Vertical differentiation, wage bargaining and intra-industry trade liberalization.*

Emanuele Bacchiega†

May 4, 2004

Abstract

This article analyzes the effects of trade liberalization between two asymmetric industries. Asymmetries concern consuemers' masses and labor endowments. The latter, together with human capital specificity in the production of the variants of a vertically differentiated good, determine market form and the range of products available in each industry. We show that market integration benefits or harms the agents in the industries following on industry-specific parameters. As the conditions on gains and losses from trade are independent between countries, bilateral losses from trade can emerge at equilibrium.

Keywords: Vertical differentiation, workers' skills, wage bargaining, trade liberalization, industry asymmetries.

JEL Classification: L11, J00, F14

1 Introduction

On the last decades the process of integration has, become a key feature of the world's economic environment; the volume of internationally traded goods and services has been constantly increasing over the years. See, for example, data provided by the World Trade Organization (2002).

More specifically, empirical evidences shows the growing importance of vertical intra industry trade (IIT) in exchange relations among countries. Fontagné *et al.* (1997) show that in the period 1980-1994 the share of vertical IIT within the European Union's countries has increased noticeably with respect to the

*I wish to thank professors J. Gabszewicz, P.Garella, X. Wauthy for their very helpful comments and suggestions. I am grateful to professor E. Maskin for very a interesting discussion on this paper. Of course all remaining errors are mine.

†Dipartimento di Scienze Economiche, Università degli Studi di Bologna, Bologna-Italy and CORE, Université catholique de Louvain, Louvain-la-Neuve Belgium. Email: bacchieg@spbo.unibo.it

share of horizontal intra industry trade. Other papers, such as Aturupane *et al.* (1997), Clark and Stanley (1999) show that of vertical IIT applies to trade between developed and less developed countries as well[1].

Industrial Organization has proposed many contributions that study trade flows by means of oligopoly models. In particular, several articles tackle the problem of determining magnitude and sign of gains from trade at aggregate as well as at the single agents' level; among these, see, for example, Markusen (1981), Gabszewicz *et al.*(1981) Anderson *et al.* (1989), Motta (1992), De Fraja (1996), Naylor (1999),Cabrales and Motta (2001). The literature, as a standard result, stresses the creation of gains from trade at integrated level, even though single countries may lose from trade.

Factor endowments play a crucial role in determining the flow directions in vertical IIT. Courakis (1991), Webster (1996), Oulton (1996) Mason *et al.* (1996), Greenaway and Torstensson (1997), Martìn-Montaner and Orts (2002) relate the quality level of a country's exports to its factors endowments, and in particular to the skill level of its work force. Intuitively the production of higher-quality goods requires the use of *higher-skilled, sector-specific* labor units. Stated differently, there exists a *quality transfer* from production factors to products.

Gabszewicz and Turrini ((1999) and (2000)), Turrini (2000) develop this intuition formally within oligopoly models. The contribution of highly-skilled work force -the only input- is necessary to the production of the higher variants of a vertically differentiated good. Hence both the availability of skilled workers and the labor market structure have a direct influence on the final goods' market equilibrium. These articles, however, assume a competitive wage setting for the skilled work force. This specific modeling choice contrasts with the intrinsic non-competitive nature of markets for sophisticated production factors. Indeed, when skills are specific, skilled workers (the only owners of the necessary human capital) are conscious of the monopoly power they exert in the production of the higher variants of the goods. Symmetrically, those firms hire skilled workers are likely to be aware of their monopsony power towards the work force. In this paper we wish to address this particular issue. To this end, we further develop a

[1] Specifically, Aturupane *et al. (1997)* study trade flows between the European Union and the Central and Eastern European States, while Clark and Stanley (1999) perform a similar analysis for the In the US-Developing Countries case.

simple model -Bacchiega (2002)- in which, following Brander and Spencer (1988) we justified and applied a cooperative mechanism, namely the Nash Bargaining Solution, to the skilled workers' wage setting. This allowed us to study the welfare effects of variations in the relative bargaining power in the skilled labor's market. More precisely we extend the framework proposed in Bacchiega (2002) to vertical IIT. Many studies deal with the effects of trade liberalization on the products markets when factor (and in particular labor) markets are not competitive (see, e.g. Huzinga (1993), Sørensen (1993), Naylor (1998)), but, as far as we know, they do not simultaneously include into the analysis skill-specificity (and its implications) and vertical product differentiation, two key features of intra-industrial trade.

More in detail, we analyze the effects of trade liberalization between two asymmetric industries that, after a period of autarchy, are allowed to freely trade.

Our analysis rests on two key assumptions:

(i) Higher variants of a vertically differentiated good *cannot* be produced without the use of high-skill, product-specific labor. Therefore, industries that are not endowed with this kind of input are limited in the quality range they can supply to consumers.

(ii) Wage for the skilled workers is set through a Nash bargaining process between them and the firm(s) that decides to employ this input.

The specificity of human capital requires a modeling technique for the skilled workers' wage that incorporates the monopoly-monopsony relations in the market for skilled labor. Although labor economics literature in general does not deal with vertical differentiation issues, the choice to model the interaction between the set of skilled workers and the firms that hire them through the Nash Bargaining Solution directly relates this work with the literature dealing with Union-Firm bargaining (see, for example, Brander and Spencer (1988), Dowrick (1988), Dhillon and Petrakis (2002)).

The model we propose develops a three-period game. The first two periods are played in autarchy, while in the third trade is opened. Two national markets are involved: the first, under oligopolistic market structure, is endowed both with skilled and unskilled labor, while the second, competitive, can employ

unskilled workers only[2]. When trade is opened the two markets integrate. This affects market structures and determines redistributive effects in the industries under analysis.

We show that trade liberalization can hurt the two industries simultaneously. Yet, the reasons that generate trade liberalization gains or losses are different between the two industries. Moreover significant wealth redistribution effects take place inside the economies, making the different agents display different attitudes towards trade liberalization. Finally, a non competitive labor market structure contributes to explain the relations between the degree of unionization of a national market and the size of trading partners in determining the sign of gains from trade.

