0.802	0.773

Table 2: Wage and price ratios, mark-up and real wage values, calculated for different values of the population share θ of the domestic country ($\bar{\sigma}_H = \bar{\sigma}_F = 5$; $\Delta\sigma_H = 8$, $\Delta\sigma_F = 1$, $\tau = 2$).

price ratios, markups and real wage rates (w_H/p_H,w_F/p_F), calculated for different values of the population share θ of the domestic country ($\bar{\sigma}_H = \bar{\sigma}_F = 5$; $\Delta\sigma_H = 8$, $\Delta\sigma_F = 1$, $\tau = 2$).

As can be seen, the asymmetry in consumer taste distributions leads to a violation of the equality between price and wage ratios valid for the traditional model of trade. Besides, the equalization of the wages and prices in the two symmetric countries now ceases to hold: the first row of the table indicates that both of them turn out to be smaller in the country having more dispersed consumer taste parameters. Also, as Table 2 demonstrates, the key prediction of Krugman's model of trade, which claims that the larger country should always have the higher wage rate, is no longer valid in our framework (see calculations for $\theta = 0.5$, $\theta = 0.6$ and $\theta = 0.7$).

In addition, we have different markups for symmetric countries. This means that, despite identity in country size, the asymmetry in taste distributions, by provoking discrepancy in demands across countries, not only prevents wages and prices from equalization, but also provides different levels of domestic competition (see the first row of the Table 2). A country having more dispersed preferences demonstrates a higher degree of domestic competition as the greater taste dispersion in consumer preferences prevents firms from executing their market power. On the contrary, the narrower taste dispersion, by making tastes of the consumers to be alike, facilitates firms to exercise their monopoly power through charging higher markups. When country sizes in population do not coincide with each other, we also have higher markups in the country with less dispersed tastes. As Table 2 shows, the smaller country's markups increase when its size decreases; the reverse is true for the larger country, where markup values increase along with country size.

Markups behavior in symmetric countries vs consumer taste dispersion in a foreign country is illustrated in Fig.2 ($\bar{\sigma}_H = \bar{\sigma}_F = 5$; $\tau = 2$).

It shows that an increasing spread in the taste parameter, which changes from $\Delta\sigma_F = 1$ up to $\Delta\sigma_F = 8$ at fixed dispersion of the taste parameter in the home country equal to unity ($\Delta\sigma_H = 1$), provides an increasing spread in markups, driving the markup value in the home country to go up while the markup value in the foreign country goes down.

When comparing the real wages in two destination countries, one can verify that the purchasing power of consumers in a larger economy slightly exceeds the purchasing power of consumers in a smaller one, thus making consumers in the larger country better off. This finding also contrasts

