Time Zones, Shift Working and International Outsourcing

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Abstract

We build a trade model with two identical countries located in different time zones and a monopolistically competitive sector of which production requires differentiated goods produced in two successive stages. We introduce shift working disutility and allow consumers to choose between day and night shifts. Shift working disutility raises the cost of night production and firms can reduce costs by "virtually" outsourcing foreign labor. We found that firms only outsource if relative costs of outsourcing are low and shift disutility is high. When outsourcing occurs under free trade, it generates the highest level of welfare among production modes. An intermediate range of shift working disutility can generate the lowest level of welfare and be not affected by the reduction of outsourcing costs.

Keywords: Shift working, time zones, outsourcing, monopolistic competition

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1 Introduction

The costs of time and distance have remarkably been reduced because of the recent developments in information technology (IT). Internet, for instance, allows the instantaneous exchange of information by e-mail between people located thousands of miles away from each other. Such technology creates the possibility of trade in services that take advantage of differences in time zones. For example, when the workday ends to American workers, it starts to Indian workers. If there are efficient communications networks linking these two countries, services, such as call centers, can be provided to the American market during the night by Indian workers at their normal working hours, and *vice versa*. If wages are sufficiently cheap in India, call centers providing services twenty four hours a day in the US may opt for outsourcing such services from India and reduce costs.[1] Likewise, production that would take two normal working days in the US might take only one day if half of the work is outsourced from a country located in a different time zone.

In this logic, a pattern of comparative advantage arises when countries are located in different time zones as Marjit (2007) argues using a Ricadian model. Cost and time can be saved if countries outsource production during the time their countries are not working. If trade costs are too high than outsourcing may be not advantageous but, if trade costs are almost inexistent, then trade is probably beneficial. On the other hand, efficient communications networks, as pointed out by Harris (2001), can create "virtual" mobility of factors at very low costs. If countries are connected through communications networks, then services can be provided by foreign labor located at a different time zone and the outsourcing firm can save time. In this context, communications networks play an important role as determinant of trade patterns as Kikuchi (2006, 2009) and Kikuchi and Iwasa (2009) argue. As such, most of the literature related to time zones have mainly focused on the time-reduction aspect of outsourcing.

Time, however, is also related to labor supply and consumption decisions. Twenty-

[1] Head, Mayer and Ries (2009), however, find that the volume of trade in services are still subject to physical distance.

four-hour services, for instance, require the supply of labor during the whole time of service provision, that is, production and consumption must take place simultaneously. In that case, time-reduction is not possible and labor is necessary at day and at night. Workers, however, are likely to face disutility from working at a night shift due to various factors such as health problems, imconpatibility with leisure time of the family, availability of services during nighttime, etc. As a result, wages paid for *day shift* work and for *night shift* work are supposed to differ (Eels, 1956). Consumers usually demand higher wages for working at night[2], thus firms that operate twenty four hours a day have increased costs for night production. If communications networks allow for virtual outsourcing of foreign labor during night production, then trade liberalization might be beneficial. Firms can reduce costs of production by shifting stages of production to cheaper countries. This is our departure point.

The purpose of this note is to illustrate with a simple two-country model how the introduction of disutility caused by shift working affects trade and production patterns between countries located in different time zones. Production requires two successive stages of production such that both day and night labor supply is necessary. We assume the existence of shift disutility that forces firms to pay higher wages to night supply of labor, which, in turn, raises firms costs. Under free trade, communications networks allow firms to outsource production stages from a country located in a different time zone and reduce costs. We conclude that firms only outsource if relative costs of outsourcing are relatively low and shift disutility is sufficiently high. When outsourcing occurs under free trade, it generates the highest level of welfare among production modes. An intermediate range of shift working disutility can generate the lowest level of welfare and be not affected by the reduction of outsourcing costs. We provide a very tractable framework that relates shift working disutility, time zones, and international outsourcing. To the best of our knowledge, this paper is first to focus on the issue of shift working decisions in trade models.

[2]See Kostiuk (1990) and Lanfranchi et al. (2002) for example.