The remainder of the paper is organized as follows: in the next section the model is presented, section 3 performs equilibrium analysis, section 4 analyzes the effects of trade liberalization; section 5 relates this work to the existing literature and section 6 briefly concludes.

2 The Model

For sake of clarity we will discuss separately the modeling choices for Home and for Foreign, even if they overlap in many aspects. Finally we sketch the time structure of the game.

2.1 Home

Consumers

Consumers's utility is defined over variants of a vertically differentiated good. Denote θ the parameter measuring the intensity of preferences for quality of consumer θ. We assume that this parameter is uniformly distributed over the interval $[0, \bar{\theta}]$. Consumer's mass is normalized to 1.

A consumer can buy either one unit of the good or nothing. We assume that his preferences are modeled *à la* Mussa and Rosen (1978). Hence, the utility of

[2] The former may be seen as a developed country, while the second as a less developed one, in the spirit of Aturupane *et al.*(1997) and Clark and Stanley (1999).

consumer θ is:

$$U(\theta, u_i) = \begin{cases} U_0 + \theta u_i - p_i \text{ if he buys one unit of good } i, \\ 0 \text{ if not.} \end{cases}, \tag{1}$$

where p_i is the price of quality variant i. The parameter U_0 is high enough to always guarantee market coverage (i.e. all consumers buy one unit of the good). Suppose that two qualities only of the good are available for consumption: a high-quality variant (h) and a low-quality one (l). A standard approach allows to write down market demands: let $\theta_{h,l}$ be the marginal consumer (e.g. the consumer that is indifferent between purchasing one unit of variant h and one unit of variant l at their market prices). It is easy to verify that

$$\theta_{h,l} = \frac{p_h - p_l}{u_h - u_l}.$$

Market demand for the high-quality variant writes, then:

$$D_h(p_h, p_l) = \frac{1}{\bar{\theta}}(\bar{\theta} - \theta_{h,l}), \tag{2}$$

and, since market is covered, demand for the low-quality one:

$$D_l(p_h, p_l) = \frac{\theta_{h,l}}{\bar{\theta}}. \tag{3}$$

Firms

Two (ex-ante symmetric) profit-maximizing firms are active in Home[3]; they first choose the quality level of the good they will produce and compete on the final goods market in prices. Anticipating a Bertrand equilibrium argument we can exclude the case in which they both specialize in the production of the same good[4]. We will henceforth label firms with the index related to the variant they produce. Firms' technologies are characterized by constant-returns-to-scale. Labor is the only input. One unit of labor produces one unit of the good, irrespectively of its quality. More specifically, unskilled labor produces the low-quality variant of the good only, while skilled one can be used in the production of both the high-and the low-quality variants. Market demands for the differentiated commodity hence represent firms' labor demands as well.

These assumptions allow us to write firms' profits as:

$$\pi_h(p_h, p_l) = D_h(.)(p_h - w) \tag{4}$$

$$\pi_l(p_h, p_l) = D_l(.)(p_l - r) \tag{5}$$

[3] We do not deal with the case of potential entrants.

[4] Section devoted to equilibrium analysis will more rigorously prove this claim.

Where r is the (exogenous) remuneration of skilled labor and w is the wage paid to skilled workers when employed in the production of the high-quality variant.

Work force

In Home two types of workers are present: skilled and unskilled. They are all endowed with one unit of labor which they supply inelastically. Unskilled workers are arbitrarily many and wage takers.

Skilled workers can be employed indifferently in the production of the high- or the low-quality good. In the first case they fully exploit their skills, and receive a wage w that is determined through a bargaining process between a *union* and each single firm that decides to employ skilled labor. In the latter case their productivity equals the unskilled workers' one, consistently they are paid the exogenous unskilled workers' wage r. We assume that *all* the skilled workers (and them only) belong to the union, therefore there exists a unique w exclusively determined by the bargaining process. We use the Nash Bargaining solution to determine the outcome of the bargaining between the union and the firm(s). The justifications for this choice twofold. Firstly, this concept is widely used in the literature for modeling the interaction between unions and firms (Brander and Spencer (1988), Dowrick (1989), Huzinga (1993), Naylor (2002), Dhillon and Petrakis (2002) among the many). Moreover, as Binmore *et al.* (1986) showed, it can be seen as the solution of a game of alternating offers when the time gap between offers tends to zero.

The union and the firm(s) producing the high-quality variant bargain over the skilled workers' *wage*. The level of employment is then unilaterally set by the producer(s). The framework is, hence, consistent to the *right-to-manage* models (see, for example, Nickell and Andrews (1983)).

The union is interested in maximizing the skilled workers' *expected* wage. This is obtained as the combination of the wages w and r with weights equal to a union member's probability of being hired as skilled (and conversely as unskilled) *given* market demands and the number of members of the union (equal to the number of skilled workers). Denoting this last variable N[5], the

[5] We assume that there are no rationing issues in the model. In other words that the quantity of skilled labor units available in Home exceeds the maximum of the demand for the high-quality variant that can stem out adding "local" demands. Notice that this maximum exists because the dimension of markets both in home and in Foreign is finite (see page 12 in particular).

skilled workers' expected wage writes:

$$E[w](.) = w\rho_h(.) + r(1 - \rho_h(.)), \tag{6}$$

where $\rho_h(.) = \frac{D_h(.)}{N}$ is the probability of being hired in the production of the high-quality variant.

2.2 Foreign

The superscript F stands for Foreign.

Consumers

Foreign is a replica of Home from the preferences viewpoint. In particular the support of the appreciation-for-quality parameter θ and the quality level u_i consumers attribute to variant i ($i \in \{h, l\}$) are the same. So utility for Foreign consumers writes:

$$U(\theta^F, u_i) = \begin{cases} U_0 + \theta^F u_i - p_i^F \text{ if he buys one unit of good, } i(i \in \{h, l\}) \\ 0 \text{ if not.} \end{cases}.$$

Parameter θ^F is uniformly distributed on the interval $[0, \bar{\theta}]$. Consumers' mass is M. Again, the marginal consumer approach identifies market demands.