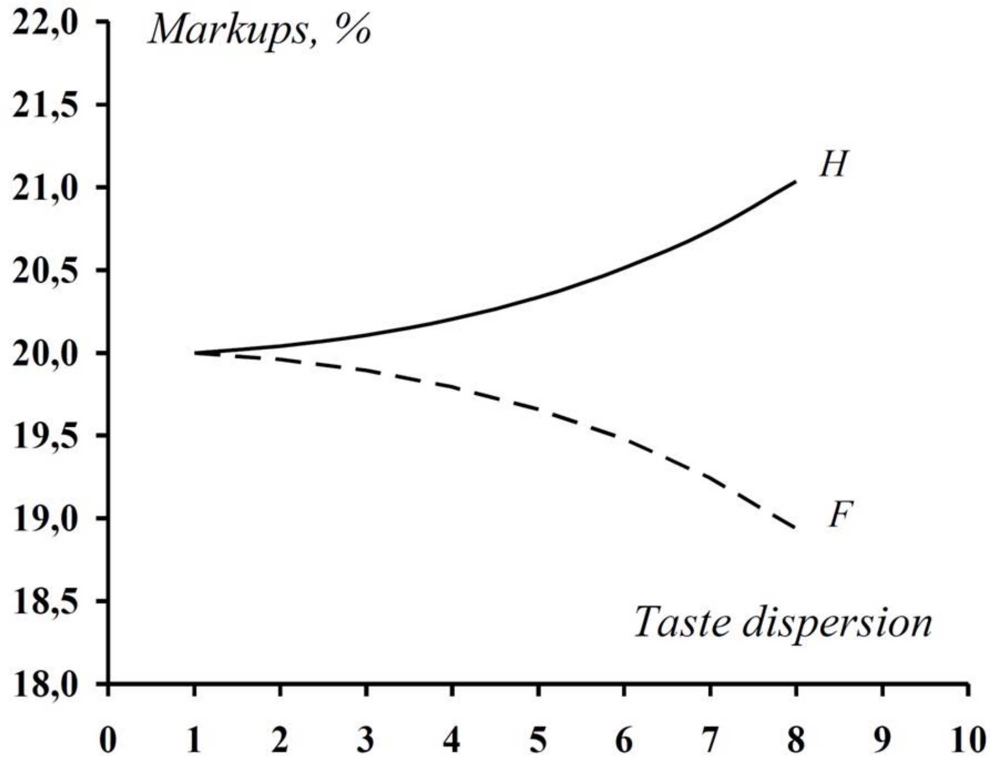

Figure 2: Markups in trading countries versus taste dispersion in foreign country

with the conventional model of trade where the purchasing power of consumers in both countries turns out to be the same.

Results obtained in this section relate to those found in research on trade which has evidenced that markups and prices are greater in the higher per-capita income countries (Hummels and Lugovskyy, 2009; Simonovska, 2010). Simonovska offers strong empirical support for this relationship, presenting data from a clothing manufacturer that sells identical goods online to twenty-eight countries and charges higher prices in richer markets. The author argues that such price discrimination on the basis of income suggests that firms exploit different price elasticities of demand across countries that differ in income. As our calculations show (see Table 2), the present model has mixed predictions on this point, showing that under different conditions higher wages may correspond to both higher and lower markups.

Fig.3 demonstrates the influence of the openness to trade (measured by inverse of the transportation cost index $1/\tau$) upon the markups in countries having different relative size (the home country is assumed to be larger than foreign one: $\theta = 0.8$; $\bar{\sigma}_H = \bar{\sigma}_F = 2$; $\Delta\sigma_H = 2$, $\Delta\sigma_F = 0.2$). It shows that trade liberalization intensifies competition and reduces firms' market power in a smaller country with less dispersed preferences of consumers (i.e. foreign country F). This happens due to sufficient enlargement of the smaller country's market due to the impact of domestic demand. In contrast to a smaller country, openness to trade reduces the level of competition in a larger

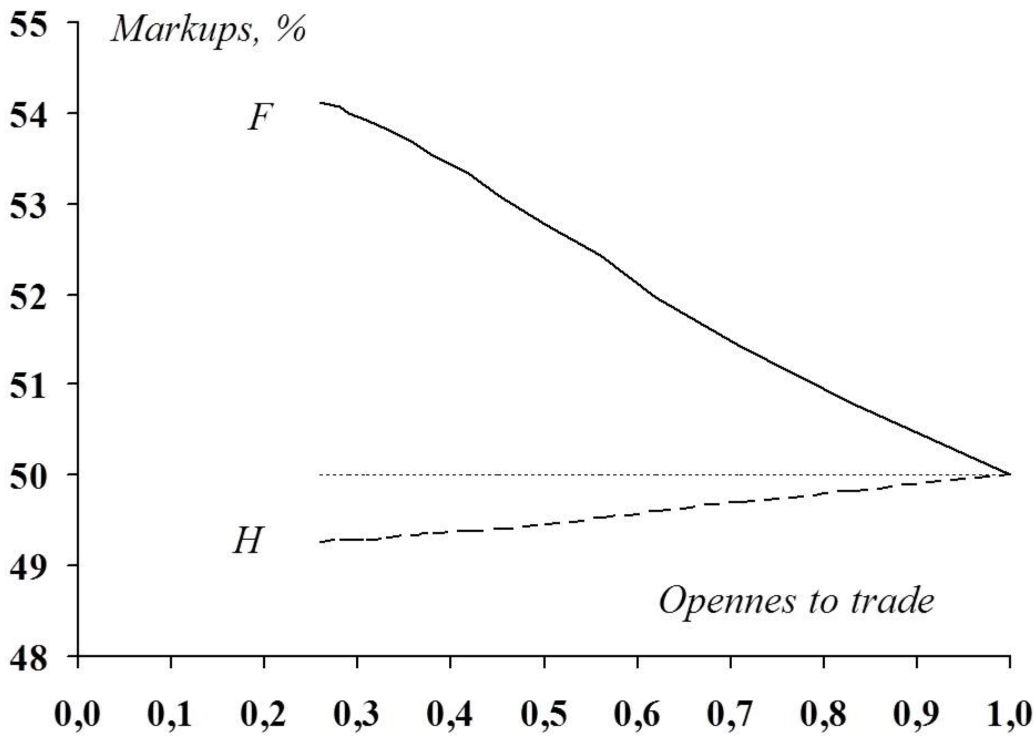

Figure 3: Markups in big (H) and small (F) countries versus openness to trade $1/\tau$