This note is structured as follows. In Section 2 we present the basic model, in Section 3 we analyze the outsourcing decision, and in Secition 4 we see the implications of shift working and disutility on welfare. Section 4 concludes this work.

2 The Model

In this section we present the basic framework. There are two identical countries, Home and Foreign (of which variables are denoted by the superscript *), each with Ω consumers that are endowed with L individual amount of labor. Each country is located in different time zones such that when it is daytime at Home it is nighttime at Foreign and *vice versa*. There is one competitive sector producing a final good that is not traded. This final good is produced using intermediate differentiated goods that can be produced at Home or at Foreign. Trade between countries is possible only through communications services provided by a communications network.

2.1 Consumption

Each consumer is endowed with L units of available time that is spent in labor and leisure. Consumers derive utility U from the amount consumed of the final good, C, and from leisure time, l. The level of utility also depends, however, on the time the consumer works, i.e., the time consumption occurs. In our model, working at night causes disutility in consumption, thus consumers value day and night shifts differently in the following way:[3]

$$U = \frac{1}{\epsilon}\left(\frac{C}{h_s}\right)^{\epsilon} + l \qquad 0 < \epsilon < 1. \tag{1}$$

Here, h_s denotes a disutility parameter that depends on the time of work s chosen by the consumer. A consumer can choose to work at a day shift ($s = d$), or at a (mid)night shift ($s = m$). It is intuitive to assume that a night shift causes higher disutility, thus we

[3]Disutility from working at night shift includes health problems, incompatibility with leisure time of the family, availability of services, etc. See explanations by Eels (1956) for example. Note that no significant changes would occur if the disutility coefficient affected leisure instead of consumption.

assume $h_m > h_d$.[4] Denoting the price of the final good as P and the wage rate paid at shift s as w_s, the budget constraint is given by:[5]

$$PC + w_s l = w_s L. \tag{2}$$

Solving the utility maximization problem, we obtain the demand function for final goods and the supply function of labor $L - l$ of consumers working at shift s:

$$C_s = \left(\frac{w_s}{P}\right)^{\frac{1}{1-\epsilon}} {h_s}^{\frac{\epsilon}{\epsilon-1}} \tag{3}$$

$$L - l_s = \left(\frac{w_s}{P}\right)^{\frac{\epsilon}{1-\epsilon}} h_s^{\frac{\epsilon}{\epsilon-1}}. \tag{4}$$

Note that both the demand for the final good and the supply of labor depend negatively on the level of disutility.

Given the optimal amount of C_s and $L - l_s$ under a given wage rate w_s, consumers choose between day and night shift based on the level of utility, that is, consumers prefer to work in the shift that gives them the highest level of utility. We can also derive the indirect utility function that depends positively on wage rate w_s and negatively on price P and disutility coefficient h_s:

$$V(w_s, P, h_s) = \left(\frac{1-\epsilon}{\epsilon}\right)\left(\frac{w_s}{P h_s}\right)^{\frac{\epsilon}{1-\epsilon}} + L. \tag{5}$$

A closer look at the above equation reveals that night wages should be higher than day wage in order to compensate for the night shift disutility.

[4]Note that it is possible to consider heterogeneous consumers that differ in terms of shift preferences, but we restrict our analysis to homogeneous workers.

[5]The budget constraint could include the profits of firms, but we omit them here because in the long run they are driven down to zero, as it will become clear later on.

2.2 Production

Now let us turn to the supply side. As in Ethier (1982), the final good is produced under constant returns to scale in a competitive sector that utilizes intermediate differentiated goods (varieties) produced under monopolistic competition. Denoting the input of a variety i (i^*) produced at Home (Foreign) as x_i (x_{i^*}), the number of Home varieties as n and Foreign varieties as n^*, then the level of production of the final good, X, is given by the following Dixit-Stiglitz type CES production function:[6]

$$X = \left(\sum_{i=1}^{n} (x_i)^{\theta} + \sum_{i^*=1}^{n^*} (x_{i^*})^{\theta} \right)^{\frac{1}{\theta}}, \qquad 0 < \theta < 1. \tag{6}$$

