1 Introduction

In new economic geography (NEG) models that explain firms' and workers' localization decisions, consumers'/workers' preferences are usually assumed to be homogenous and represented through the same utility function. In particular, in many of these models there is a specific category of workers who are interregionally mobile - usually identified as skilled workers - and a category of interregionally immobile workers - usually identified as unskilled workers. Thanks to NEG models we can analyze how the actual and endogenous movements of mobile workers, together with those of firms, give rise to a certain number of centripetal and centrifugal forces, whose interplay leads to a particular equilibrium outcome in which the economic activity is more or less agglomerated depending on the strength of all particular forces at work. However, NEG models do not generally consider the case in which some of these forces may be generated by workers' preference differences, even though there are some exceptions to which we will refer later on. In any case, we may think that the assumption of homogenous preferences across workers has the capacity to keep things simple in already complex frameworks.

Let us consider, for instance, the seminal core-periphery model by Krugman (1991). In this model a change in trade cost levels, through skilled workers' and firms' mobility, may modify the intensities of two agglomeration forces - described as the market access effect and the price index effect - and the intensity of one dispersion force - the so called market-crowding effect.[1] Depending on trade cost levels, these forces will lead to a stable equilibrium of complete agglomeration of the modern sector in one region, or to a symmetric equilibrium in which all economic activity is evenly distributed across space. We would like to point out that skilled and unskilled workers considered in this model have the same preferences. Moreover, changes in their interregional distribution cannot modify the strength of forces that determine the distribution of the economic activity, because of the assumption of the particular version of the monopolistic competition model

[1] See, for instance, chapter 2 in Baldwin et al. (2003).

developed by Dixit and Stiglitz (1977) and of iceberg trade costs.[2] According to Ottaviano et al. (2002, p. 410):

> Taken together, these assumptions yield a demand system in which the own-price elasticities of demands are constant, identical to the elasticities of substitutions, and equal to each other across all differentiated products. This entails equilibrium prices that are independent of the spatial distribution of firms and consumers. Though convenient from an analytical point of view, such a result conflicts with research in spatial pricing theory that shows that demand elasticity varies with distance while prices change with the level of demand and the intensity of competition.

Thus, Ottaviano et al. (2002) propose a new framework in order to take into account their objections and, in this work, we will heavily draw on their model, which we modify to show our point.

In particular, we argue that, besides the traditional forces treated in new economic geography models, we may consider a new kind of force generated from workers' preference differences, whose nature of agglomeration or dispersion force will be discussed and identified below, and whose action contributes to the determination of equilibria stability properties. Moreover, in order to simplify our analysis, we assume that workers' preference differences are connected to skills differences and we will later justify this assumption. Now we observe that a class of new economic geography models distinguish two groups of workers, that is: interregionally immobile unskilled workers and interregionally mobile skilled workers. Hence, we retain this distinction introducing the following additional assumption: we associate to the difference in workers' skill endowments and mobility characteristics differences in their preferences, with one group of workers more willing to consume the modern differentiated good than the traditional good and, at the same time, more keen on having a greater variety of the differentiated good. In fact, it does not seem unrealistic to think

[2] See, for instance, Ottaviano and Thisse (2003).

that agents which have a greater love for the modern good also appreciate its differentiation more.

Moreover, at this stage of the paper, we do not have to state which of the two types of workers has a stronger preference for the modern good and for a greater differentiation in its consumption. Nevertheless, in many of our comments in the paper, we will refer to the case in which this type of workers is that of mobile skilled workers, since it seems fair to assume that more skilled mobile workers are also the ones that have a stronger preference for the consumption of the modern good and for a greater variety in its consumption.

As mentioned before, we need to say that, even if new economic geography models generally consider that all workers have the same structure of preferences, the papers by Tabuchi and Thisse (2002) and by Murata (2003) are an exception to this common line. Tabuchi and Thisse (2002) introduce taste heterogeneity by allowing different mobile workers to react in different ways to regional differences, and they show that this heterogeneity produces a strong dispersion force. Tabuchi and Thisse (2002, p. 156) write that, in this way, they are allowed to "show how falling transport costs and individual heterogeneities in perceptions of regional differences interact to affect firms' and workers' locations and, therefore, the geographical pattern of the industry and population". Also in Murata (2003) taste heterogeneity in residential location of the single type of mobile workers acts as a dispersion force.

However, the form of heterogeneity that we introduce differs from that considered by Tabuchi and Thisse (2002) and Murata (2003) in different aspects. First of all, because the heterogeneity that we consider arises from a different source, that is from different tastes in the consumption of goods, and not from different reactions to regional differences. Secondly, because it does not arise within the same category of mobile skilled workers, but between the two different categories of skilled and unskilled workers.

The remaining part of the work is organized as follows. In Section 2 we introduce a simple modification in the linear model of economic geography proposed by Ottaviano et al. (2002) by allowing preference differences between skilled and unskilled workers.[3] Section 3 shows that the introduction of this assumption may affect the results of the interplay of agglomeration and dispersion forces in determining the equilibrium outcomes, and Section 4 more deeply discusses the *preference* and *competition effects on prices* determined by changes in the localization of workers and firms, underlining that the heterogeneity in preferences we introduce may be responsible for the emergence of stable asymmetric equilibria. Finally, Section 5 concludes.

2 The model with heterogeneous preferences

We consider a model with two regions, indexed with r and s, endowed with two factors/workers, which are distinguished between skilled interregionally mobile workers, indexed with H, and unskilled interregionally immobile workers, indexed with L. The total number of skilled workers is H, while each region is endowed with $L/2$ unskilled workers. Workers consume M varieties of a modern manufactured good, with each variety denoted by suffix i and consumed in the quantity q_i, and the quantity q_0 of a traditional good (the numeraire of the model). Moreover, workers' preferences are represented by the following quadratic utility function:

$$U(q_0; q_i, i \in [0, M]) = \alpha_j \int_0^M q_i di - \frac{\beta_j - \delta_j}{2} \int_0^M q_i^2 di - \frac{\delta_j}{2} \left(\int_0^M q_i di \right)^2 + q_0 \qquad (1)$$

with $j = H, L$, $\alpha_j > 0$ and $\beta_j > \delta_j > 0$.

The total number (mass) of produced varieties M, is the sum of the n_r varieties produced in region r and the n_s varieties produced in region s. Parameters α_j, β_j and δ_j describe workers' preferences. Particularly, parameter α_j expresses the intensity of the preference for the differentiated good with respect to the traditional good, and the two parameters β_j and δ_j, with $\beta_j > \delta_j$, express the intensity of the preference of consumers of type j for differentiation in the consumption of the modern good. Hence, for any given value of β_j, parameter δ_j underlines the degree of

[3] We choose to work with this model because of its tractability. Moreover, we notice that Tabuchi and Thisse (2001) also adopt this structure.

substitutability between varieties and the higher δ_j is, the higher the degree of substitutability of varieties is.