country and increases the market power of firms in this country. However, this effect is not as pronounced as that of the smaller economy.

It should be noted that the negative relation between firm-level markups and openness to trade corresponds with most of empirical research (Feenstra and Weinstein, 2010; Chen et al., 2009; Behrens et al., 2014; Edmond et al., 2015). Nevertheless, at least one example exists (see Fan et al., 2015), which contradicts these findings by demonstrating the reverse dependence of markups vs trade liberalization. Interestingly, this evidence is observed for China, which has the biggest population in the world, and, hence, may provide a larger dispersion of consumer preferences, compared to other countries. Results obtained by Fan et al. (2015) are also in contrast with the imports-as-market-discipline point of view, which claims that an increased openness to trade should intensify competition and decrease the market power of a firm in either of the destination countries.

3.3 Different average values of the tastes parameters in trading countries

Finally, assume different average values of the taste parameters in trading countries ($\bar{\sigma}_H = 2;\bar{\sigma}_F = 3$), while keeping the differences $\Delta\sigma_H$ and $\Delta\sigma_F$ equal to each other ($\Delta\sigma_H = \Delta\sigma_F = 2$). Tables 3 and 4 contain wage and price ratios, markups and real wages, calculated for different values of the

θ	w_H/w_F	p_H/p_F	$m_H(\%)$	$m_F(\%)$	w_H/p_H	w_F/p_F
0.5	0.962	0.997	40.97	38.81	0.590	0.611
0.6	0.980	1.020	42.55	40.23	0.574	0.597
0.7	1.001	1.042	44.19	41.90	0.558	0.580
0.8	1.026	1.063	45.93	43.97	0.540	0.560
0.9	1.055	1.077	47.83	46.76	0.521	0.532

Table 3: Wage and price ratios, mark-up and real wage values, calculated for different values of the population share θ of the domestic country ($\bar{\sigma}_H = 2; \bar{\sigma}_F = 3$; $\Delta\sigma_H = 2$, $\Delta\sigma_F = 2$), for transportation costs $\tau = 1.2$.

θ	w_H/w_F	p_H/p_F	$m_H(\%)$	$m_F(\%)$	w_H/p_H	w_F/p_F
0.5	0.853	0.961	43.54	36.40	0.564	0.636
0.6	0.900	1.026	44.86	37.16	0.551	0.628
0.7	0.955	1.097	46.10	38.12	0.538	0.618
0.8	1.027	1.179	47.31	39.48	0.526	0.605
0.9	1.133	1.277	48.52	42.01	0.514	0.579

Table 4: Wage and price ratios, mark-up and real wage values, calculated for different values of the population share θ of the domestic country ($\bar{\sigma}_H = 2; \bar{\sigma}_F = 3$; $\Delta\sigma_H = 2$, $\Delta\sigma_F = 2$), for transportation costs $\tau = 2$.

population share θ of the domestic country at low ($\tau = 1.2$) and very high ($\tau = 2$) transportation costs.

As our results show, the wage rate in a larger country having a smaller average value of taste parameter (i.e. country H) may be either less or greater than the wage rate in a smaller country with a greater average value of sigma (country F). The reason for this is straightforward and easily understood. The key relation in determining wages in different countries is the trade balance condition. In accordance with this relation, the wage rate in the home country turns out to be directly proportionate to the total expenditure of foreign consumers purchasing home country goods and vice versa (see Appendix). This means that the wage rate within a particular country depends not only on the demand structure, provided by domestic consumers, but also on the perception of these goods by consumers living abroad. The higher the demand of consumers in country F for varieties produced in country H, the higher the wage rate of workers in the latter is. Speaking from the demand-side point of view, the wage rate in a particular country cannot be solely determined by the preferences of consumers/workers living in this country; it also depends on the way foreign consumers perceive and value varieties produced within this country. As a consequence, the wage rate in a particular country can be viewed as a resultant force of consumer demands in both the domestic and foreign countries.