In this setting, the cost of production decreases with the number of differentiated intermediate goods employed. Moreover, the price of the final good P is equal to its cost of production, which depends on the price p_i of each variety i:[7]

$$P = \left(\sum_{i=1}^{n} (p_i)^{\frac{\theta}{\theta-1}} + \sum_{i^*=1}^{n^*} (p_{i^*})^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}}. \tag{7}$$

We, then, derive the demand of final good producer for Home and Foreign varieties or intermediate goods:

$$x_i = \left(\frac{p_i}{P} \right)^{\frac{1}{\theta-1}} X \tag{8}$$

$$x_{i^*} = \left(\frac{p_{i^*}}{P} \right)^{\frac{1}{\theta-1}} X. \tag{9}$$

In the intermediate goods sector, a variety i needs to be produced in two successive stages, each taking half a day to be performed. This assumption denotes the time constraint present in services, that is, supply and consumption must take place at the same

[6]Note that, under autarky, no Foreign variety is employed in the production of the final good, thus Foreign variables disappear from the expression.

[7]It is well-known that assuming a CES production function as (6) and large number of varieties, $\sum_{i=1}^{n} p_i x_i + \sum_{i^*=1}^{n^*} p_{i^*} x_{i^*} = PX$ (=total cost) holds.

time, thus it is not possible to shrink the time necessary to produce one variety.[8]

Under autarky (denoted by the superscript A), intermediate goods firms need to perform both stages domestically. Each stage (day and night) requires the use of a fixed amount α^D and a variable amount βx_i^D of labor. Thus the profit of the producer of variety i is:

$$\pi_i^A = p_i^A x_i^A - w_d \beta x_i^A - w_d \alpha^D - w_m \beta x_i^A - w_m \alpha^D. \tag{10}$$

The cost of each stage is subtracted from revenues. The pricing rule is the standard monopoly price:

$$p_i^A = \frac{(w_d + w_m)\beta}{\theta}. \tag{11}$$

Note that both day and night wages affect prices. With free entry and exit in the long run, the output of varity i is given by:

$$x_i^A = \frac{\alpha^D \theta}{\beta(1-\theta)}. \tag{12}$$

Next, we examine how production takes place under free trade. One of our central assumptions is that, under free trade, producers of differentiated products can sell to both domestic and foreign final producers and choose to produce each stage either domestically or by outsourcing production using foreign labor through communications services.[9] An intermediate good firm, then, will choose the cheapest place of production for each stage.

If both stages are performed in the country of origin of the intermediate good producer, that is, there is free trade with domestic production (denoted with the superscript D), again each stage requires the use of a fixed amount α^D and a variable amount βx_i^D of labor. Then the profit π_i^D of Home variety i selling to domestic and foreign final producers

[8]Call centers that provides services twenty four hours a day are prime examples.

[9]This is referred by Harris (2001) as "virtual mobility" of factors, in which foreign labor is outsourced through the use of communications technologies. We do not, however, assume network externalities in this paper.

with both stages being domestically produced is given by:

$$\pi_i^D = p_i^D x_i^D + p_i^{*D} x_i^{*D} - w_d\beta(x_i^D + x_i^{*D}) - w_d\alpha^D - w_m\beta(x_i^D + x_i^{*D}) - w_m\alpha^D. \quad (13)$$

We obtain the pricing rule under domestic production from the above equation:

$$p_i^D = \frac{(w_d + w_m)\beta}{\theta} \quad (= p_i^A). \quad (14)$$

Considering zero profits in the long run due to free entry and exit of firms, we obtain the output of Home variety i producing only domestically:

$$x_i^D + x_i^{*D} = \frac{\alpha^D \theta}{\beta(1-\theta)}, \quad (15)$$

which is equivalent to the output level under autarky.

