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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 one sector with intermediate differentiated goods produced in two successive stages. We introduce shift working disutility that raises night wage and firms that "virtually" outsource foreign labor. We found that firms only outsource if outsourcing costs are relatively low and shift disutility is high. When outsourcing occurs, it generates the highest level of welfare among production modes. Intermediate values of shift working disutility generate the lowest level of welfare. Outsourcing and domestic labor are substitutes at the firm level and complements at the economy level.

1. Introduction

The costs of time and distance have remarkably been reduced because of the recent developments in information and communications technology (ICT). 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 24 h a day in the US may opt for outsourcing such services from India and reduce costs.[2] 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.

The use of outsourcing at industries supplying 24-hour services, however, is not limited to call centers, an industry characterized by intensive use of unskilled labor. The health care industry has used outsourcing as a way to cut costs and cover shortage of specialized labor. Hospitals have increasingly outsourced medical services during the night or weekend (when costs are higher) to English-speaking countries located at different time zones such as Australia, Malaysia, India and South Africa.[3] Also, in the electronics industry, some chip manufacturers keep global 24-hour chip design systems with engineering teams located in different parts of the globe such as the US, India and Europe in order to respond to rapid changes in demand and cut costs. Each

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[1] Tel.: +81 78 803 7247.
[2] Head, Mayer, and Ries (2009) find that the volume of trade in services is still subject to physical distance.
[3] One example is the outsourcing of radiology services. See Forbes Magazine (July 23, 2003) and Wachter (2006) for example.

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team works at its normal working hours, but the system works 24 h a day.[4] In principle, all services that do not require the presence of labor (skilled or unskilled) at the location of supply and present higher costs during the night have the possibility of being outsourced through communications networks. That applies to online schools for language teaching, media companies for supply of international news or firms in the hospitality industry for online reservations, etc.

In such industries a pattern of comparative advantage arises when countries are located in different time zones as Marjit (2007) argues using a Ricardian model. Cost and time can be saved if countries outsource production during the time labor in their countries is 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 (2010) argue. As such, most of the literature related to time zones has mainly focused on the time-reduction aspect of outsourcing.

Time, however, is also related to labor supply and consumption decisions. Twenty-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, incompatibility 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,[5] thus firms that operate 24 h 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. In our model, outsourcing substitutes domestic labor at the firm level, but at the economy level, outsourcing complements domestic labor. 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 the first to focus on the issue of shift working decisions in trade models.

This note is structured as follows. In Section 2 we present the basic model, in Section 3 we analyze the outsourcing decision, and in Section 4 we see the implications of shift working and disutility on welfare. Section 5 concludes this work.

2. The model

In this section we present the basic framework, which is similar to the model of Krugman (1981). There are two identical countries, Home and Foreign (of which variables are denoted by the superscript *), each with a mass Ω of 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. International outsourcing is enabled by communications services provided through communications infrastructure.

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[6]:

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

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

[4] Gupta and Seshasai (2007) use the term "24-hour knowledge factory" for such systems. See also Brown and Linden (2009, p. 87).
[5] See Kostiuk (1990) and Lanfranchi, Ohlsson, and Skalli (2002) for example.
[6] Note that no significant changes would occur if the disutility coefficient affected leisure instead of consumption.