Firms

In order to keep the analysis simple we assume that a competitive fringe of producers is installed in Foreign, each one of them is endowed with a constant-returns-to-scale technology: One unit of labor produces one unit of good.

Work force

Foreign is not endowed with skilled workers. On the contrary unskilled labor is abundant, and workers are wage-takers. The quality level of the only good they can produce -namely the low-quality one- is u_l, exactly the same as in Home. We hence assume that their remuneration is equal to r[6].

[6] A series of remarks:

1) The many similarities between Home and Foreign, in addition to keeping calculations manageable, allow to keep the focus of the analysis on the consequences of factor endowment and size asymmetries, the purpose of this study.

2) The absence of skilled workers in Foreign prevents this industry from having a domestic production of the high-quality variant of the good. However consumers' preferences are defined on it as well.

3) Competitive market form could be dropped assuming oligopolistic firms playing a price game on the only good they can produce: a classical Bertrand argument would lead price to marginal cost and profits down to zero, so (autarchic) oligopoly equilibrium would correspond to competitive equilibrium.

Finally, we assume that workers, consumers and firms are immobile, goods only can flow between countries.

2.3 Time structure

We structure the model around three periods. Label them $\tau = 0, 1, 2$. We ignore discounting between periods.

Period $\tau = 0$ concerns Home only: firms in that country make their (irreversible) decisions on the quality they specialize in. Their decisions are taken evaluating the flow of profits they will receive in the following periods, and agents perfectly foresee the pace of trade liberalization.

Period $\tau = 1$ is played in autarchy: no trade is allowed between Home and Foreign. In Foreign, the production of the low-quality variant of the good takes place. In Home a two-stage subgame (as in Bacchiega (2002)) is played: in the first stage the firm that has decided to produce the high-quality variant of the good bargains with the union over the skilled workers wage, in the second firms compete *à la* Bertrand in the vertically differentiated domestic market.

At the beginning of period $\tau = 2$ trade is liberalized at zero transportation costs. In Foreign again no game takes place: producers continue to supply the market with the low quality good sold at its marginal cost. In Home, on the contrary, firms and union are free to set again the skilled workers' wage and market prices following market liberalization. A two-stage game as the one played in period $\tau = 1$ takes place.

3 Equilibrium analysis

We look for subgame perfect Nash Equilibria of the three-period game. As trade liberalization is exogenous, equilibria in periods 1 and 2 are independent, so we describe the former first.

3.1 Autarchy ($\tau = 1$)

Home

Equilibrium analysis for Home industry parallels the one developed in Bacchiega (2002), and which we refer to for a detailed description. We shall recall

the procedure followed to describe equilibrium, presenting the main results (interested readers may see Bacchiega (2002)).

Subgame-prefect Nash equilibria in period 1 are found solving backwards the two stages of the game. The solution to:

$$\begin{cases} \frac{\partial \pi_h(.)}{\partial p_h} = 0 \\ \frac{\partial \pi_l(.)}{\partial p_l} = 0 \end{cases},$$

namely

$$\begin{cases} p_h^*(w) = \frac{r+2[w+(u_h-u_l)\bar{\theta}]}{3} \\ p_l^*(w) = \frac{2r+w+(u_h-u_l)\bar{\theta}}{3} \end{cases}$$

is the price-subgame equilibrium. Plugging these values in the definition of demands, profits and expected wage (eqs. (2)-(6), allows us to write them as a function of the skilled workers' wage w.

The next step is then to solve the bargaining game and find the equilibrium value for w through the Nash bargaining solution.

In order to apply this concept, the definitions of agents' utility functions and outside options (the maximum each agent can guarantee himself in case of failure in reaching the agreement) are required.

The choice of utilities is straightforward: profits for firm h and expected wage for the union. Outside options reflect the basic features of our model. As for the firm that has decided to produce the high-quality variant it is zero: if it fails to reach the agreement with the union it *cannot* employ skilled workers, so given our technological assumptions, it *cannot* produce the high-quality good. In this case it can either employ unskilled workers and produce the low-quality good; but this will generate a Bertrand on a homogeneous good with the other firm, otherwise it can exit the market. In both cases its profits are zero. The outside option for the union is the unskilled workers wage r. If no agreement is reached, no skilled worker can be employed in the production of the high-quality good. In this case we assume that all the members of the union find (inside or outside the industry under analysis) an alternative job. But as their human capital is *specific* they perform not better than unskilled workers, and consequently receive the same wage r.

Accordingly, we write the (weighted) Nash product as:

$$B(w) = [\pi_h(w)]^{\mu}[E(w) - r]^{1-\mu}, \tag{7}$$

where μ (res. $1-\mu$) represents the weight attributed to the high-quality firm (res. union) in the bargaining process. Maximization of (7) with respect to w leads as unique solution:

$$w^*(.) = r + \mu(u_h - u_l)\bar{\theta}.$$

Prices, demands, profits and expected wage can be written as function of the model's parameters. Equilibrium prices, profits and expected wage are given by the following expressions:

$$p_h^*(.) = r + \frac{2(1+\mu)(u_h - u_l)\bar{\theta}}{3},\ p_l^*(.) = r + \frac{(1+\mu)(u_h - u_l)\bar{\theta}}{3};$$

$$\pi_h^*(.) = \frac{(2-\mu)(u_h - u_l)^2\bar{\theta}}{9},\ \pi_l^*(.) = \frac{(1+\mu)(u_h - u_l)\bar{\theta}}{9},$$

and

$$E[w]^*(.) = r + \frac{\mu(2-\mu)(u_h - u_l)\bar{\theta}}{3N}.$$

We again refer to Bacchiega (2002) for detailed comments on these results.

Foreign

Equilibrium analysis for Foreign before market integration is straightforward.