Now we turn to the outsourcing case. Outsourcing is only possible if the firm is connected to an international communications network that allows trade and virtual mobility of labor across countries to occur. We assume that the fixed cost coefficient incurred in outsourcing, α^O, includes an additional fixed amount of labor incurred from the use of communications services such that $\alpha^O > \alpha^D$.[10] Then generally, firms will have an incentive to produce using the cheapest labor available at the time of production. Note that both stages can be outsourced, but as we assume identical economies, wages are equalized over countries and day-time labor is always cheaper than night-time labor in any country. Thus, if a firm outsources, it will always domestically produce the first stage at daytime and outsource the second stage at nighttime (daytime at the other country). Then, the profit π_i^O of Home variety i that outsources becomes:

$$\pi_i^O = p_i^O x_i^O + p_i^{*O} x_i^{*O} - w_d\beta(x_i^O + x_i^{*O}) - w_d\alpha^O - w_d^*\beta(x_i^O + x_i^{*O}) - w_d^*\alpha^O. \quad (16)$$

[10]Without changing the qualitative results of our analysis, we assume an additional fixed cost to all stages of production although only one stage is outsourced. The extra fixed cost can be interpreted as the cost of connection, such as additional labor employed in training, translation or coordination between headquarter and subsidiary firms, which increases the fixed costs of all stages.

Under free trade, the pricing rule becomes:

$$p_i^O = \frac{(w_d + w_d^*)\beta}{\theta}, \tag{17}$$

and the output of variety i is given by:

$$x_i^O + x_i^{*O} = \frac{\alpha^O \theta}{\beta(1-\theta)}. \tag{18}$$

Before turning to the outsourcing decision problem, we analyze how equilibrium is characterized under the two production modes. As a benchmark, we first analyze the autarkic equilibrium, then proceed to free trade without outsourcing and, finally, free trade with outsourcing. We compare the three equilibria and check the consistency of outsourcing and welfare-improving conditions.

2.3 The Autarkic Equilibrium

Under autarky, the final good producer utilizes only Home varieties, which requires domestic day-time and night-time labor to be produced. In order to have positive labor supply at both day and night, however, wage rates should be set so as to equalize the levels of utility of day-shift and night-shift consumers, that is:

$$V(P, w_d) = V(P, w_m). \tag{19}$$

Under the above condition, consumers are indifferent between working at day or at night. Then, from (19) the *shift premium* w_m/w_d is determined:

$$\frac{w_m}{w_d} = \frac{h_m}{h_d}. \tag{20}$$

We take day labor as the numeraire ($w_d = 1$) and assume $h_d = 1$, thus $w_m = h_m$. Denoting the share of consumers working at a day shift as δ and consumers working at

a night shift as $1-\delta$, then the day-time and night-time market clearing conditions are given by:[11]

$$\delta\Omega(L-l_d) = n\beta x_i^A + n\alpha^D \tag{21}$$

$$(1-\delta)\Omega(L-l_m) = n\beta x_i^A + n\alpha^D. \tag{22}$$

The total amount of labor (time) is equal to the sum of the variable and fixed amount of labor demanded by each variety producer. The aggregate demand for the final good is represented by total demand from day-shift and night-shift consumers:

$$X = \delta\Omega C_d + (1-\delta)\Omega C_m. \tag{23}$$

Now we are ready to calculate the price index under autarky, P^A. From (3), (4), (6), (7), (8), (9) to (12) and (20) to (23), and assuming symmetry of firms in the intermediate sector, we obtain:[12]

$$P^A = \left[\frac{2\alpha^D p^{A\frac{\theta}{1-\theta}}}{\Omega(1-\theta)}\right]^{\frac{(1-\theta)(1-\epsilon)}{\theta-\epsilon}}, \tag{24}$$

with $p^A = (1+h_m)\beta/\theta$. As expected, under autarky, the higher the night shift disutility is, the higher is the wage rate for night shift. This increases the price of each variety and consequently, the price index and lowers individual welfare. Also, higher price P also lowers the real wage decreasing labor supply, and thus, total production.

2.4 The Free Trade Equilibrium

Now suppose countries can trade freely but firms in the intermediate sector do not outsource foreign labor. With completely symmetric countries, day-time labor can be taken as the numeraire ($w_d = w_d^* = 1$ and $w_m = w_m^* = h_m$). Then the market-clearing

[11] Conditions for Foreign are analogous.