It is straightforward to notice that the setup we consider only differs from that originally proposed by Ottaviano et al. (2002) in the fact that we introduce the suffix j that characterizes parameters in (1). This suffix draws attention to the fact that skilled and unskilled workers have different preferences. In the rest of the paper we show this simple extension of the original framework may give rise to some interesting results, given that prices will show a new kind of dependence on the spatial distribution of workers and firms, and given that this will allow us to identify a new force related to the demand side that can be at work in determining the regional distribution of the economic activity.

Each worker maximizes (1) given its budget constraint

$$\int_0^M p_i q_i di + q_0 = w_j + \bar{q}_0 \tag{2}$$

where w_j represents the wage of the worker of type j and $\bar{q}_0$ is the endowment of the numeraire of each individual.[4]

The demand function for each variety produced in region z of any worker j located in region v is

$$q^j_{zv}(p_{zv}) = a_j - (b_j + d_j M)p_{zv} + d_j P_v \tag{3}$$

where $v, z = r, s$. The first element in the suffix of quantities and prices expresses the location of producers, while the second, the location of the worker who demands the good. Moreover, the new parameters are obtained in the following way: $a_j = \alpha_j/[(\beta_j + (M-1)\delta_j]$, $b_j = 1/[\beta_j + (M-1)\delta_j]$ and $d_j = \delta_j/(\beta_j - \delta_j)[\beta_j + (M-1)\delta_j]$.[5] Finally, P_z is the price indexes prevailing in region z, which, given the symmetry of all firms in a particular region, is

$$P_z = n_z p_{zz} + n_v p_{vz} \tag{4}$$

[4] As usual, the individual endowment of the numeraire is supposed to be sufficiently large to have a positive consumption of the traditional good in equilibrium for each individual.

[5] See, for instance, Ottaviano et al. (2002) and Fujita and Thisse (2002).

In order to simplify the notation, we drop the suffix L in the three parameters, α_L, β_L and δ_L, which refer to unskilled workers and we assume that parameters referred to skilled workers H are proportional to those of unskilled workers, with the factor of proportionality given by $\rho > 0$. Therefore, we have that

$$\begin{aligned} \alpha_H &= \alpha_L/\rho = \alpha/\rho \\ \beta_H &= \beta_L/\rho = \beta/\rho \\ \delta_H &= \delta_L/\rho = \delta/\rho \end{aligned} \tag{5}$$

Moreover, from (5) and the definitions of a_j, b_j and d_j, it is easily verified that

$$a_H = a_L = a; \quad b_H = \rho b_L \quad \text{and} \quad d_H = \rho d_L \tag{6}$$

These simple assumptions allow us to introduce a particular kind of workers' preference heterogeneity, sufficiently simple to handle because it requires that parameters referring to skilled workers are proportional to those of unskilled workers. It would certainly be more general to consider the case in which these parameters were different, without necessarily being proportional. However, as it will later appear, this simplification alone is sufficient to complicate the analysis enough to suggest to avoid making matters worse with a more general framework with different and not necessarily proportional parameters. Hence, we choose to adopt the simplification in (5), since we already obtain some interesting results with it, and given that it can be considered as a particular case of a more general one, in which the results of the former would continue to hold under particular conditions.[6]

In Fig. 1 we plot the inverse demand function for a variety produced in region z of the $j-th$ worker located in region v, that is

$$p_{zv} = \frac{a - q^j_{zv}(p_{zv})}{\rho(b + dM)} + \frac{dP_v}{(b + dM)} \tag{7}$$

[6] The nature of our results would be the same when parameters for skilled workers are all lower (higher) than those for unskilled workers. However, for any other case different from ours it would be possible to compute equilibrium results, even though for their interpretation we should use simulations.

with $v, z = r, s$.[7] In particular, Fig. 1 contains the graphics of two inverse demand functions which are drawn for two different values of ρ, that is $\rho_1 < \rho_2$. We note that the two curves intersect in I when $q_{zv} = a$. Moreover, as the graphics show, any increase in the preference for the manufactured good and variety in its consumption, which reduces ρ, produces a clockwise rotation of the demand curve around I. In particular, we observe that when the preference parameter ρ goes to zero because of a very strong preference for differentiation that tends to annihilate any substitutability between varieties, then

$$\lim_{\rho \to 0} q_{zv}^{j}(p_{zv}) = a \tag{8}$$

Insert figure 1 about here

As we have already stated, in many of our comments, we refer to the case in which $\rho < 1$, which corresponds to the case in which skilled workers have a stronger preference for the modern good and variety in its consumption. These assumptions imply that skilled workers' elasticity of demand is smaller than that of unskilled workers. To justify the assumptions that skilled workers' preference for the modern good is stronger than that of unskilled workers, we may consider that skilled workers' incomes are usually higher than those of unskilled workers. Therefore, by assuming $\rho < 1$ we may in some sense reflect Joan Robinson's (1969) thought that increases in agents' incomes make individuals demand less elastic. Moreover, we may justify the fact that skilled workers have a stronger preference for variety in the consumption of the modern good, by observing, for instance, that skilled workers are the ones who produce the differentiated modern goods and, therefore, they are more able to appreciate this differentiation.

Let us define with λ_r the fraction of skilled workers in region r. We notice that each representative firm which produces in region r sells on the local market the quantity

$$q_{rr}(p_{rr}) = q_{rr}^{L}(p_{rr})\frac{L}{2} + q_{rr}^{H}(p_{rr})\lambda_r H \tag{9}$$

[7] It is clear that given our assumption, the demand function of unskilled workers corresponds to the case in which $\rho = 1$.

The quantity sold on the foreign market is instead

$$q_{rs}(p_{rs}) = q^L_{rs}(p_{rs})\frac{L}{2} + q^H_{rs}(p_{rs})(1-\lambda_r)H \tag{10}$$

Similar expressions can be obtained for firms that produce in region s.

Operating profits of a representative firm which produces in r are obtained by adding operating profits which derive from sales in r, π_{rr}, to those derived from sales in s, π_{rs}, which are, respectively,

$$\pi_{rr} = p_{rr}q_{rr} \quad \text{and} \quad \pi_{rs} = (p_{rs}-t)\, q_{rs} \tag{11}$$

The production cost of each firm in region $z = r, s$ is generated by the fixed cost that firms have to sustain in order to employ f skilled workers and are given by

$$TC_r = fw_r \tag{12}$$

Therefore, pure profits π_r of the representative firm which produces in region r are

$$\pi_r = \pi_{rr} + \pi_{rs} - fw_r \tag{13}$$

Finally, the assumption of full employment of workers implies that

$$H_r = \lambda_r H = n_r f \quad \text{and} \quad H_s = (1-\lambda_r)H = n_s f \tag{14}$$

3 Preference differences and equilibrium outcomes

In this section we derive equilibrium prices and quantities and skilled workers' indirect utility functions used to evaluate the stability properties of the different potential outcomes. First of all, from the first order conditions for the maximization of profits, we obtain the following equilibrium price for varieties sold at home

$$p^*_{zz}(\lambda_z, \rho) = \frac{td_L\left(\frac{L}{2}+\rho\lambda_z H\right)(1-\lambda_z)\, M + 2a\left(\frac{L}{2}+\lambda_z H\right)}{2\,(2b_L + d_L M)\left(\frac{L}{2}+\rho\lambda_z H\right)} \tag{15}$$

where $z = r, s$. The asterisk always denotes equilibrium values.