Contrary to the wage and price ratios, we have an unambiguous prediction on the behavior of the markups in destination countries: a country with a smaller average value of the taste parameter has greater markups compared to a country with a larger average value of sigma. This means that

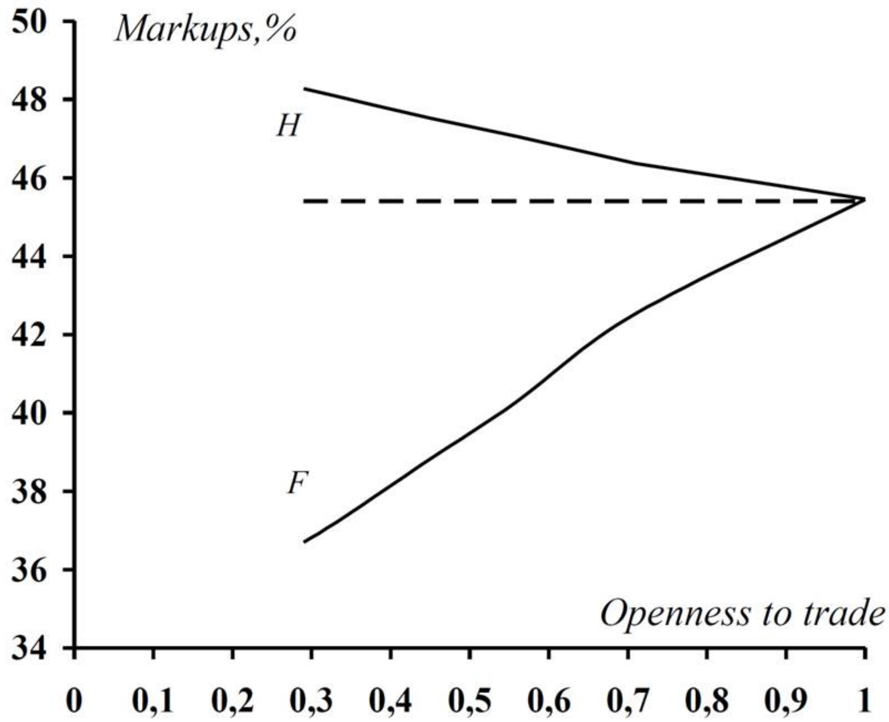

Figure 4: Markups vs trade liberalization, for $\bar{\sigma}_H < \bar{\sigma}_F (\bar{\sigma}_H = 2, \bar{\sigma}_F = 3; \Delta\sigma_H = \Delta\sigma_F = 2)$

in this case the dominant role is played by the price elasticity coefficient of the domestic demand.

Fig.4 and Fig.5 show how markups in domestic (H) and foreign (F) countries respond to the openness to trade when the relative size of the home country is greater than the relative size of the foreign one ($\theta = 0.8$). Fig.4 corresponds to $\bar{\sigma}_H < \bar{\sigma}_F$ ($\bar{\sigma}_H = 2, \bar{\sigma}_F = 3; \Delta\sigma_H = \Delta\sigma_F = 2$), Fig.5 corresponds to $\bar{\sigma}_H > \bar{\sigma}_F$ ($\bar{\sigma}_H = 3, \bar{\sigma}_F = 2; \Delta\sigma_H = \Delta\sigma_F = 2$).

As can be seen from the plots, in both cases the markup value turns out to be larger in the country having a smaller average value of the taste parameter. The openness to trade provides a reduction in markup values in the country having smaller average sigma and an increase in markups in the country having a higher average sigma. The effect of markup deviation turns out to be more pronounced for a country having a smaller relative size.