[12] We assume throughout the paper that $\theta > \epsilon$ to ensure that varieties are substitutes to each other. See Fukushima and Kikuchi (2009) for details.

conditions change to:

$$\delta\Omega(L - l_d) = n\beta(x_i^D + x_i^{*D}) + n\alpha^D \tag{25}$$

$$(1 - \delta)\Omega(L - l_m) = n\beta(x_i^D + x_i^{*D}) + n\alpha^D, \tag{26}$$

and the aggregate demand for varieties becomes:

$$X = \frac{\Omega}{2}C_d + \frac{\Omega}{2}C_m = \frac{\Omega(1 + h_m)}{2P^{\frac{1}{1-\epsilon}}}. \tag{27}$$

From (3), (4), (6) to (9), (13) to (15), (20) and (25) to (27), the equilibrium price index under free trade with domestic production is obtained:

$$P^D = \left[\frac{\alpha^D p^{D\frac{\theta}{1-\theta}}}{\Omega(1-\theta)}\right]^{\frac{(1-\theta)(1-\epsilon)}{\theta-\epsilon}}, \tag{28}$$

with $p^D = p^A = (1 + h_m)\beta/\theta$.

Next, we examine the equilibrium under free trade with outsourcing. When wages are equalized, if outsourcing occurs, then it occurs for both Home and Foreign variety producers. There is mutual outsourcing of day-time labor of the other country, and there is no demand for night-time labor in either economy. The market clearing condition at Home is now:

$$\Omega(L - l_d) = n\beta(x_i^O + x_i^{*O}) + n^*\beta(x_{i*}^O + x_{i*}^{*O}) + n\alpha^O + n^*\alpha^O, \tag{29}$$

and the aggregate demand for varieties becomes:

$$X = \Omega C_d = \frac{\Omega}{P^{\frac{1}{1-\epsilon}}}. \tag{30}$$

When there are no trade restrictions and wages are equalized, the number of varieties produced and consumed are completely equalized across countries and trade is balanced.

From (3), (4), (6) to (9), (16) to (18), (20), (29) and (30), the equilibrium price index under free trade with outsourcing is calculated:

$$P^O = \left[\frac{\alpha^O {p^O}^{\frac{\theta}{1-\theta}}}{\Omega(1-\theta)}\right]^{\frac{(1-\theta)(1-\epsilon)}{\theta-\epsilon}}, \tag{31}$$

with $p^O = 2\beta/\theta$. Note that, once both domestic and foreign firms outsource, the price index is not dependent on the level of shift disutility.

Given the above results, we need to discuss under which conditions firms will outsource foreign labor before we compare the price indices we obtained.

3 The Outsourcing Decision

In this section we analyze the choice of production mode of variety producers under free trade. As we have seen, outsourcing may reduce marginal costs by employing cheaper foreign labor at the second stage but, at the same time it increases fixed costs. Thus firms will engage in outsourcing only if the change in profits is non-negative. In analyzing the decision of production mode, firms take the total number of firms in the market as given, that is, fixed. Also, each firm knows that all firms are symmetric and that if it chooses one production mode, all other firms should choose the same production mode. Under these assumptions, $P = N^{\frac{\theta-1}{\theta}} p_i$ holds with N as the sum of Home and Foreign varieties.

First, let us derive the profit of the firm producing only domestically. From (3), (13) to (15) and (23) we obtain

$$\pi_i^D = (1-\theta)\Omega N^{\frac{\epsilon-\theta}{\theta(1-\epsilon)}}(1+h_m)(p_i^D)^{\frac{\epsilon}{\epsilon-1}} - (1+h_m)\alpha^D. \tag{32}$$

Analogously, from (3), (16) to (18) and (30), we derive the profit of the outsourcing firm:

$$\pi_i^O = (1-\theta)\Omega N^{\frac{\epsilon-\theta}{\theta(1-\epsilon)}} 2(p_i^O)^{\frac{\epsilon}{\epsilon-1}} - 2\alpha^O. \tag{33}$$

Firms will outsource production if and only if $\pi_i^O - \pi_i^D \geq 0$, that is:

$$\pi_i^O - \pi_i^D = \frac{(1-\theta)\Omega}{N^{\frac{\theta-\epsilon}{\theta(1-\epsilon)}}}\left(\frac{\beta}{\theta}\right)^{\frac{\epsilon}{\epsilon-1}}[2^{\frac{1-2\epsilon}{1-\epsilon}} - (1+h_m)^{\frac{1-2\epsilon}{1-\epsilon}}] + [(1+h_m)\alpha^D - 2\alpha^O] \geq 0. \quad (34)$$