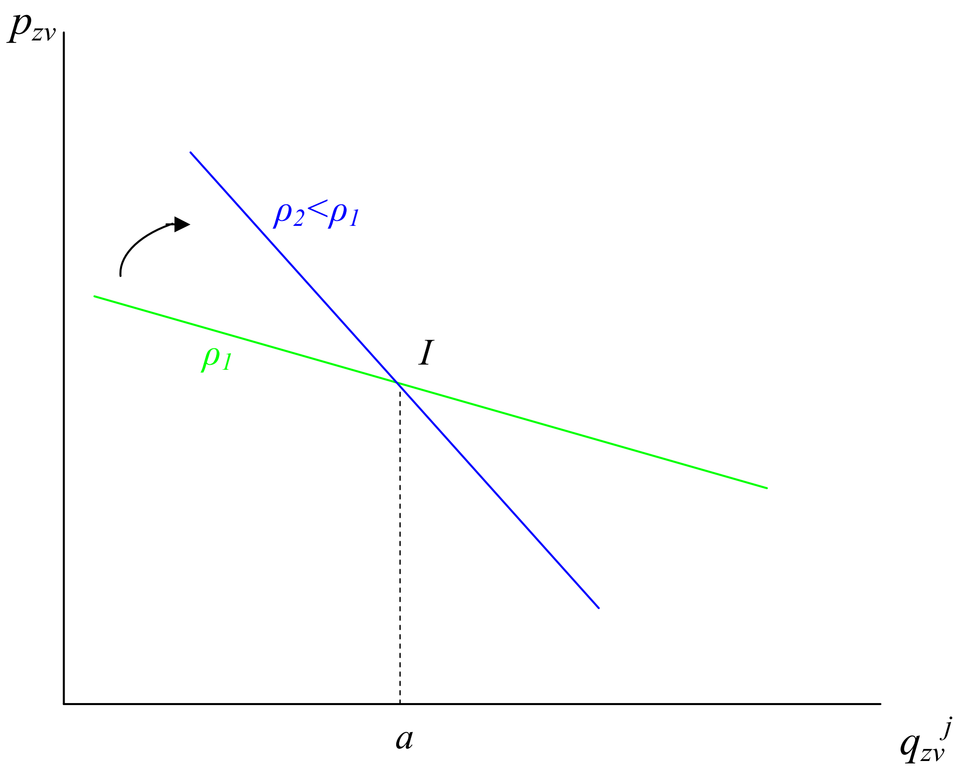

Fig. 1

Moreover, the price of exported varieties from region z to region v is

$$p_{zv}^{*}(\lambda_z, \rho) = p_{vv}^{*} + \frac{t}{2} \tag{16}$$

where $v, z = r, s$ and $v \neq z$. From the previous expression we note that, even though prices differ from the original linear core-periphery model by Ottaviano et. al. (2002), the relationship between prices of locally produced varieties, p_{vv}, and the imported varieties, p_{zv}, is still the one found in the linear model.

In order to have positive exports from region z to region v, exporting prices, p_{zv}^{*}, must be higher than transport costs, t, and this requires that

$$t < t_{zv}^{*} = \frac{2a\,(L + 2H)}{(2b_L + d_L M)\,(L + 2\rho H)} \tag{17}$$

where $v, z = r, s$ and $v \neq z$.

It can be easily verified from (15) and (16) that

$$\frac{\partial p_{zr}^{*}(\lambda_r, \rho)}{\partial \rho} < 0 \tag{18}$$

with $z = r, s$. The result in (18) reflects the fact that when skilled workers' preference for the manufactured good and the variety in its consumption increase, that is when ρ decreases, the price of each variety, either locally produced or imported, increases.

Moreover, we obtain that

$$\frac{\partial p_{zr}^{*}(\lambda_r, \rho)}{\partial \lambda_r} = \frac{1}{2(2b_L + d_L M)}\left[-d_L M t + \frac{4LaH(1-\rho)}{(L + 2\lambda_r H\rho)^2}\right] \tag{19}$$

with $z = r, s$. Thus, we may notice that, as in Ottaviano et al. (2002), equilibrium prices are dependent on the distribution of the workers' demand and firms between the two regions. However, while Ottaviano et al. (2002, p. 417) find that "the prices charged by both local and foreign firms fall when the mass of local firms increases (because price competition is fiercer)", we find that this is true only when $\rho \geq 1$, that is, when skilled workers have a weaker preference for the modern good and variety in the consumption of the same. Thus, prices charged by both local and foreign firms are not obliged to fall whenever the mass of local firms increases, because expression (19) shows that if the intensity of skilled workers' preference for the modern good and its variety is stronger (with $\rho < 1$), prices charged by firms, either local or foreign, may even increase when the mass of local firms increases. This result arises in our work from the fact that, together with the *competition effect* on prices generated by changes in the distribution of workers and firms, already described in Ottaviano et al. (2002), there is another contextual effect on prices due to preference heterogeneity which acts through the change in the relative weight of demand for the modern goods with respect to the traditional good. We call this effect the *preference effect* and its action will be more deeply discussed in next section.

Another new and significant result, strictly associated with the previous one, is that the increase of the mass of local firms in a region, for instance region r, is no longer always associated with an increase of the price of varieties sold in the other region, as it happens when $\rho = 1$. In fact, given that

$$\frac{\partial p_{zs}^{*}(\lambda_r, \rho)}{\partial \lambda_r} = \frac{1}{2(2b_L + d_L M)} \left[d_L M t - \frac{4LaH(1-\rho)}{(L + 2(1-\lambda_r)H\rho)^2} \right] \tag{20}$$

with $z = r, s$, it is easily verified that if skilled workers have a stronger preference for the modern good and variety in its consumption, that is if $\rho < 1$, then an increase of the mass of local firms in region r may also be associated with a decrease in prices of varieties sold in the other region s.

Moreover, we derive the equilibrium quantities which depend not only on the distribution of firms and workers between the two regions, but also on the value of ρ. Particularly, for any firm the equilibrium value of the quantity sold in the home region is

$$q_{zz}^{*}(\lambda_z, \rho) = \frac{(b_L + d_L M)\left[t d_L M \left(1 - \lambda_z\right)\left(L + 2\rho\lambda_z H\right) + 2a(L + 2\lambda_z H)\right]}{4(2b_L + d_L M)} \tag{21}$$

where $z = r, s$. We also compute the equilibrium value of the quantity that any firm in v sells abroad, that is

$$q_{vz}^*(\lambda_z,\rho) = q_{zz}^*(\lambda_z,\rho) - \frac{t(b_L + d_L M)(L + 2\rho\,(1-\lambda_z)\,H)}{4} \tag{22}$$

where $v, z = r, s$ and $v \neq z$.

