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Longitude Matters: Time Zones and the Location of FDI

Stein, Ernesto (Inter-American Development Bank) y Daude, Christian (University of Maryland at College Park)

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by

Ernesto Stein

and

Christian Daude[⊗]

Abstract: In recent years a lot of attention has been paid to geographic latitude and its relationship with key economic variables like growth, development, and institutional quality. In this paper we show that longitude – in the form of time zone differences – also matters. Using bilateral Foreign Direct Investment (FDI) data, we find that differences in time zones have a negative and significant effect on the location of FDI. Furthermore, once we control for time zone differences the effect of distance on FDI is substantially reduced and, in most cases, no longer significant. We find that time zones also have a negative effect on trade, but this effect is much smaller than that on FDI. Finally, using panel data we analyze the evolution of the time zone effect over time, and find that the impact of this variable is increasing. Our results suggest that the problem posed by time zones is not likely to go away with the introduction of new information technologies. If anything, technological change may increase the importance of this factor for the location decisions of multinational businesses.

JEL Classification: F21, F23

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[⊗] Inter-American Development Bank and Department of Economics, University of Maryland at College Park, respectively. The views expressed in this document are those of the authors' and do not necessarily reflect those of the Inter-American Development Bank. The authors would like to thank Josefina Posadas for superb research assistance, and Eduardo Levy-Yeyati and Ernesto Shargrodsky, as well as conference participants LACEA 2001 in Montevideo and internal IDB seminars for comments and suggestions.

Corresponding author: Ernesto Stein, ernestos@iadb.org, Inter-American Development Bank, 1300 New York Avenue NW, Washington DC 20577, USA. Tel. +1(202)623-2823, Fax +1(202)623-1772.
Christian Daude, daude@econ.umd.edu, University of Maryland at College Park, 3105 Tydings Hall, MD 20742.

I. Introduction

A lot has been written in the recent literature on geography and economic development about the importance of latitude. Hall and Jones (1999), for example, find a positive correlation between the distance to the equator and output per worker, mediated by the social infrastructure. Gallup, Sachs and Mellinger (1999) argue that the tropical climate in locations near the equator has an adverse effect on human health, agricultural productivity and consequently on economic growth. Acemoglu, Johnson and Robinson (2001) claim that tropical diseases, associated with latitude, affected the kind of settlements and institutions colonizers established in the colonies, and thus had an important impact on their later development path. However, little attention has been paid to the economic effects of longitude.

In this paper, we center our attention on a variable that is closely related to longitude: the difference in time zones between locations. In particular, we estimate the effects of time zone differences on bilateral stocks of foreign direct investment (FDI), using OECD data for 17 OECD source countries and 58 host countries for 1997. We present evidence that longitude - in the form of time zones - imposes an important transaction cost on foreign direct investment. This effect is not totally captured by traditional variables that account for related transaction costs, such as distance.

Why should time zones matter? The empirical literature, in particular the one related to the gravity model of bilateral trade, has used two types of variables to control for transaction costs. On the one hand, geographical characteristics of countries or country pairs, such as distance, adjacency, remoteness, and whether one or the two countries in the pair are landlocked or islands are used to capture mainly transportation costs. On the other hand, other variables related to cultural and historical ties between the countries, such as common language, cultural similarities or past colonial links are frequently used in order to account for other factors that may affect the cost of doing business. However, none of these variables captures the transaction costs related to the need for frequent interaction in real time between the parties. Distance, in particular, does not capture this effect. Provided that telephone, e-mail and videoconference communication are close substitutes for face-to-face interaction, North-South distance should not be such a large problem. In contrast, differences in time zones can matter even given today's easy and low-cost communications, for the obvious reason that people at night usually prefer to sleep.

An alternative way to communicate in real time is to travel. In this case, again, East-West transaction costs may be more important than North-South ones, since jet lag can affect the effectiveness of business travelers, or require longer trips to adjust to the time difference. Jet lag, in effect, may lead to an exception to the rule that people tend to sleep at night: those severely affected by jet lag in fact tend to sleep during the day!