Outsourcing decision is taken based on relative lower marginal costs and increased fixed costs. Since the price index in the long run equilibrium with outsourcing is given by (31), the outsourcing condition can be represented in terms of relative costs of outsourcing and relative variety prices (level of shift disutility). We obtain the following lemma:

Lemma 1. *Under free trade, firms outsource if and only if* $\frac{\alpha^O}{\alpha^D} \leq \left(\frac{1+h_m}{2}\right)^{\frac{\epsilon}{1-\epsilon}}$ *holds.*

Firms find it profitable to outsource if extra costs incurred in outsourcing are not too high or the shift disutility (nigh wage) is sufficiently low.

4 Welfare

As we have seen, individual welfare can be denoted by (5) and depends on the price index level. In this section we compare the equilibrium price index of each equilibrium to derive changes in welfare. Comparing the price indices of the trade equilibrium with domestic production, (28), and of the autarky equilibrium, (24), we obtain:

$$\frac{P^D}{P^A} = \left(\frac{1}{2}\right)^{\frac{(1-\theta)(1-\epsilon)}{\theta-\epsilon}} < 1. \quad (35)$$

Thus, trivially, trade liberalization with domestic production equilibrium is welfare-enhancing when compared to autarky as Foreign varieties become available to the Home producer of the final good and the price index decreases.

Conversely, comparing the price levels of the outsourcing equilibrium, (31), and of the autarky equilibrium, (24), we obtain:

$$\frac{P^O}{P^A} = \left[\frac{\alpha^O}{2\alpha^D}\left(\frac{2}{1+h_m}\right)^{\frac{\theta}{1-\theta}}\right]^{\frac{(1-\theta)(1-\epsilon)}{\theta-\epsilon}}, \quad (36)$$

which can be either larger or smaller than one depending on the value of the term inside the brackets. Particularly, an outsourcing equilibrium is welfare-enhancing when compared to an autarky equilibrium if the following condition holds:

$$\frac{\alpha^O}{\alpha^D} \leq 2\left(\frac{1+h_m}{2}\right)^{\frac{\theta}{1-\theta}}. \tag{37}$$

Again, it is possible to obtain a relation between the relative cost of outsourcing and relative variety prices.

Lastly, we compare free trade equilibria with domestic production and outsourcing. From (28) and (31) we obtain:

$$\frac{P^O}{P^D} = \left[\frac{\alpha^O}{\alpha^D}\left(\frac{2}{1+h_m}\right)^{\frac{\theta}{1-\theta}}\right]^{\frac{(1-\theta)(1-\epsilon)}{\theta-\epsilon}}. \tag{38}$$

Thus, when it occurs, an outsourcing equilibrium leads to a higher welfare level than a domestic production equilibrium if the following condition holds:

$$\frac{\alpha^O}{\alpha^D} \leq \left(\frac{1+h_m}{2}\right)^{\frac{\theta}{1-\theta}}. \tag{39}$$

Conditions (37), (39) and *Lemma 1* are depicted in Figure 1 as curves A, B and C, respectively. A firm only chooses outsourcing in equilibrium in the area below curve C. In the area below curve A outsourcing increases welfare as compared to the autarkic equilibrium, and in the area below curve B outsourcing increases welfare as compared to the free trade equilibrium with domestic production.[13]

[13]Note that there are other configurations for the three curves, but their relative position never changes, that is, they never cross each other nor their order changes.