The intuition underlying such markup behavior is quite easy to grasp by taking into account that the elasticity coefficient in any particular country depends on the consumer taste distribution in both of these countries. Indeed, trade liberalization implies that the foreign consumers intensify their impact on home country demand (the lower the transportation costs the greater the foreign consumers' contribution to the home country demand is). When consumer tastes in the home country are characterized by the lower value of the average sigma ($\bar{\sigma}_H < \bar{\sigma}_F$), then an increase in the foreign component of the home market demand will be accompanied by an increase in the elasticity $\bar{\varepsilon}_H$ and will lead to a decrease in markups within the domestic country. Since the

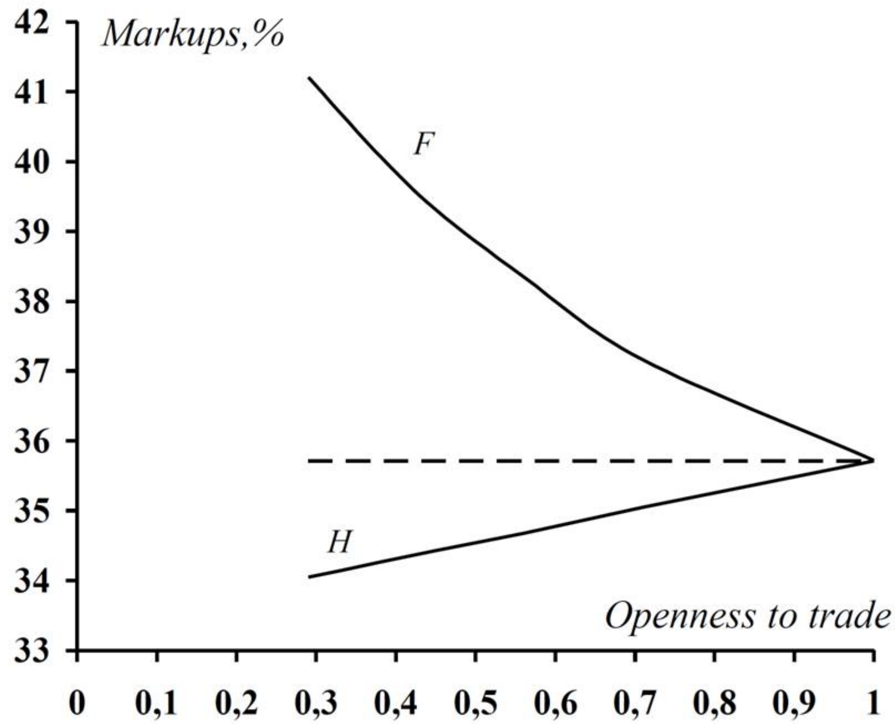

Figure 5: Markups vs trade liberalization, for $\bar{\sigma}_H > \bar{\sigma}_F(\bar{\sigma}_H = 3, \bar{\sigma}_F = 2 : \Delta\sigma_H = \Delta\sigma_F = 2)$.

home country is assumed to be larger than the foreign one, the influence of the foreigners on domestic markups is supposed to be modest, while the impact of home country consumers on foreign markups will be more pronounced. This is exactly what we see in Fig.4. The opposite effect is observed when home country consumers' tastes are characterized by the higher value of the average sigma ($\bar{\sigma}_H > \bar{\sigma}_F$). In such a case an increase in the foreign share of domestic demand is accompanied by a decrease in the elasticity coefficient $\bar{\varepsilon}_H$, which leads to an increase in home country markups, resulting in softer competition among domestic firms and tougher competition among foreign firms (see Fig.5).

As has already been mentioned above, although the pro-competitive behavior of markups has been reported in numerous publications, it should be noted that currently there is no consensus on this point, since some evidence of the reverse behavior of markups also exists. Two examples of this are (Fan et al., 2015) for China, where trade liberalization via input tariff reductions induced an incumbent importer/exporter to increase product markups, and (Thompson, 2002) for Canada, who found no consistent evidence that imports reduced the markups of Canadian firms during the 1970s period of trade liberalization.

Comparative static analysis fulfilled in the previous and present sections clearly demonstrates the capabilities of the present heterogeneous model of trade which turns out to be rather versatile in revealing both types of markup behavior.

4 Conclusions

In this paper the general equilibrium model of trade featuring heterogeneity in consumer preferences, both within and between countries, has been developed. The incorporation of heterogeneity into the traditional monopolistic competition setting is achieved by assuming different elasticities of substitution in the CES utility function for different consumers and different countries. This makes it possible to generate different demand functions for the same variety across destination countries when consumers in these countries have nonidentical distributions of taste. The proposed setup expands on the traditional CES-model of trade by demonstrating a richer set of the country specific effects.

Nevertheless, when the tastes of consumers in different countries are identically distributed, the present model of trade can be reduced to the canonical one by replacing the taste parameter appearing in the CES utility function of the traditional model of trade by the common average value of the taste parameter, characterizing equivalent preferences of the consumers in different countries.