The transactions costs associated to the difference in time zones should be important in activities that require a great deal of interaction in real time. For this reason, we think that

FDI offers a perfect setting in which to study the effects of time zone differences. Frequent real time communications should be particularly important between headquarters and their foreign affiliates, as well as between a firm and its prospective foreign partners.[1] In this sense, while time zones may also affect bilateral trade, the need for real time communication is probably smaller among trading partners, so we expect their effects to be relatively more important for FDI.

In the only somewhat related paper that we know of, Kamstra et al (2001) investigate the effect of daylight-savings time changes on equity returns. They find that returns are significantly lower immediately after the weekend the change occurred.[2] If sleeping disorders caused by small time changes can affect the patterns of judgment, reaction time and problem solving of stock market participants, the jet lag associated to inter-continental travel should also lead to important adverse effects. The problems associated with the jet lag are obviously well known, as are the difficulties posed by time zone differences for live communications, even in the era of internet and e-mail.[3] However, to the best of our knowledge, this is the first paper that tries to quantify the effect of time zones on the cost of doing business. The impact of time zones on the location of FDI is more than an academic curiosity. It may help us understand the pattern of competition among countries to attract FDI. For example, it is possible that a country such as Costa

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[1] It is possible that the effect may go in the opposite direction in some specific sectors (such as perhaps software development), in which differences in time zones may allow multinational firms to gain some advantage by working around the clock. Since our data do not include a sectorial breakdown we could not investigate possible differences across sectors.

[2] Portes and Rey (1999) also bears some relationship with our paper. These authors look at the determinants of cross border equity flows, and use the volume of bilateral telephone call traffic as a variable of interest, in the context of a gravity model. They find that this variable has a positive and significant impact on cross border equity flows.

[3] In fact, the inspiration for this paper came from the difficulties experienced while writing a recent paper

Rica competes with Chile or Mexico, but does not compete to the same extent with Malaysia.

The rest of the paper is organized as follows. Section II describes the data and our empirical strategy, based on two alternative specifications: the gravity model, and the capital-knowledge model of multinational activity developed by Markusen (1997), and Carr, Markusen and Maskus (2001).[4] In Section III, we present our estimates of the effect of time zones differences on the location of FDI. We find that time zones have a significant impact on the location of FDI. Furthermore, in most of the specifications used we find that, once we control for time zones, distance is no longer significant. In Section IV, we present some robustness checks. In particular, we check whether our results are robust to the use of different time zone variables, and different estimation methods. In Section V, we analyze the importance of time zones as a determinant of bilateral trade. As expected, time zones matter also for trade, but their impact is much smaller than that on FDI. In addition, we look at the evolution of the impact of time zones over time, using panel data from the same OECD database, from 1988 through 1999. We find that the impact of time zones increases over time, a result that we attribute to the development of new communications technologies, which have reduced dramatically the cost of North-South distance, but have not reduced the cost of East-West distance to the same extent.

with a co-author in Lebanon.

[4] In what follows we will call this model the CMM model.

II. Data and Empirical Methodology

In order to analyze the effects of time zones on foreign direct investment, we use bilateral data on FDI stock from the *OECD Direct Investment Statistics*. This variable is available for 17 source countries - all of them from the OECD - and 58 host countries, which results in a total of 986 observations. In our cross-section regressions, we consider the values for 1997, since more recent data are still in some cases subject to revisions. This database has been used previously by Wei (1997, 2000) to study the effect of corruption on FDI; by Stein and Daude (2001) to address the impact of the quality of institutions on the location of FDI; by Levy-Yeyati et al (2002) to analyze the relationship between FDI and regional integration; and by Blonigen et al (2002) in order to test empirically different theories of FDI.[5]

We work with two different empirical models. The first one is based on the standard gravity equation, augmented with a variable to measure the impact of time difference. The second one is more grounded on FDI theory, and follows recent work by Carr, et al (2001) and Blonigen et al (2002).

The gravity model

The gravity model is the standard specification in empirical models of bilateral trade, and

[5] The OECD database presents some problems regarding the reporting of zeros and missing values. In particular, source countries are not required to report values for hosts with which FDI is zero. For this reason, the data on bilateral FDI stocks required some adjustments. The criteria used to distinguish the true missing observations from the zeros are described in detail in the appendix.

has also been used recently to estimate the determinants of bilateral FDI stocks and flows.[6] In its simplest formulation, it states that bilateral trade flows (in our case bilateral FDI stocks) depend positively on the product of the GDPs of both economies and negatively on the distance between them. Typical variables added to the simplest gravity specification in the trade literature include GDP per capita, as well as dummies indicating whether the two countries share a common border, a common language, past colonial links, etc. Here we augment the standard gravity equation, including a variable that measures the difference in time zones.