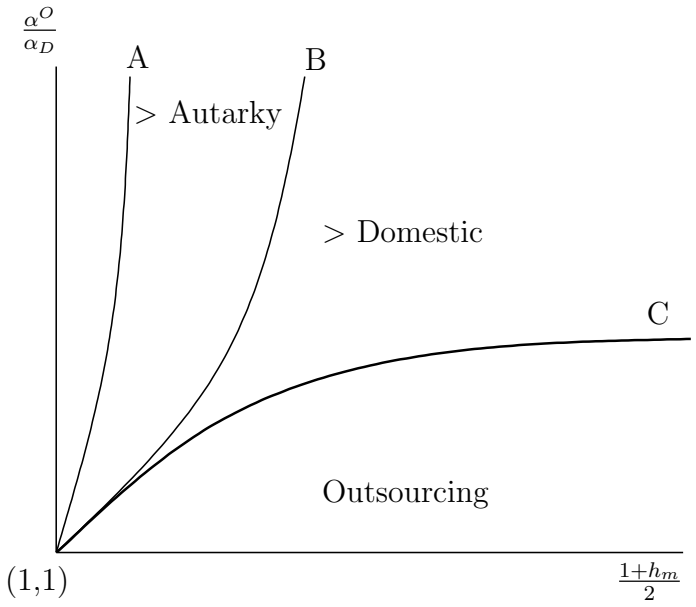

Figure 1: Outsourcing and Welfare ($\theta > 1/2, \epsilon < 1/2$)

Note that in the area between curves B and C outsourcing does not occur, but if it did so, welfare would be higher. It is possible to conclude that, when it occurs, outsourcing always increases welfare when compared to autarky and free trade domestic production since the area below curve C is always contained in the area below curve B. The higher the shift disutility and the lower is the relative cost of outsourcing, the more likely is outsourcing to take place. We summarize our results in the following proposition.

Proposition 1. *Suppose a communications network allows two identical countries located in different time zones to virtually utilize each other's labor. If outsourcing takes place, it generates a higher welfare level than both the autarkic equilbrium and the free trade equilibrium with domestic production.*

Trade liberalization that leads to outsourcing has several effects in the economy. Besides increasing the number of varieties available in the economy, outsourcing enhances firms' productivity by lowering marginal costs. Both effects work to lower the price index, which, in turn, increases real wages and, hence, labor supply. Again, an enlarged labor supply affects the number of varieties as the economy is able to accommodate more varieties. Outsourcing improves welfare also by directly eliminating shift disutility as it diminishes the necessity of night shift labor.

Figure 2 illustrates how welfare level changes according to the level of shift disutility and production modes taking the cost of outsourcing as fixed: curve O for outsourcing under free trade (independent of h_m), curve D for domestic production under free trade and curve A for autarky. Point b delimits the range in which firms outsource (shift disutility level above b). The thick parts of the curves denote welfare levels achieved in equilibrium. Welfare under autarky is always inferior to free trade with domestic production and, in the range between the origin and point b, domestic production prevails under free trade. Outsourcing provides the highest level of welfare for disutility levels above point b, which is always larger than point a.

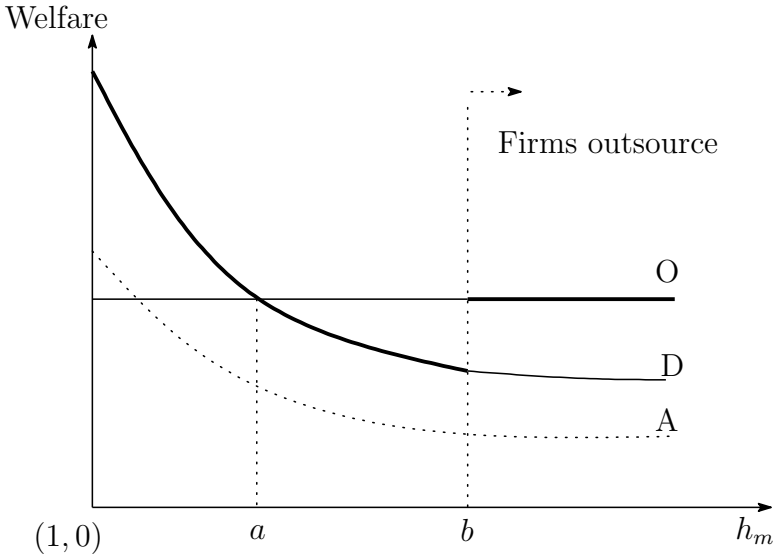

Figure 2: Welfare and Shift Disutility (α^O fixed)

As can be inferred from Figure 2, intermediate values of shift disutility result in the lowest levels of welfare in equilibrium.