The lack of skilled workers in that industry prevents the production of the high-quality variant of the good. Still the production of the low-quality is possible. The competitive fringe of producers sells the low-quality variant of the good at it marginal cost, so that $p_l^{F*} = r$, earning zero profits. Notice that at this price market is covered in Foreign: support and distribution of preferences in F is the same as in H and we assumed that home market was covered at $p_l^* > p_l^{F*}$. Hence market demand for the low-quality is $D_l^{F*}(.) = M$.

3.2 Trade ($\tau = 2$)

At the beginning of the second period trade is opened at zero transportation costs between Home and Foreign[7]. The interplay of two forces determines the new equilibrium configuration. The first -acting through the increase in the

[7] As markets are integrated we perform a unique analysis for H and F.

mass of consumers in the integrated industry- is the *market expansion* effect. The second -due to changes in equilibrium prices- is the *competitive* effect.

On one side, both the oligopolists in Home and the competitive fringe in Foreign face a new market whose consumers' mass is given by $1 + M$, strictly greater than the autarchic ones (*market expansion* effect).

The *competitive* effect calls for a more detailed analysis. Consider low-quality producers first. The quality level of the low-quality variants produced in Home and in Foreign is the same; hence after market integration each consumer who is willing to purchase this variant will address to the firm that sells it at the lowest price. As market structure does not change in F, the price charged by F-fringe on both markets will be the marginal cost of production r. Home's low-quality producer must match this price r and makes zero profits. In this case the share of the total demand that H's oligopolist and F's fringe serve is *a priori* undetermined. To perform calculations on the effects of trade liberalization, we assume a "*home-bias* effect": consumers towards choose local production when prices are the identical.

As far as the high-quality producer is concerned, the direct competition of low-price foreigner fringe directly reduces the demand for the good it produces and -because of his strategic reaction to the fall its rivals' prices- the price it can charge on each unit sold too.

Consider the union that represent skilled workers. It benefits from the market expansion effect, as Foreign's demand for the high-quality variant will translate in a higher demand for skilled labor. The competitive effect, which acts through the low-quality good, on the contrary, leads to a reduction of the firm's gross profits, which represent the total amount of revenue to be shared between the firm and the union itself.

We now move to the description of the trade equilibrium configuration. A hat ($\hat{}$) over the variables identifies trade period ($\tau = 2$). Again, in order to find a subgame-perfect equilibrium we tackle the market game first, moving then to the bargaining game. Incidentally notice that, as H's low-quality producer has been "trapped" by the competitive F's competitive fringe, the only optimization is performed by the h-firm[8].

[8] Markets integration creates a dominant firm-competitive fringe market form in a vertical differentiation framework. For a reference -even not with vertical differentiation- see Carlton

From the previous paragraphs we know that $\hat{p}_l^* = \hat{p}_l^{F*} = r$. Demands for the high- and low-quality in H write:

$$\hat{D}_h(\hat{p}_h, r) = \frac{1}{\bar{\theta}}(\bar{\theta} - \frac{\hat{p}_h - r}{u_h - u_l}) \text{ and } \hat{D}_l(\hat{p}_h, r) = \frac{1}{\bar{\theta}}(\frac{\hat{p}_h - r}{u_h - u_l});$$

while in F:

$$\hat{D}_h^F(\hat{p}_h^F, r) = \frac{M}{\bar{\theta}}(\bar{\theta} - \frac{\hat{p}_h^F - r}{u_h - u_l}) \text{ and } \hat{D}_l^F(\hat{p}_h^F, r) = \frac{M}{\bar{\theta}}(\frac{\hat{p}_h^F - r}{u_h - u_l}),$$

where $\hat{p}_h^F$ is the price charged by the high-quality producer on foreigner market.

Profits to the H-firm are

$$\hat{\Pi}_h(\hat{p}_h, \hat{p}_h^F, r) = \hat{D}_h(\hat{p}_h, r)(\hat{p}_h - \hat{w}) + \hat{D}_h^F(\hat{p}_h^F, r)(\hat{p}_h^F - \hat{w}). \tag{8}$$

The h-firm maximizes (8) with respect to $\hat{p}_h$ and $\hat{p}_h^F$ jointly. Equilibrium prices are therefore:

$$\hat{p}_h^*(\hat{w}) = \hat{p}_h^{*F}(\hat{w}) = \frac{r + \hat{w} + (u_h - u_l)\bar{\theta}}{2}.$$

Since only consumers' masses in Home and Foreign differ, the optimal prices are the same in Home and Foreign.

In order to solve the bargaining stage of period $\tau = 2$ we plug the equilibrium values for prices into the definitions of demands and profits.

We now define the probability of being hired in the production of the high-quality variant in the integrated industry as:

$$\hat{\rho}_h(\hat{w}) = \frac{\hat{D}_h(\hat{w}) + \hat{D}_h^F(\hat{w})}{N}.$$

We assume that $N > \max_{\hat{w}}[\hat{D}_h(\hat{w}) + \hat{D}_h^F(\hat{w})]$ in order to have a meaningful probability measure[9]. A skilled worker's expected wage after trade liberalization is then:

$$E[\hat{w}](.) = \hat{\rho}_h(\hat{w})\hat{w} + (1 - \hat{\rho}_h(\hat{w}))r. \tag{9}$$

The interpretation of (9) parallels the one of (6): the union can guarantee to a fraction $\hat{\rho}_h(\hat{w})$ of its members a job in the production of the high-quality

and Perloff (1994).

[9] At equilibrium this condition writes $N > 1 + M$. This is the condition which we referred to in a note in page 6.

variant of the good and to the complementary fraction the unskilled workers' remuneration r. The market expansion effect adds to the Home demand for the h-version the demand stemming out from Foreign consumers.

With respect to the analysis developed for autarchy, the definitions of the agents' utilities and outside options do not change: if the agreement is not reached, the firm either exits the market or produces the low-quality good, earning in both cases zero profits. From the union's point of view, an agreement failure implies that all its members will receive the unskilled workers wage. Hence the Nash product is:

$$\hat{B}(\hat{w}) = [E[\hat{w}](.) - r]^{\mu}[\hat{\Pi}_h(\hat{w})]^{1-\mu}, \tag{10}$$

where $\mu \in [0,1]$ (res. $1-\mu$) is still the weight attributed to the union (res. to the firm) in the bargaining process. Solution to the problem

$$\max_{\hat{w} \geq r} \hat{B}(\hat{w})$$

determines the bargained wage.