It can be readily verified from (21) and (22) that

$$\frac{\partial q_{zz}^*(\lambda_z,\rho)}{\partial \rho} > 0 \quad \text{and} \quad \frac{\partial q_{vz}^*(\lambda_z,\rho)}{\partial \rho} < 0 \tag{23}$$

where $v, z = r, s$ and $v \neq z$. Therefore, a reduction in ρ, due to an increase in the preference for the manufactured good and the variety in its consumption for skilled workers, does always reduce equilibrium quantities of locally produced varieties, and increase those of imported varieties.

We notice from (23) and (8) we can derive that

$$q_{zz}^*(\lambda_z,\rho) > a \quad \text{and} \quad q_{vz}^*(\lambda_z,\rho) < a \tag{24}$$

with $v, z = r, s$ and $v \neq z$.

Skilled workers' indirect utility function in region r is given by the following expression

$$V_{Hr}(\lambda_r,\rho) = S_{Hr}(\lambda_r,\rho) + w_r^*(\lambda_r,\rho) + \overline{q}_0 \tag{25}$$

where the individual consumer surplus for skilled workers, $S_{Hr}(\lambda_r,\rho)$, is given by

$$\begin{aligned} S_{Hr}(\lambda_r,\rho) \quad = \quad & \frac{a^2 M}{2b_H} - a\ \left[n_r(\lambda_r,\rho)p_{rr}^*(\lambda_r,\rho) + n_s(\lambda_r,\rho)p_{sr}^*(\lambda_r,\rho)\right] + \\ & + \frac{b_H + d_H M}{2}\left[n_r(\lambda_r,\rho)(p_{rr}^*(\lambda_r,\rho))^2 + n_s(\lambda_r,\rho)(p_{sr}^*(\lambda_r,\rho))^2\right] + \\ & - \frac{d_H}{2}\left[n_r(\lambda_r,\rho)p_{rr}^*(\lambda_r,\rho) + n_s(\lambda_r,\rho)p_{sr}^*(\lambda_r,\rho)\right]^2 \end{aligned} \tag{26}$$

and the equilibrium skilled wage in region r, $w_r^*(\lambda_r,\rho)$, is derived from the free entry condition, which implies that profits in (13) are equal to zero in equilibrium.

We follow the myopic adjustment process adopted in Ottaviano et al. (2002), from which we know that a spatial equilibrium corresponds to the case in which each mobile worker located in a region cannot increase its utility level by moving to the other region. Therefore, we may write that a spatial equilibrium arises at an interior point, with $\lambda_r \in (0,1)$, when

$$\Delta V_H(\lambda_r, \rho) \equiv V_{Hr}(\lambda_r, \rho) - V_{Hs}(\lambda_r, \rho) = 0 \tag{27}$$

or at the extreme point of full agglomeration in region s with $\lambda_r = 0$ (in region r with $\lambda_r = 1$) when $\Delta V_H(0, \rho) \leq 0$ ($\Delta V_H(1, \rho) \geq 0$).[8]

Finally, while it is easily verified that the agglomerated equilibria are always stable, the interior equilibria are stable when the slope of $\Delta V_H(\lambda_r, \rho)$ is negative.[9]

The indirect utility differential is

$$\Delta V_H(\lambda_r, \rho) = \frac{(2\lambda_r - 1)\, M}{(2b_L + d_L M)^2} \left[(b_L + d_L M)\,(a_0 t^2 + b_0 t) + c_0\right] \tag{28}$$

where the three coefficients a_0, b_0 and c_0, respectively, are

$$\begin{aligned}
a_0(\rho) &= -\frac{(L+H\rho)d_L^2 M^2 + 2(3H\rho+L)b_L d_L M + 6b_L^2 H\rho}{4H} < 0 \\
b_0(\lambda_r, \rho) &= \frac{a\left\{\begin{array}{c} 2(L + 2\lambda_r H\rho)[L + 2(1-\lambda_r)H\rho]d_L M + \\ +[(4-\rho)L^2 + 2(4-\rho)\rho HL + 12(1-\lambda_r)\lambda_r H^2\rho^2]b_L \end{array}\right\}}{[L+2(1-\lambda_r)H\rho](L+2\lambda_r H\rho)} \\
c_0(\lambda_r, \rho) &= -\frac{2a^2 HL(1-\rho)\left\{\begin{array}{c} [L + 2(1-\lambda_r)H\rho](L + 2\lambda_r H\rho)d_L M + \\ +[(2-\rho)L^2 + (3-\rho)\rho HL + 4(1-\lambda_r)\lambda_r H^2\rho^2]b_L \end{array}\right\}}{[L+2(1-\lambda_r)H\rho]^2(L+2\lambda_r H\rho)^2}
\end{aligned} \tag{29}$$

We observe that we obtain the results in the linear core periphery model by Ottaviano et al. (2002) when $\rho = 1$. In this particular case, $c_0 = 0$. We also note that when $\rho < 1$, it is always true that $b_0 > 0$ and $c_0 < 0$.

In table 1 we compare the case in the linear core periphery model ($\rho = 1$) to our extension ($\rho > 0$) and we draw the attention to the fact that in the latter case a_0 depends only on ρ, while b_0 and c_0 depend both on ρ and λ_r, while in the former case no coefficients depend on the distribution of skilled workers.

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[8] See Ottaviano et. al. (2002)

[9] The reader interested in the specification of the migration process may find its accurate description in Ottaviano et al (2002, p. 419).

	a_0	b_0	c_0
$\rho > 0$	$a_0(\rho)$	$b_0(\lambda_r, \rho)$ with $b_0(0, \rho) = b_0(1, \rho)$	$c_0(\lambda_r, \rho)$ with $c_0(0, \rho) = c_0(1, \rho)$
$\rho = 1$	$a_0 = -\frac{(L+H)d_L^2 M^2 + 2(3H+L)b_L d_L M + 6b_L^2 H}{4H}$	$b_0 = a(3b_L + 2d_L M)$	0

Table 1.

Fig. 2 plots the indirect utility differential $\Delta V_H(\lambda_r, \rho)$ when $\rho < 1$ and shows not only that agglomeration may result unstable for parameter values for which it was stable with $\rho = 1$, but also that asymmetric stable equilibria outcomes may arise when the symmetric equilibrium is unstable. In fact, when $\rho < 1$ there is another dispersion force at work which acts together with all traditional forces in determining the equilibria of the model. In particular, this force arises because in the region with the highest (lowest) density of workers, prices tend to increase (decrease) due to the stronger (weaker) demand for the differentiated good compared with that for the traditional good, and it accompanies the agglomeration competition effect on prices which tend to decrease (increase) in the same region because of the fiercer (weaker) competition originated by the greater (smaller) number of firms.