Now we examine how the equilibrium changes with an exogenous decrease in α^O. We know from (31) that the welfare level in the outsourcing mode increases and, from *Lemma 1*, we know that point b shifts leftward to point b' as depicted in Figure 3. If $h_m < b'$ there is no change in welfare but, if $h_m > b$, then there is an increase in welfare due to a change in the number of firms in equilibrium and, if $b' < h_m < b$, then there is an increase in welfare due to a shift in production mode.

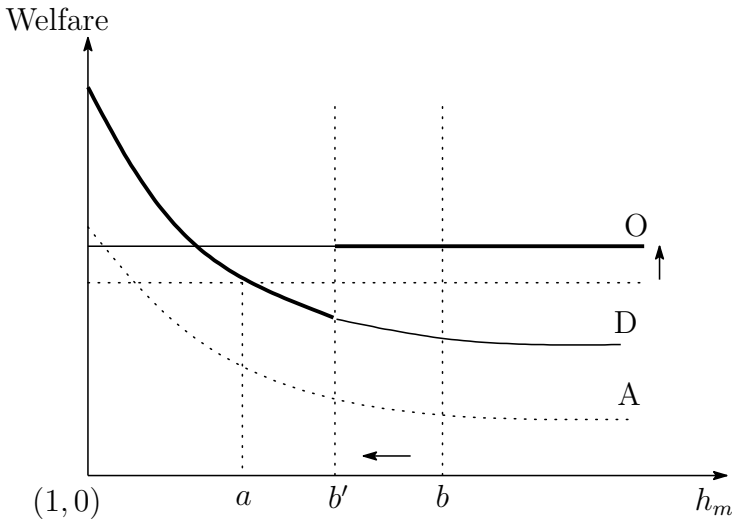

Figure 3: Change in Outsourcing Costs

Thus an exogenous decrease in outsourcing costs can improve welfare through gains in productivity and changes in the production mode as far as the resulting equilibrium features outsourcing.

As we have seen, in our setting, trade liberalization is always welfare-enhancing. When exogenous shift disutility is considered, however, it becomes clear that the production mode heavily influences the level of welfare. Particularly, if shift disutility takes intermediate values that are not able to force firms to shift their production modes, there is a possibility that the economy ends up with the lowest levels of welfare. In this context, although an improvement in technology (particularly, in fixed costs of outsourcing), can improve welfare not only by increasing the number of varieties consumed in equilibrium but also by causing shifts to more efficient production modes, it may not take place in certain intermediate ranges.

Although we have worked with completely identical economies in this model, much richer patterns can be achieved through assymetries of countries including population size, marginal productivities and shift preferences. In this paper we just gave a first step to include shift disutility, but cross-country differences in wages are crucial in the decision of outsourcing and a more realistic model would include it in the analysis.

5 Concluding Remarks

The role of time zones in international trade has recently being focused in the literature as a new phenomenom. There is, however, an inherent difficulty in introducing time (not in the dynamic sense) into formal models. This paper aimed at introducing time in the consumption side so as to analyze the effects of time in labor markets and industries that make use of time differences. We built a trade model with two identical countries located in different time zones, a monopolistically competitive sector, and communications network services that enable countries to trade with each other and "virtually" outsource labor from other countries. We introduced shift working disutility such that night shift workers are paid a shift premium that raises production costs. Firms take advantage of time differences to decrease marginal costs by outsourcing foreign labor but have to pay extra fixed costs in order to do so.

We concluded that outsourcing takes place only under certain conditions and it generates higher welfare levels than other production modes. Especifically, firms choose to outsource when the relative cost of outsourcing is low and the shift disutility is high. Generally, the higher the shift working disutility is, the lower is welfare under domestic production. Above a certain level of shift disutility, however, firms shift production to outsourcing and welfare reaches a higher level, which is independent of the level of shift disutility. Intermediate values of disutility in which firms have no incentive to outsource generates the lowest welfare level and may be immune to reduction of outsourcing costs.

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