Lemma 1 *The skilled workers wage under trade is*

$$\hat{w}^*(.) = r + \frac{\mu(u_h - u_l)\bar{\theta}}{2}.$$

Proof. Consider first the case $\mu \in]0,1[$. Taking logs of (10) and using first order conditions[10] gives as unique solution:

$$\hat{w}(.) = r + \frac{\mu(u_h - u_l)\bar{\theta}}{2} = \hat{w}^*.$$

Then notice that when $\mu = 0$ (10) reduces to $\hat{B}'(\hat{w}) = \hat{\Pi}_h(\hat{w})$, which always decreases in $\hat{w}$. The solution to the maximization problem is then $\hat{w}' = r = \hat{w}^*|_{\mu=0}$.

Finally, consider the case $\mu = 1$. (10) writes $\hat{B}''(\hat{w}) = E(\hat{w}) - r$. The maximum of $\hat{B}''(\hat{w})$ is obtained for $\hat{w}'' = r + \frac{(u_h - u_l)\bar{\theta}}{2} = \hat{w}^*|_{\mu=1}$. ■

Plugging $\hat{w}(.)$ into prices, demands profits and expected wage allows to write them as a function of the model's parameters only. We present them in the following

[10] Second order conditions are always satisfied.

Lemma 2 *The values for equilibrium prices, profits and expected wage write:*

$$\begin{aligned}
\hat{p}_h^*(.) &= \hat{p}_h^{F*}(.) = r + \frac{(u_h - u_l)(2+\mu)\bar{\theta}}{4},\ \hat{p}_l^*(.) = r, \\
\hat{\Pi}_h^*(.) &= \frac{(1+M)(u_h - u_l)(2-\mu)^2\bar{\theta}}{16},\ \pi_l^*(.) = 0 \\
E[\hat{w}]^*(.) &= r + \frac{(1+M)\mu(2-\mu)(u_h - u_l)\bar{\theta}}{8N}.
\end{aligned}$$

These preceding values will be useful in the section devoted to the study of the effects of trade liberalization.

The last step in order to conclude equilibrium analysis is to solve the game played by Home firms at $\tau = 0$.

3.3 Quality choice ($\tau = 0$)

Label the two (symmetric) firms in Home before they make their product choice Firm 1 and Firm 2. Their strategy set is given by $q_k = \{h, l\}$, where $k \in \{1, 2\}$ and h (res. l) stands for the choice to specialize in the production of the high (res. low) quality variant of the good. We can write a payoff matrix

$$\begin{array}{cc} & Firm\ \ 2 \\ Firm\ \ 1 & \begin{array}{|c|c|c|} \hline & h & l \\ \hline h & 0,0 & \pi_h^*(.) + \hat{\Pi}_h^*(.), \pi_l^*(.) \\ \hline l & \pi_l^*(.), \pi_h^*(.) + \hat{\Pi}_h^*(.) & 0,0 \\ \hline \end{array} \end{array}. \tag{11}$$

Nash equilibria in pure strategies are (h, l) and (l, h). The choice to specialize in the same variant of the good leads to a Bertrand war between symmetric firms on a homogeneous product, and hence zero profits. As firms are symmetric, no matter which equilibrium branch is taken at $\tau = 0$: the structure of the subsequent game remains the same as the one described in the previous paragraphs.

4 The effects of trade liberalization

In this section we finally discuss the effects of trade liberalization and hence the attitudes agents have towards it. We will firstly tackle the problem from the single agents (firms and union) in Home -remember that Foreign agents are all price takers- and then we will use welfare measures to perform the same analysis from a Government/Social Planner point of view, both for Home and Foreign.

Consider Home firms first. After trade liberalization, the low-quality producer's profits fall down from a (strictly) positive value, namely $\pi_l^*(.)$ to zero, while the high-quality producer's ones move from $\pi_h^*(.)$ to $\hat{\Pi}_h^*(.)$. A direct comparison between these four values leads to the following

Proposition 1 *Home's low-quality producer always loses from trade liberalization, while the high-quality producer gains from trade liberalization iff*

$$\hat{\Pi}_h^*(.) \geq \pi_h^*(.) \Leftrightarrow M \geq \frac{7}{9} = M^h.$$

The competitive effect lowers the price (through the strategic response of firm h to the fall in the price of the l-variant) and the demand addressed to the h-firm on its domestic market (because the decrease in the l-variant's price exceeds the decrease of the h-variant's one). However the market expansion one pushes towards increasing the total volume of sales. The increase in sales will be proportional to the mass of consumers in F-market. If this mass exceeds the threshold value M^h, the market expansion effect more than compensates the competitive one. Notice that, since the mass of consumers in H is normalized to 1, from the h-firm point of view trade liberalization with a "*smaller, but not too much*" partner is advantageous.

Let us analyze the union's incentives towards trade liberalization. Comparison between the expected wages obtained in $\tau = 1$ and $\tau = 2$ allow to write the following

Proposition 2 *The set of skilled workers, represented by the union, benefits from trade liberalization iff*

$$E[\hat{w}]^*(.) \geq E[w]^*(.) \Leftrightarrow M \geq \frac{5}{3} = M^u.$$

The competitive and market expansion effects' interplay determines the sign and magnitude of gains from trade for skilled workers. The latter increases the probability of being hired as skilled at equilibrium, the former's double effect on one side reduces this probability and on the other lowers the price to be paid for each unit of the h-quality good.