Our main motivation in developing an extended model of trade is in accounting for the differences in markups across destination countries, reflecting the differences between levels of competition within the country. Unlike the canonical CES-models of trade, where markups in different countries are constant and identical to each other, the present model, by taking consumer heterogeneity into account, provides potentially different aggregate demands across destination countries, characterized by different price elasticity coefficients. This leads to the different markups across countries, incorporating both heterogeneity and trade specifics. The variability of markups is one of the key novelties which the heterogeneity assumption brings into the traditional model of trade.

Another finding which we revealed and which has to be highlighted is the violation of the standard CES trade model prediction regarding the relationship between wage rates in countries having a different population size. In contrast to the commonly accepted setting, our model suggests that the larger country can have a higher, lower, or the same wage rate, depending on the preference specifics and transportation costs.

5 Appendix

A1) Price elasticity of an individual demand curve of a consumer in country r

Letting the price elasticity of an individual demand for variety i, produced in country r, be given by $\varepsilon_i^{rr}(\omega_r) \equiv -\frac{p_i^r}{x_i^{rr}(\omega_r)}\frac{\partial x_i^{rr}(\omega_r)}{\partial p_i^r}$, and for variety j, produced in country s, be given by $\varepsilon_j^{sr}(\omega_r) \equiv -\frac{p_j^s}{x_j^{sr}(\omega_r)}\frac{\partial x_j^{sr}(\omega_r)}{\partial p_j^s}$, where $x_i^{rr}(\omega_r)$, $x_i^{sr}(\omega_r)$ are taken from (3)-(4), and taking into account that a firm's price choice has no impact on the price aggregate $P_r(\cdot)$, we get

$$\varepsilon_i^{rr}(\omega_r) \equiv \varepsilon^r(\omega_r) = \sigma_r(\omega_r)$$

and

$$\varepsilon_j^{sr}(\omega_r) \equiv \varepsilon^r(\omega_r) = \sigma_r(\omega_r)$$

. In view of these expressions, we may alternatively associate the taste parameter of a consumer in country r with the parameter driving price elasticity coefficients of an individual demand for the particular varieties, produced in countries r and s respectively. As can be seen, these coefficients do not depend upon indexes i, j and coincide with each other, which means that consumer ω_r in country r generates the same demand for varieties irrespective of the country, where these varieties were produced.

A2) Relationships connecting β - and γ-integrals

Some of the integrals appearing in the formulas (16)-(17)for the price elasticity coefficients are connected with each other. This can be shown by rearranging integrands in the integrals β_{FH}, β_{FF}, γ_{FH} and γ_{FF}:

$$\beta_{FH} \equiv \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}} = \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} =$$

$$= \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\left(1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}-1\right)d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} =$$

$$= \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\left(1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}\right)d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} - \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} =$$

$$= \frac{1}{\Delta\sigma_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} d\sigma_H - \beta_{HH} = 1-\beta_{HH}.$$

This provides the first relationship between β_{HH} and β_{FH} integrals:

$$\beta_{HH} + \beta_{FH} = 1.$$

Applying similar algebra to β_{FF} yields

$$\beta_{FF} \equiv \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1+\tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F-1)}} = \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\tilde{N}(\tau\tilde{p})^{\sigma_F-1}d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} =$$

$$= \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\left(1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}-1\right)d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} =$$

$$= \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\left(1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}\right)d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} - \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} =$$

$$= \frac{1}{\Delta\sigma_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} d\sigma_F - \beta_{HF} = 1-\beta_{HF}.$$

Thus provides the second relationship, connecting β-integrals:

$$\beta_{FF}+\beta_{HF}=1.$$

Similarly, one can obtain two additional relationships for γ-integrals:

$$\gamma_{FH} \equiv \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}} = \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} =$$

$$= \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H\left(1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}-1\right)d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} =$$

$$= \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H\left(1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}\right)d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} - \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} - =$$

$$= \frac{1}{\Delta\sigma_H\bar{\sigma}_H}\int\limits_{\sigma_{H1}}^{\sigma_{H2}} \sigma_H d\sigma_H - \gamma_{HH} = 1-\gamma_{HH},$$