Insert figure 2 about here

Finally, we note that when $\rho < 1$, the indirect utility differential in (28) at $\lambda_r = 1$ depends on the the values of $a_0(\rho) < 0$, $b_0(1, \rho) > 0$ and $c_0(1, \rho) < 0$.[10] Clearly, the expression in square brackets in (28) depends on the level of economic integration. More precisely, it is a concave parabola in t, with its maximum for $t_1 = -b_0(1, \rho)/(2a_0(\rho)) > 0$. Hence, given that the sign of $\Delta V_H(1, \rho)$ depends on that of the parabola, we can state that full agglomeration is never a potential equilibrium for high and low trade costs, while it may be an equilibrium for intermediate

[10] In particular, $b_0(1, \rho) = a\left[(4-\rho)\, b_L + 2Md_L\right] > 0$ and $c_0(1, \rho) = -2Ha^2 \frac{(1-\rho)[(2-\rho)Lb_L + (3-\rho)\rho H b_L + (L+2H\rho)Md_L]}{(L+2H\rho)^2} < 0$.

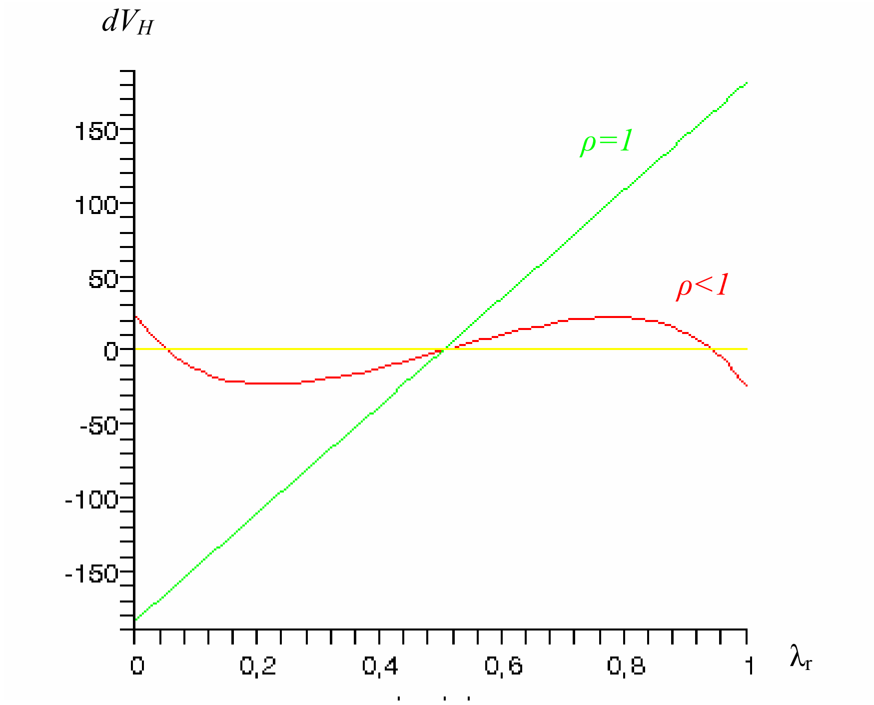

Fig. 2

trade costs.[11] In any case, we note that in the previous phrase we used the word potential to qualify the equilibrium, because we remember that trade costs must be compatible to positive prices and quantities, which require expression (17) to be satisfied.

On the other hand, when $\lambda_r = 1/2$ the indirect utility differential in (28) is decreasing in λ_r, and therefore we have an equilibrium at $\lambda_r = 1/2$ only when

$$\left.\frac{\partial\left(\Delta V_H(\lambda_r,\rho)\right)}{\partial\lambda_r}\right|_{\lambda_r=1/2} = \frac{2M\left[(b_L+d_LM)\left(a_0(\rho)t^2+b_0(1/2,\rho)t\right)+c_0(1/2,\rho)\right]}{\left(2b_L+d_LM\right)^2}<0$$

Clearly, the previous inequality is true when the expression in square brackets is negative. We observe that, when $\rho < 1$, this expression is depicted by a concave parabola in t with $a_0(\rho) < 0$, $b_0(0.5,\rho) > 0$ and $c_0(0.5,\rho) < 0$. Thus, the symmetric equilibrium is stable only for high and low trade costs, provided that (17) is satisfied, while it is unstable for intermediate trade cost values.[12]

4 The competition effect and the preference effect in detail

In order to more deeply discuss the findings in the previous section, we recall that Ottaviano et al. (2002) find that there are different effects which give rise to the agglomeration and dispersion forces, whose interplay defines the properties of the equilibrium outcomes. These forces are the dispersion force originated by the demand of immobile unskilled workers, and the agglomeration force originated from the fact that a greater number of firms in a region implies that fewer varieties are imported, and that equilibrium prices of all varieties sold in this region are smaller (*competition effect on prices*).

In this work, we show that these effects are partially modified and enriched by the additional force which is generated when $\rho \neq 1$. In particular, the centrifugal force generated by immobile

[11] In particular, with $\rho < 1$, when $\lambda_r = 1$ and $t = t^*$, we know that $\Delta V_H(1,\rho) > 0$ if $b_0(1,\rho)^2 > \frac{4a_0(\rho)c_0(1,\rho)}{(b_L+d_LM)}$.

[12] In particular, $b_0(0.5,\rho) = 2ad_LM + \frac{a[(4-\rho)L(L+2\rho H)+3H^2\rho^2]b_L}{(L+H\rho)^2}$ and $c_0(0.5,\rho) = -2a^2H(1-\rho)\left\{(L+H\rho)d_LM+\left[\left((2-\rho)L+(3-\rho)\rho H\right)L+H^2\rho^2\right]b_L\right\}L\frac{1}{(L+H\rho)^4}$

unskilled workers as well as the agglomeration force originated by the fact that fewer varieties are imported are still at work in our case. However, the result that a larger number of firms located in a particular region always implies lower equilibrium prices of all varieties sold in the same region is no longer true. This difference arises because when $\rho < 1$ we have an additional centrifugal force generated by the fact that equilibrium prices of all varieties sold in a region may increase, rather than decrease, when λ_r increases because of the *preference effect on prices.* An increase in λ_r, therefore, has an ambiguous impact on prices of varieties sold in r, and the results of the trade-off generated by the two above mentioned effects is in favour of the preference effect when (19) is such that

$$\frac{\partial p_{zr}^*(\lambda_r, \rho)}{\partial \lambda_r} > 0 \tag{30}$$

with $z = r, s$. Expression (30) is true only when the share of skilled workers in region r, λ_r, is sufficiently low that

$$l_r \equiv (L + 2\lambda_r H\rho)^2 < \frac{4LaH(1-\rho)}{d_L M t} \tag{31}$$

Note that we define the left hand side of (31) as l_r. Expression (31) tells us that, when $\rho < 1$, the prevalence of the dispersion force originated by an increase in the concentration of skilled workers in region r can leave the predominance to the agglomeration force when the number of firms in the region, positively related to λ_r, becomes sufficiently high to reverse the inequality sign in (31).