The *bargained* skilled worker's wage w, and hence *skill premium* - e.g. the difference between the skilled-unskilled workers remuneration- *always decreases*

after trade liberalization: $w^*(.) > \hat{w}^*(.)$. As the bargained wage is correlated with h-firm's competitive performance, harsher competition lowers it. This incidentally suggests that trade liberalization -hence the potential increase in skilled workers demand- *per se* is not the reason of skill premia increases, and supports the idea that other reasons, such as skill-biased technological change (see, for example Acemoglu (2003), Desjonqueres *et al.*(1999)) have to be taken into account in order to explain this phenomenon.

Let us now move to the welfare analysis. Following Gabszewicz and Turrini (2000) we capture the objective function of a central planner by the sum of consumer's surplus, firm's profits and workers' wages. Since this is a partial equilibrium model, we assume that there are no income effects in consumption or, alternatively, that the set of consumers and the set of workers in the two industries do not intersect.

In $\tau = 1$ Home' welfare at equilibrium is:

$$W^* = \frac{1}{\bar{\theta}} \int_0^{\theta_{h,l}} (U_0 + \theta u_l) d\theta + \frac{1}{\bar{\theta}} \int_{\theta_{h,l}}^{\bar{\theta}} (U_0 + \theta u_h) d\theta,$$

while in Foreign:

$$W^{F*} = \frac{M}{\bar{\theta}} \int_0^{\bar{\theta}} (U_0 + \theta u_l) d\theta.$$

Denoting $\hat{\theta}_{h,l}$ and $\hat{\theta}^F_{h,l}$ the marginal consumers respectively in Home and Foreign in $\tau = 2$ trade equilibrium welfare in Home writes[11]

$$\hat{W}^* = \frac{1}{\bar{\theta}} \int_0^{\hat{\theta}_{h,l}} (U_0 + \theta u_l) d\theta + \frac{1}{\bar{\theta}} \int_{\hat{\theta}_{h,l}}^{\bar{\theta}} (U_0 + \theta u_h) d\theta + \hat{D}_h(.) p_h^{F*}(.),$$

where the last term represents the sum of profits and wages earned by Home agents on foreigner market, which add to the welfare generated by production and consumption on the domestic market.

Similarly, welfare of Foreign when trade is opened is:

$$\hat{W}^{F*} = \frac{M}{\bar{\theta}} \int_0^{\hat{\theta}^F_{h,l}} (U_0 + \theta u_l) d\theta + \frac{M}{\bar{\theta}} \int_{\hat{\theta}^F_{h,l}}^{\bar{\theta}} (U_0 + \theta u_h - p_h^*) d\theta.$$

[11] Notice that the assumption of *home bias* effect we made allows us to attribute local production of the l-variant to the local welfare measure.

When trade is opened F consumers benefit form the increase in the variety of products they are offered, but a part of the consumers that under autarchy consumed the locally product low-quality variant of the good now address to the h-quality producer in Home. The gross profits derived by this demand flow to Home's instead of accruing to Foreign's welfare.

Direct comparisons allow to write

Lemma 3 *The welfare of Home's industry increases with trade liberalization iff*

$$\hat{W}^* \geq W^* \Leftrightarrow M \geq \frac{(u_h - u_l)(10 + 7\mu)\bar{\theta}}{18[4r + (u_h - u_l)(2 + \mu)\bar{\theta}]} = M^W.$$

First of all notice that consumers in Home always benefit from trade liberalization as the prices they pay for both variants are lower: $\hat{p}_h^* < p_h^*$ and $\hat{p}_l^* < p_l^*$. But competitive effect makes domestic demand shift towards the low-quality variant of the good, indeed $\hat{D}_h^*(.) < D_h^*(.)$. This shift reduces the total welfare generated in Home, as the willingness to pay for the lower variant is smaller then the one for the high-variant. If the gross profits derived form exports on foreigner market are high enough (that is to say if the market expansion effect is high enough), H's industry may gain from trade. Incidentally notice that M^W increases with μ, the weight attributed to the union in the bargaining process: as this weight increases, the bargained wage and hence the price of the high-quality product increase. This lowers its competitiveness with respect to the low-quality one both on the domestic and on the foreigner market. The competitive effect is strengthened. Hence the mass of consumers of the trading partner (and so the market expansion effect) has to increase in order to allow for gains from trade. This observation suggests that there should be a positive relation between the degree of unionization in a country and the size of its trading partners. Indeed, countries with a higher degree if unionization (that can be approximated by a higher μ) can worthily trade only with partners whose size (approximated by consumers mass) is sufficiently high. As a consequence, there should exists an empirically testable negative relation between these two variables.

Proposition 3 *The threshold values of M that determine the attitudes of agents towards trade liberalization can be univocally ranked in the following way*

$$M^W < M^h < M^u.$$

Home's economic agents can display different attitudes towards (the perspective of) trade liberalization: When F's market size is very small ($M < M^W$) all the agents in the economy opposite to market integration. As the size of the trading partner increases first the government-central planner (that trades off firms and union's losses with consumer surplus increase), then the high-quality producer and eventually skilled worker's union agree on trade liberalization. It is clear that if M lies in between M^W and M^u (the two industries' markets are "similar" in size) some agents lobby in favor and some against trade liberalization. Needless to say, Home's low-quality producer is always against withdrawing trade barriers.

Consider Foreign.

Lemma 4 *The welfare of Foreign's industry increases with trade liberalization iff*

$$\hat{W}^{F*} \geq W^{F*} \Leftrightarrow r \leq \frac{(u_h - u_l)(2-\mu)\bar{\theta}}{8} = r^F.$$

Foreign does not export to Home, so it is not affected by market expansion effect; neither its producers lose from trade, as they were earning zero profits in autarchy. But trade liberalization makes a part of the consumers shift in consumption from the locally-made l-quality variant to the imported h-quality variant. in this shift their utility increases. Foreign industry's wage mass (the individual wage times the number of workers employed in industry) on the contrary decreases. If the unskilled workers' wage is "low enough" ($r \leq r^F$) the loss in terms of wage mass is more than compensated by the gain in terms of consumer's surplus, so the welfare of the industry increases[12]. Notice that r^F inversely depends on the μ: the more powerful is the union in Home the lower has to be the unskilled workers' wage level in order to obtain gains from trade. Indeed that the higher μ the higher $\hat{p}_h^{F*}$ the lower F-consumer's surplus from the consumption of the h-variant. Hence the loss in terms of wage mass has due to consumption shift has to be low enough to lead to gains from trade.