$$\gamma_{HH}+\gamma_{FH}=1.$$

$$\gamma_{FF} \equiv \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F d\sigma_F}{1+\tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F-1)}} = \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F\tilde{N}(\tau\tilde{p})^{\sigma_F-1}d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} =$$

$$= \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F\left(1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}-1\right)d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}}$$

$$= \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F\left(1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}\right)d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} - \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} =$$

$$= \frac{1}{\Delta\sigma_F\bar{\sigma}_F}\int\limits_{\sigma_{F1}}^{\sigma_{F2}} \sigma_F d\sigma_F - \gamma_{HF} = 1-\gamma_{HF},$$

$$\gamma_{FF} + \gamma_{HF} = 1.$$

Accounting for above relationships, connecting β- and γ-integrals, only four (instead of eight) integrals are needed to represent the elasticity coefficients and to describe the general equilibrium of the model. They are

$$\beta_{HH} \equiv \frac{1}{\Delta\sigma_H} \int_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1 + \tilde{N}(\tilde{p}/\tau)^{\sigma_H - 1}} = 1 - \frac{1}{\Delta\sigma_H \ln(\tilde{p}/\tau)} \ln\left(\frac{1 + \tilde{N}(\tilde{p}/\tau)^{\sigma_{H2}-1}}{1 + \tilde{N}(\tilde{p}/\tau)^{\sigma_{H1}-1}}\right),$$

$$\beta_{FF} \equiv \frac{1}{\Delta\sigma_F} \int_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1 + \tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F - 1)}} = \frac{1}{\Delta\sigma_F \ln(\tau\tilde{p})} \ln\left(\frac{1 + \tilde{N}(\tau\tilde{p})^{\sigma_{F2}-1}}{1 + \tilde{N}(\tau\tilde{p})^{\sigma_{F1}-1}}\right),$$

$$\gamma_{HH} \equiv \frac{1}{\Delta\sigma_H \bar{\sigma}_H} \int_{\sigma_{H1}}^{\sigma_{H2}} \frac{\sigma_H d\sigma_H}{1 + \tilde{N}(\tilde{p}/\tau)^{\sigma_H - 1}} =$$

$$= 1 - \frac{1}{\Delta\sigma_H \bar{\sigma}_H \ln(\tilde{p}/\tau)} \ln \frac{\left(1 + \tilde{N}(\tilde{p}/\tau)^{\sigma_{H2}-1}\right)^{\sigma_{H2}}}{\left(1 + \tilde{N}(\tilde{p}/\tau)^{\sigma_{H1}-1}\right)^{\sigma_{H1}}} - \frac{Li_2\left(-\tilde{N}(\tilde{p}/\tau)^{\sigma_{H2}-1}\right) - Li_2\left(-\tilde{N}(\tilde{p}/\tau)^{\sigma_{H1}-1}\right)}{\Delta\sigma_H \bar{\sigma}_H (\ln(\tilde{p}/\tau))^2},$$

$$\gamma_{FF} \equiv \frac{1}{\Delta\sigma_F \bar{\sigma}_F} \int_{\sigma_{F1}}^{\sigma_{F2}} \frac{\sigma_F d\sigma_F}{1 + \tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F - 1)}} =$$

,

$$= \frac{1}{\Delta\sigma_F \bar{\sigma}_F \ln(\tau\tilde{p})} \ln \frac{\left(1 + \tilde{N}(\tau\tilde{p})^{\sigma_{F2}-1}\right)^{\sigma_{F2}}}{\left(1 + \tilde{N}(\tau\tilde{p})^{\sigma_{F1}-1}\right)^{\sigma_{F1}}} - \frac{Li_2\left(-\tilde{N}(\tau\tilde{p})^{\sigma_{F2}-1}\right) - Li_2\left(-\tilde{N}(\tau\tilde{p})^{\sigma_{F1}-1}\right)}{\Delta\sigma_F \bar{\sigma}_F (\ln(\tau\tilde{p}))^2},$$

where $\bar{\sigma}_H \equiv (\sigma_{H2} + \sigma_{H1})/2$ and $\bar{\sigma}_F \equiv (\sigma_{F2} + \sigma_{F1})/2$ denote the average values of the tastes parameters in countries H and F, correspondingly, $Li_2(\cdot)$ is the dilogarithm (or Spence's) function (Lewin, 1958), which can be calculated by using functional relationships, presented in (Morris, 1979).