Moreover, from (20) we are able to show that, when $\rho < 1$, there could be another dispersion force which could dominate because when the number of firms in a region increases, prices in the other region, in our example in region s, may decrease. In this case we would have the following result

$$\frac{\partial p_{zs}^*(\lambda_r, \rho)}{\partial \lambda_r} < 0 \tag{32}$$

with $z = r, s$. On the other hand, the opposite could be true when the competition effect prevails, with prices increasing as the number of firms decreases. Expression (32) is true when the share of skilled workers in region r, λ_r, is such that

$$l_s \equiv (L + 2(1 - \lambda_r)H\rho)^2 < \frac{4LaH(1-\rho)}{d_L M t} \tag{33}$$

Note that we define the left hand sides of (33) as l_s.

We can clearly observe that both (31) and (33) identify a unique threshold value in correspondence of which the inequality sign changes, which is given by

$$\varphi^* = \frac{4LaH(1-\rho)}{d_L M t} \tag{34}$$

We observe that φ^* is increasing in L, a, H and decreasing in d_L, M, t and ρ. Moreover, we notice that the threshold φ^* would be nil (negative) if ρ were equal to 1 (larger than 1). In other words, the case of prices decreasing in the region in which the number of firms and workers increases would be absent not only when $\rho = 1$, as in Ottaviano et al. (2002), but also when $\rho > 1$, because in this specific case, skilled workers' preference for the consumption of the modern good and variety is weaker than for unskilled workers. Thus, increasing the number of workers in a particular region would reduce the aggregate preference for variety in that particular region and this fact, together with the stronger competition due to the increase in the number of firms, would end up by reducing prices even more and strengthening agglomeration forces. The additional increase in agglomeration forces is originated by the second addend which we found in the square brackets in (19).

Let us consider the case in which we are more interested; that is the case in which $\rho < 1$, because it is more likely that skilled workers are more willing to consume the modern differentiated good and more keen on having a greater variety in its consumption. In this case, a larger share of skilled workers in region r may result either in higher or in lower prices of varieties sold in the same region. Thus, there is a trade off originated by an increase in the share of skilled workers in a region. In fact, on one hand this larger share is associated with a larger number of firms and, consequently, with a stronger competition that tends to reduce prices in r. On the other hand, when $\rho < 1$, the intensity of total demand for modern goods and differentiation in their consumption would also be stronger, and this tends to increase prices in r. The latter effect dominates only if λ_r is sufficiently low that expression (31) is true, while the former dominates when λ_r becomes too high. In the latter case, the larger share of skilled workers in r would be associated with a sufficiently high number of firms located in the same region whose increased competition would reduce prices in r. Finally, we notice that the intensities of these two effects, that is the *competition effect* and the *preference effect* are, respectively, described by the two addends in the square brackets in expression (19).

Moreover, we may deduce from (33) that if a certain number of skilled workers leaves region s, there would be two other contrasting effects in region s. On one hand, fewer skilled workers in s mean a reduced preference intensity for the modern goods which would imply lower prices in s. On the other, fewer skilled workers in s mean also fewer firms and less competition between the firms left in the same region that would imply higher prices in region s. The result of these contrasting effects is an increase in prices in region s when a certain number of skilled workers leaves the region only if the number of firms in s is sufficiently low, that is only if λ_r is already sufficiently high. Again, we point out that the intensities of these two effects, that is the *competition effect* and the *preference effect* are, respectively, described by the two addends in the square brackets in expression (20).

In summary, we may write that while the competition effect is already present in the original framework developed by Ottaviano et al. (2002), the preference effect obviously arises only once we allow for preference differences.

Let us continue with the case in which $\rho < 1$. We note that if a certain number of skilled workers moves toward region r when λ_r is sufficiently small that (31) and (33) are satisfied, both the phenomena of higher prices in the region of destination, r, and of lower prices in the region of provenience, s, are originated from the stronger preference that skilled workers have for the consumption of the modern good and for the variety in its consumption. On the contrary, when λ_r is sufficiently high that (31) and (33) are not satisfied, both the phenomena of lower prices in the region of destination, r, and of higher prices in the region of provenience, s, are originated from the stronger (weaker) price competition that firms face in a region where their number is higher (lower).

Both l_r and l_s are convex parabola in the endogenous variable λ_r which are plotted in Fig. 3 for the relevant range of λ_r, that is $[0, 1]$. While l_r is increasing in λ_r, l_s is decreasing.[13] Moreover, l_r and l_s intersect only once for $\lambda_r \in [0, 1]$, when $\lambda_r = 1/2$, and they have the same value when $\lambda_r = (1-\lambda_r)$, that is when $H_r = H_v$. This allows us, to concentrate on the description of what happens for $\lambda_r \in [1/2, 1]$, because the opposite considerations are true for the other range $\lambda_r \in [0, 1/2]$.

Insert figure 3 about here

In Fig. 3 we also plot different values of φ^*, which may vary according to many factors. In particular, when $\rho < 1$, we have the following four kinds of potential cases depending on the values of parameters in the models, which imply different effects of changes in λ_r on local, p^*_{zr}, and foreign, p^*_{zs}, prices.

Case 1 *When $0 \leq \varphi^* \leq L^2$, the competition effect on both local, p^*_{zr}, and foreign, p^*_{zs}, prices is always stronger than the preference effect, given that $l_r, l_s > \varphi^* \forall \lambda_r \in [1/2, 1]$. Thus, an increase in λ_r always results in a reduction in prices of varieties sold in r, with $\frac{\partial p^*_{zr}(\lambda_r,\rho)}{\partial \lambda_r} < 0$, and in an increase in prices of varieties sold in s, with $\frac{\partial p^*_{zs}(\lambda_r,\rho)}{\partial \lambda_r} > 0$.*

Case 2 *When $L^2 \leq \varphi^* \leq (L + H\rho)^2$, the competition effect prevails on the preference effect for foreign prices, p_{zs}, only if λ_r is not so high that $l_s < \varphi^*$, with $\frac{\partial p^*_{zs}(\lambda_r,\rho)}{\partial \lambda_r} > 0$. However, when the number of firms in region s is sufficiently small to have $l_s < \varphi^*$, prices in s, p^*_{zs}, are decreasing in λ_r because the small number of skilled workers in s reduces the pressure of demand for manufacturing goods and differentiation in their consumption. On the other hand, when we consider prices of varieties sold in region r, p^*_{zr}, we note that $l_r > \varphi^* \ \forall \ \lambda_r \in [1/2, 1]$. In this case, prices in region r are declining in λ_r because in this region the number of firms is always sufficiently high to mitigate the strength of the preference effect with respect to the stronger competition effect.*

Case 3 *When φ^* is higher, that is when it is such that $(L + H\rho)^2 \leq \varphi^* \leq (L + 2H\rho)^2$, the preference effect on local prices, p^*_{zr}, prevails on the competition effect, but only provided that the share of skilled workers in r is not too high to have $l_r > \varphi^*$. Vice versa, the competition effect on local prices, p^*_{zr}, prevails when the number of firms in region r is sufficiently high that $l_r > \varphi^*$.*

[13] It is simple to verify that the minimum of (31) is for $\lambda_r = -L/(2\rho H) < 0$, and that the minimum of (33) is for $\lambda_r = (L + 2H\rho)/(2H\rho) > 1$.