Combining the two last Lemmata we obtain

[12] This result derives from the implicit assumption that the workforce no longer used after trade liberalization in the production of the low-quality variant remain unemployed. This assumption can be weakened admitting that a only a share of them remains unemployed outside the industry or that they find another job but at a wage lowe than r. The threshold values would change but the interpretation would remain the same.

Proposition 4 *If both $M < M^W$ and $r > r^F$ then both Home and Foreign's industries lose form trade liberalization.*

When the industry endowed with skilled labor faces a small trading partner, and the wage level in this latter industry is high enough, trade liberalization is disadvantageous for both: On one side the market expansion effect (which depends on the relative dimensions of the industries) fails to compensate the competitive one (that on the contrary is independent on their relative dimensions). On the other side the loss in terms of wage mass is not compensated by the gains in consumers' surplus.

5 Related literature

Brander and Spencer's (1988) Model, even if similar to the present one as far as the structure is concerned, does not deal with vertical differentiation issues. Nonetheless some of the results the authors propose hold true in the scenario we analyze too. In particular Brander and Spencer's (1988) claim that the welfare of the world as a whole decreases following one country's unionization (the shift from a situation in which workers have no power in setting their own wage to a situation in which a union bargains with the firm over the workers' wage) finds a counterpart in the observation that the sum two industries welfares under trade ($\hat{W}^* + \hat{W}^{F*}$) decreases with the weight of the union (μ) in the wage setting. The reason in our model is slightly different: while in Brander and Spencer (1988) unionization (an increase from zero to a positive value of the union's bargaining weight) translates into a reduction of demands, in our model the increase in the bargaining weight itself determines a consumption shift (both in Home and Foreign) towards the low-quality variant, that limits welfare creation.

Moreover, in our model, bilateral losses from trade can arise, due to the combination of both competitive and market expansion (in Home) and employment loss- consumer's surplus creation in Foreign.

Cabrales and Motta (2001) identifies in the asymmetries in domestic market sizes the sources of higher probabilities of resulting as the market leader (that is to say the supplier of the high-quality variant) in a vertically differentiated trade oligopoly. The authors, interested in the quality-choice decisions, are not concerned with wage setting issues and so consider, in the main body of the

paper, symmetric (zero) production costs. From a welfare point of view trade is always welfare improving for both countries even if not all the economic agents have positive gains from trade at equilibrium. Our contribution assumes, on the contrary, that the endowment of differentiated production factors determines the leadership in the vertically differentiated market. The structure of the open economy (dominant firm-competitive fringe, unionized skilled workers, skill specificity in the production of vertically differentiated goods, for example) is different from Cabrales and Motta's (2001) one but some of the conclusion concerning welfare and wealth distribution can be compared, once adapted the model's structure. In particular Cabrales and Motta's (2001) result that the opening of trade is beneficial for both countries taken as a whole is no longer true. Moreover, we find that losses from trade can emerge at the integrated industry's level too. This is an interesting result because it casts some doubt onto the usual result that in intra industry trade the losses of a country are more than compensated by the gains of the partner.

Sørensen (1993) claims that the distribution of gains from trade within each of two symmetric countries depend on the extent unions and firms re-establish their market power after trade liberalization. In his contribution workers and firm-owners are consumers as well, hence the framework differs from ours, however his claim: "if neither unions nor firms reestablish lost market power, it is very likely that both workers and capitalists gain on integration". This result comes from the fact that the losses in terms of wages and profits are more than compensated by gains doe to the fall in prices. In our contribution the result that for Home aggregate gains from trade are the more likely to obtain (M^W is smallest than M^u and M^h) confirms Sørensen's (1993) result.

Using a model more similar to ours, Huzinga (1993) shows that with linear demands and monopoly union both union rents and firms profits in two symmetric countries increase with trade liberalization. This result is not confirmed by our analysis, indeed some agents (the low-quality firm in particular) always lose from trade liberalization, while the others' gains directly depend on the dimension of the trading partner.

6 Conclusion

Our work shows the importance of taking into account single markets specificities when undertaking positive and normative studies of industrial organization. First of all in order to model more realistically (even with the *caveat* related to partial-equilibrium analysis) the asymmetries empirical literature describes the economic system. Secondly because, allowing for model asymmetries brings the possibility of distinguishing the different reasons that would lead different policy-makers to take the same decisions, such as -recalling results in the previous pages- contrasting trade liberalization.

Specifically, this paper studies the effects of trade liberalization between asymmetric, vertically differentiated industries where human capital is specific. According to empirical evidence and theoretical analyses, we take into account two key features of vertical intra-industry trade. In particular we deal with factor (and labor in particular) endowment asymmetries as determinants of trade flows and non competitiveness of specific factors markets.

Using a multi-period model of vertical product differentiation we show that the parameters governing the effects of trade liberalization differ between countries, depending on their peculiar features.

The introduction into the picture of intra-industry trade liberalization of a union representing the skilled workers has a double effect. On one side it allows to rationalize the cost differential in the production of vertically differentiated goods when human capital is specific and the wage is set through the Nash bargaining solution. Secondly it unveils a link between the degree unionization degree of the market of the country endowed with skilled labor and the size of its trading partners: the higher the former the larger has to be the latter in order gains from trade to emerge.

The industry that has a "poor" endowment in terms of human capital, on the contrary, gains from trade if its wage level is low enough, or conversely, if the labor market in the trading partner is such that the production cost (and so the market price) of the imported good is low. Finally, there exist parametric regions for which both industries, even though for different reasons, lose from trade liberalization.

The present analysis could be extended, for example, allowing for multiple inputs and hence more sophisticated production functions for quality (Gab-

szewicz and Turrini (2000)), or introducing further asymmetries on consumers' preferences and labor market structures, assuming, for example, unionization for unskilled workers as well.