A3) Alternative derivation of the identities connecting β-integrals

To derive (19) and (20) alternatively, we use budget constraints (2). Assuming identical firms, dropping indexes i and j, and renaming prices ($p_i^H \equiv p_H$, $p_j^F \equiv p_F$), the home and foreign budget constraints read as follows:

$$N_H p_H x^{HH} + N_F \tau p_F x^{FH} = y_H,$$

$$N_F p_F x^{FF} + N_H \tau p_H x^{HF} = y_F,$$

where

$$x^{HH} = \frac{y_H}{P_H}(p_H)^{-\sigma_H},$$

$$x^{FH} = \frac{y_H}{P_H}(\tau p_F)^{-\sigma_H},$$

$$x^{FF} = \frac{y_F}{P_F}(p_F)^{-\sigma_F},$$

$$x^{HF} = \frac{y_F}{P_F}(\tau p_H)^{-\sigma_F},$$

$$P_H = N_H p_H^{1-\sigma_H} + N_F(\tau p_F)^{1-\sigma_H},$$

$$P_F = N_F p_F^{1-\sigma_F} + N_H(\tau p_H)^{1-\sigma_F}.$$

Integrating these over all consumers in home and foreign countries using homogeneous distribution for sigmas, yields

$$\frac{1}{\Delta\sigma_H}\int_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1+\tilde{N}(\tilde{p}/\tau)^{\sigma_H-1}} + \frac{1}{\Delta\sigma_H}\int_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}} = 1,$$

$$\frac{1}{\Delta\sigma_F}\int_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1+\tilde{N}^{-1}(\tau\tilde{p})^{-(\sigma_F-1)}} + \frac{1}{\Delta\sigma_F}\int_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} = 1.$$

This is exactly what we have in (19) and (20) .

A4) Derivation of the trade balance condition

To derive the trade balance condition (21), notice that the value of foreign country imports in equilibrium should be equal to the imports of home country, i.e.

$$N_H \tau p_H q^{HF} = N_F \tau p_F q^{FH}.$$

Plugging

$$q^{HF} \equiv \int_{\Omega_F} x^{HF}(\omega_F)d\mu_F = \frac{Y_F}{\Delta\sigma_F}\int_{\sigma_{F1}}^{\sigma_{F2}} \frac{(\tau p_H)^{-\sigma_F}d\sigma_F}{N_F p_F^{1-\sigma_F} + N_H(\tau p_H)^{1-\sigma_F}}$$

and

$$q^{FH} \equiv \int_{\Omega_H} x^{FH}(\omega_H)d\mu_H = \frac{Y_H}{\Delta\sigma_H}\int_{\sigma_{H1}}^{\sigma_{H2}} \frac{(\tau p_F)^{-\sigma_H}d\sigma_H}{N_H p_H^{1-\sigma_H} + N_F(\tau p_F)^{1-\sigma_H}}$$

into above expressions yields

$$\frac{Y_F}{Y}\frac{1}{\Delta\sigma_F}\int_{\sigma_{F1}}^{\sigma_{F2}} \frac{d\sigma_F}{1+\tilde{N}(\tau\tilde{p})^{\sigma_F-1}} = \frac{Y_H}{Y}\frac{1}{\Delta\sigma_H}\int_{\sigma_{H1}}^{\sigma_{H2}} \frac{d\sigma_H}{1+\tilde{N}^{-1}(\tilde{p}/\tau)^{-(\sigma_H-1)}}.$$

This is equivalent to $(1-\alpha)\beta_{HF} = \alpha\beta_{FH}$, which is what we have in (21).

A5) Wage rates in trading countries and trade balance condition

By taking into account $\alpha = (\theta\tilde{w})/(1+\theta(\tilde{w}-1))$ and $1-\alpha = (1-\theta)/(1+\theta(\tilde{w}-1))$, where

$\tilde{w} \equiv w_H/w_F$, the trade balance condition derived previously can be rewritten as

$$(1-\theta)w_F\beta_{HF} = \theta w_H\beta_{FH}.$$

By juxtaposing this with its equivalent $N_H\tau p_H q^{HF} = N_F\tau p_F q^{FH}$, one can see that the wage rate abroad is proportional to the total demand of home country consumers ($N_F q^{FH}$), purchasing foreign varieties, while the wage rate in home country is proportional to the total demand of foreigners ($N_H q^{HF}$), purchasing varieties, produced at home.

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