On the other hand, when we consider foreign prices p^*_{zs}, the preference effect does always prevail on the competition effect because $l_s < \varphi^* \ \forall \ \lambda_r \in [1/2, 1]$.

Case 4 *Finally, when φ^* is high enough that $\varphi^* > (L + 2H\rho)^2$, the preference effect is always stronger than the competition effect, either on local prices, p^*_{zr}, or on foreign prices, p^*_{zs}.*

Clearly, we may have many different situations. For instance, when φ^* is low, this could either mean that skilled workers' preference for manufactured goods and the variety in their consumption is not that high (in other words ρ is not too low), or that L, H and a are sufficiently low not to have the preference effect prevailing on the competition effect. Moreover, it could also mean that the number of goods produced, M, is sufficiently high to reduce the relevance of the preference effect.

Finally, we observe that while changes in a, d_L, M and t affect only the value of φ^*, changes in ρ affect not only φ^* but also l_r and l_s.

It is particularly important to observe that when the level of economic integration between the two regions increases (trade costs fall), the value of φ^* increases showing that the range of λ_r for which the preference effect dominates increases, strengthening the new dispersion force which acts in the case in which $\rho < 1$.

In order to show how the final outcomes of all forces depend on the value of ρ, we plot in Fig. 4 the indirect utility differential, $\Delta V_H(\lambda_r)$, for different values of ρ, that is for $\rho = 0.96$ and $\rho = 0.94$. This allows us to underline that if ρ decreases an otherwise unstable symmetric outcome may became a (stable) equilibrium because of the preference effect that, with $\rho < 1$, acts as a dispersion force.

Insert figure 4 about here

In the previous section we noted that economic integration, in the form of a reduction in trade cost levels, may lead to an equilibrium with full agglomeration of the economic activity, but this may happen only provided that trade costs are at intermediate levels. We also noted that, in any case, this would not be possible for sufficiently low trade costs. In Fig. 5.a we plot the indirect utility differentials, $\Delta V_H(\lambda_r)$, for two different values of trade costs $t = 0.20$ and $t = 0.19$ when $\rho < 1$.[14] In both cases the economy is characterized by two (stable) equilibria of incomplete agglomeration and lower trade costs result in less agglomeration, because the weight of the preference effect, which acts as a dispersion force when $\rho < 1$, is reinforced by the reduction in t.

Insert figures 5.a-5.b about here

Moreover, Fig. 5.b plots the "tomahawk diagram" which is used in NEG models to depict the properties of equilibria for different levels of trade costs. The diagram is drawn for the same parameters used to obtain Fig. 5.a and it shows that the manufacturing sector is completely agglomerated in a particular region when trade costs are high. However, when $\rho < 1$ and trade costs decrease below t_a, the dispersion force generated by demand pressures can sufficiently increase manufactured good prices in the more populated region to prevent full agglomeration and to have asymmetric (stable) equilibria. Moreover, when trade cost decrease is much more sensible and $t < t_s$, then the action of the dispersion force will sustain the symmetric equilibrium characterized by an even distribution of the economic activity. If we compare our results with those which would be obtained by Ottaviano et al. (2002) with $\rho = 1$, we would get that, for the chosen parameters and for the range of t values, full agglomeration would be the only possible kind of (stable) equilibria. Hence, we are able to capture a new dispersion force which enriches the analysis.

Effects on the balance between agglomeration and dispersion forces produced by the structure of preferences are described by Puga and Venables (1996), where, however, preferences are homogeneous across individuals.[15] They consider a new economic geography model where agents

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[14] The graphics are drawn for the following parameter values: $H = 90$, $L = 50$, $a = 10$, $b_L = 0.03$, $d_L = 0.04$, $f = 5$ and $\rho = 0.96$. We remark that those parameters are compatible with positive prices and quantities. In particular, according to (17) to have positive exports from region z to region v, we need to have $t < 26.47$.

[15] In Puga and Venables (1996), pecuniary externalities, which eventually induces firms to agglomerate in a region, are produced by forward and input linkages due to the input-output structure modeled as in Krugman and Venables (1995) and in Venables (1996).

consume a modern differentiated good and a homogeneous good. The latter good cannot be consumed below a subsistence level. The assumption of non homotetic preferences gives rise to a process of successive waves of industrialization in different countries when there are exogenous increases in the size of labor endowment. In fact, increases in labor endowments expand industry more than the homogeneous sector because of the increases in wages in the country in which industry is agglomerated. However, Puga and Venables (1996) use the particular version of the monopolistic competition model developed by Dixit and Stiglitz (1977) and the assumption of iceberg trade costs, with intersectorally mobile and internationally immobile workers. On the contrary, we use the solvable model by Ottaviano et al. (2002), where our results derive from heterogeneous preferences among different kind of workers and not by the assumption of quasi homotetic preferences. Moreover, we are able to capture changes of relative prices due not only to the competition effect but also to the specific heterogeneity in preferences.

Finally, we observe that, by considering the particular case of preference heterogeneity with $\rho < 1$, we are able to find another channel through which we may reproduce the results by Helpman (1997) or by Forslid and Wooton (2003). In fact, while in Helpman (1997) complete agglomeration may be prevented by the increase in prices of non-traded goods which leads to stable asymmetric equilibria, in Forslid and Wooton (2003) these equilibria arise for intermediate trade costs when comparative advantage dominates on NEG agglomeration force. In our case, asymmetric equilibria can be found because of the effects that we described which are strictly related to the properties of the demand side.

5 Conclusions

The dependence of equilibrium prices on the spatial distribution of consumers and workers has been stressed by research in spatial pricing theory which, as Ottaviano et al. (2002, p. 410) point out, "shows that demand elasticity varies with distance while prices change with the level of demand and the intensity of competition". In order to capture this evidence, Ottaviano et al. (2002)