References

[1] Acemoglu, Daron (2003). Patterns of Skill Premia. *Review of Economic Studies*. 70(2): 199-230.

[2] Anderson, S.P. M.-P. Donsimoni and J.J. Gabszewicz (1989). Is international trade profitable for oligopolistic industries? *International Economic Review*; Vol 30, No. 4, 725-733.

[3] Aturupane, Chonira, Simeon Djankov and Bernard Hoekman (1997); Determinants of Intra Industry Trade Between East and West Europe. *CEPR Discussion Paper* 1721.

[4] Bacchiega, Emanuele (2002). Wage bargaining and vertical differentiation; *CORE Discussion Paper* 2002/76.

[5] Binmore, Ken, Ariel Rubinstein and Asher Wolinsky (1986), The Nash bargaining solution in economic modelling; *Rand Journal of Economics*, vol. 17, No. 2.

[6] Brander, James A. and Barbara J. Spencer (1988), Unionized Oligopoly and International Trade Policy; *Journal of International Economics*; 24, 217-234.

[7] Cabrales, Antonio and Massimo Motta (2001), Country Asymmetries, Endogenous Product Choice and the Timing of Trade Liberalization. *European Economic Review*; 45, 1, 87-107.

[8] Carlton, Dennis W. and Jeffrey M. Perloff (1994), *Modern industrial organization*. 2nd edition. New York: Harper Collins.

[9] Clark, Don P., and Denise L. Stanley (1999);Determinants of Intra-Industry Trade Between Developing Countries and the United States. *Journal of Economic Development*. Vol. 24, 2.

[10] Courakis, Anthony S. (1991), Labor Skills and Human Capital in the Explanation of Trade Patterns. *Oxford Economic Papers* 43, 443-462.

[11] Creedy, John (1995), *General equilibrium and welfare,* Aldershot: Elgar.

[12] De Fraja, Gianni (1996). Product Line Competition in Vertically Differentiated Markets. *International Journal of Industrial Organization.* 14(3): 389-414

[13] Desjonqueres, Thibaut, Stephen Machin and John Van Reenen (1999). Another Nail in the Coffin? Or Can the Trade Based Explanation of Changing Skill Structures Be Resurrected? *Scandinavian Journal of Economics* 101 (4) 533-554.

[14] Dhillon, Amrita and Emmanuel Petrakis (2002), A generalised wage rigidity result. *International Journal of Industrial Organization,* 20, 285-311.

[15] Dowrick, Steve (1989), Union-Oligopoly Bargaining. *The Economic Journal*, 99, 1123-1142.

[16] Fontagne,Lionel; Michael Freudenberg and Nicolas Peridy (1997). Trade Patterns Inside the Single Market; *CEPII Working Paper: 97/07* April 1997; 145.

[17] Gabszewicz, Jean, Avner Shaked, John Sutton and J.-F. Thisse (1981). International trade in differentiated products, *International Economic Review*; 22, 3, 527-534.

[18] Gabszewicz, Jean and Alessandro Turrini (1999), Workers' Skills and Product Selection. *Revue économique*; vol. *50*, no. 3, 383-391.

[19] Gabszewicz, Jean and Alessandro Turrini (2000), Workers' Skills and Industry Equilibrium. *International Journal of Industrial Organization*; 18, 575-593.

[20] Greenaway, David and Johan Torstensson (1997), Economic Geography, Comparative Advantage and Trade Within Industries: Evidence from the OECD. *FIEF Working Paper* No. 144.

[21] Huzinga, Harry (1993), International Market Integration and Union Wage Bargaining. *Scandinavian Journal of Economics*, 95 (2) 249-255.

[22] Markusen, James R. (1981) Trade and the gains from trade with imperfect competition. *Journal of International Economics*; 11, 531-551.

[23] Martin-Montaner Joan A. and Vicente Orts (2002). Vertical Specialization and Intra-industry Trade: The Role of Factor Endowments. *Weltwirtschaftliches Archiv/Review of World Economics*,138(2): 340-65.

[24] Mason, Geoffry, , Bart Van Ark, and, Karin Wagner (1996), Work force Skills, product quality and economic performance. In booth, A., Snower, D.J. (Eds.) *Acquiring Skills*. Cambridge University Press, Cambridge.

[25] Motta, Massimo (1992) *Sunk costs and trade liberalisation.* The Economic Journal; 102, 578-587.

[26] Mussa, Michael and Sherwin Rosen, (1978), Monopoly and Product Quality. *Journal of Economic Theory*; 18, 301-317.

[27] Naylor, Robin (1998), International Trade and Economic Integration When Labor Markets Are Generally Unionized. *European Economic Review*; 42, 7, 1251-67.

[28] Naylor, Robin (1999), Union Wage Strategies and International Trade. *Economic Journal*; 109, 452, 102-25.

[29] Naylor, Robin (2002), The effects of entry in bilateral oligopoly. *Warwick Economic Research Paper*: 638.

[30] Nickell Stephen J. and Martyn Andrews (1983). Unions, Real Wages and Employment in Britain 1951-79. *Oxford Economic Papers*. Supplement; 35(0): 183-206.

[31] Oulton, Nicholas (1996), Work force Skills and Export Competitiveness. In booth, A., Snower, D.J. (Eds.) *Acquiring Skills*. Cambridge University Press, Cambridge.

[32] Sørensen Jan Rose (1993) Integration of Product Markets when Labour Markets are Unionized. *Recherches Economiques de Louvain*; 59, 4 485-502.

[33] Turrini, Alessandro (2000); High-Quality Bias in Vertically Differentiated Oligopolies -a Note on Skills, Trade, and Welfare. *Journal of Economics-Zeitschrift für Nationalökonomie*, 71, 2 133-147.

[34] Webster, Allan (1993) The Skill and Higher Educational Content of UK Net Exports. *Oxford Bulletin of Economics and Statistics*, 55, 2 141-159.

[35] World Trade Organization (2002); *International Trade Statistics.*