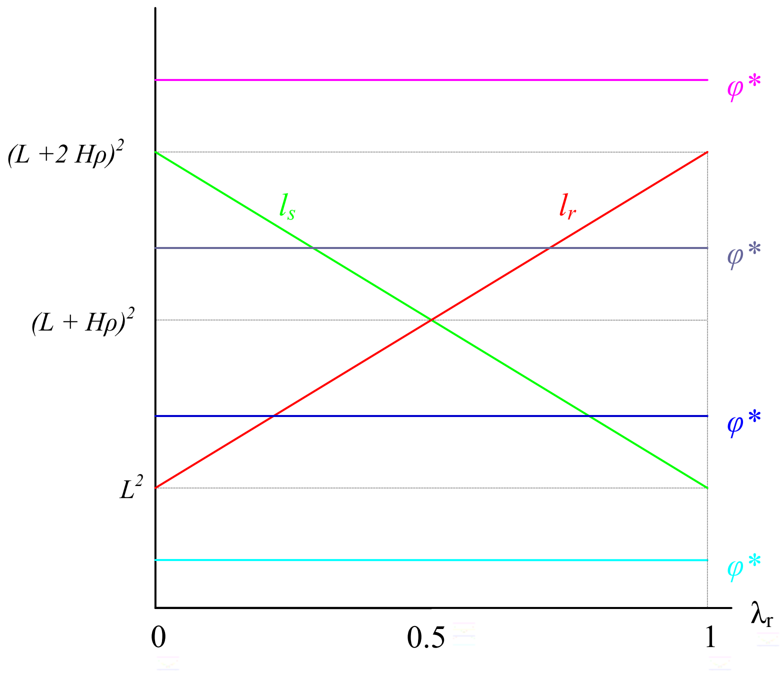


Fig. 3

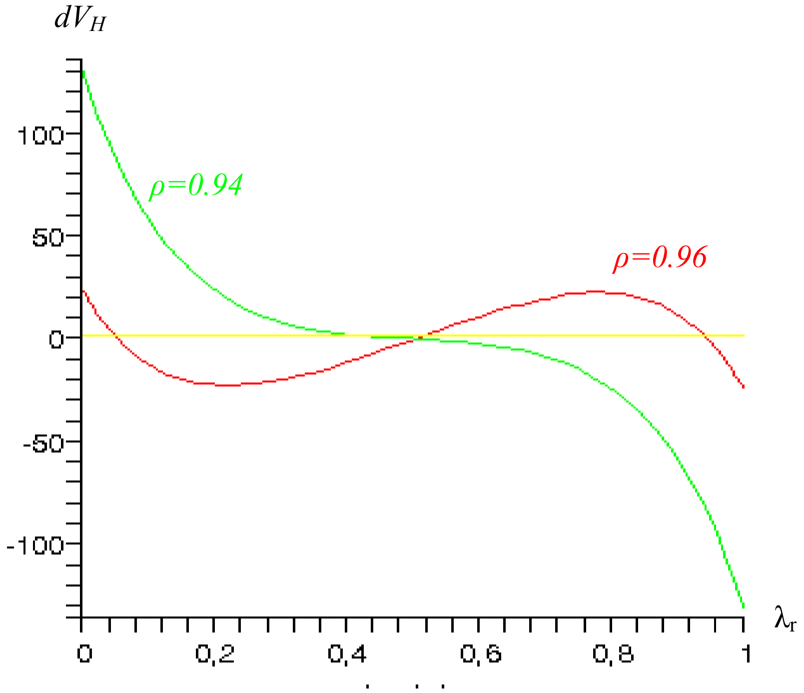
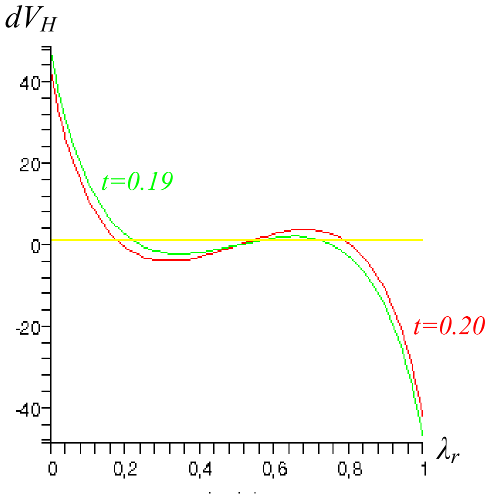
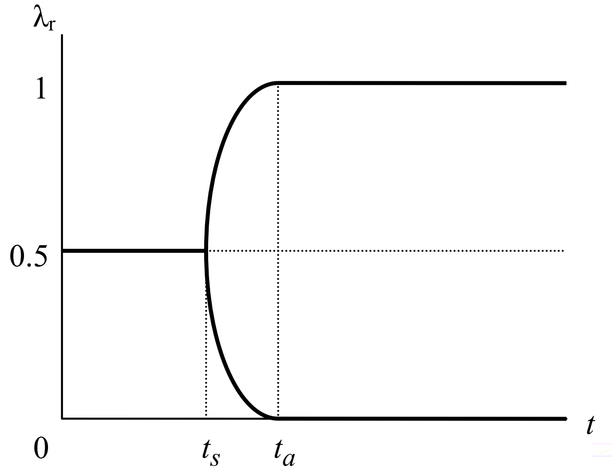


Fig. 4



dV_H
40
20
0
-20
-40
t=0.19
t=0.20
0
0,2
0,4
0,6
0,8
1
λ_r

Fig. 5.a



λ_r
1
0.5
0
t_s
t_a
t

Fig. 5.b

consume a modern differentiated good and a homogeneous good. The latter good cannot be consumed below a subsistence level. The assumption of non homotetic preferences gives rise to a process of successive waves of industrialization in different countries when there are exogenous increases in the size of labor endowment. In fact, increases in labor endowments expand industry more than the homogeneous sector because of the increases in wages in the country in which industry is agglomerated. However, Puga and Venables (1996) use the particular version of the monopolistic competition model developed by Dixit and Stiglitz (1977) and the assumption of iceberg trade costs, with intersectorally mobile and internationally immobile workers. On the contrary, we use the solvable model by Ottaviano et al. (2002), where our results derive from heterogeneous preferences among different kind of workers and not by the assumption of quasi homotetic preferences. Moreover, we are able to capture changes of relative prices due not only to the competition effect but also to the specific heterogeneity in preferences.

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propose the linear core-periphery model. In this work we claim that there is another particular channel through which equilibrium prices exhibit a dependence on the spatial distribution of firms and consumers which acts through preference heterogeneity which we introduce in the linear core-periphery model

By considering a simple potential kind of heterogeneity in the consumption of different goods among different consumers we are able to describe an additional source of dependence of equilibrium prices on the demand properties shaped by the interregional distribution of workers. In particular, this force can either strengthen, or weaken the process which leads to agglomeration. In fact, it reinforces agglomeration when skilled workers have a weaker preference for the modern good and variety in its consumption, with $\rho > 1$, which implies that prices charged by both local and foreign firms are obliged to fall when the mass of local firms increases. However, when the intensity of skilled workers' preference for the modern good and its variety is stronger, that is when $\rho < 1$, prices charged by firms, either local or foreign, may even increase when the mass of local firms increases therefore acting as a dispersion force. These results arise in our work from the fact that, together with the *competition effect* on prices generated by changes in the distribution of workers and firms, we consider the additional effect on prices due to preference heterogeneity which acts through the change in the relative weight of demand for the modern goods with respect to the traditional good, that is the *preference effect*.

Moreover, the introduction of taste heterogeneity allows us to provide another explanation of the potential outcome of asymmetric equilibria. Finally, we would like to stress that, by introducing forces generated by simple workers' preference differences on the consumption of goods, this work simply adds another plug to the complex mosaic of forces considered by NEG models as responsible of the shaping of economic activity distribution in space.

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