Our main specification is as follows:

$$(1) \qquad \ln(FDI_{ij}) = \alpha_i d_i + \beta x_{ij} + \gamma z_j + \delta timezone_{ij} + \varepsilon_{ij},$$

where FDI_{ij} is the outward stock of FDI from source country i in host country j in 1997 in millions of dollars, d_i is a vector of source country dummies, x_{ij} is a vector of bilateral control variables, such as the log of the distance between both countries, and dummies for adjacency, common language, common membership in a free trade agreement, and past colonial links, z_j is a vector of host country characteristics, including traditional gravity variables such as the log of GDP and GDP per capita, as well as other variable that may affect the attractiveness to FDI of the host country, such as the quality of institutions, $timezone_{ij}$ is the variable that captures the time zone difference between both countries,

[6] For a discussion of the empirical application and theoretical foundations of the gravity equation in trade

and ε_{ij} is a random error term.

The double log specification is used because it has typically shown the best adjustment to the data in the empirical trade literature. A problem that arises when using the log of FDI as a dependent variable, however, is how to deal with the observations with zero values. Our dataset includes a large number of observations where FDI stocks are zero (about one third), which would be dropped by taking logs. The problem of zero values of the dependent variable is typical in gravity equations, and it has been dealt with in different ways.

Some authors (see for example Rose, 2000) simply exclude the observations in which the dependent variable takes a value of zero. A problem with this approach is that those observations may convey important information for the problem under consideration. Zero observations could for example be more prevalent among countries that are far apart in terms of their longitude. Given the importance of zero observations in our sample, this strategy could lead to a serious estimation bias. Eichengreen and Irwin (1995, 1997) have proposed a simple transformation to deal with the zeros problem: work with log (1 + trade), instead of the log of trade. This has the advantage of simplicity, and the coefficients can be interpreted as elasticities when the values of trade tend to be large, since in this case log (1 + trade) is approximately equal to log (trade). In turn, following Greene (1981), they scale up the coefficients obtained from the OLS by a factor equal to the ratio between the total number of observations and the number of non-zero

theory see Frankel (1997). Papers that have used the gravity model to study the location of FDI include Wei (1997, 2000), Stein and Daude (2001) and Levy-Yeyati et al (2002).

observations. A disadvantage of this approach is that it is somewhat ad hoc. Another approach has been to use Tobit instead of OLS. Since we prefer this latter approach, we will derive our main results using the Tobit specification. In the section on robustness, however, we show that our results are robust to the use of alternative approaches.

While the standard gravity model usually includes source country's GDP and also its population or GDP per capita, in our specification, we include instead source country dummies, which should capture all the relevant characteristics of the source countries. As Wei (2000) points out, this specification is preferred because it also solves the problem of possible differences in the definition and measurement of FDI across source countries. In addition, we use a summary index of the host country's quality of institutions based on the six governance indicators compiled by Kaufmann et al (1999) in place of the host country GDP per capita. This variable has been used by Stein and Daude (2001), who found that it is a very important determinant of the location of FDI, and that, once institutions are controlled for, host country per capita GDP is no longer a significant determinant of FDI location.[7] The bilateral distance used is the great circle distance. The data on adjacency, official language and colonial links where constructed using the *World Factbook* available on the CIA's website. GDPs are measured in nominal US dollars, and were taken from the *IMF International Financial Statistics*.[8]

In order to measure the importance of time zones on FDI, in our benchmark regressions

[7] Results are very similar if GDP per capita is used instead of the institutional variable.
[8] See Table A.1 for more detailed information on the variables used in our different specifications.

we use the time difference in hours between the countries' capitals.[9] This variable varies from 0 to 12. Table A.2 in the appendix presents the time zone corresponding to each of the countries in the sample.[10] In the section on robustness we use two alternative measures of time zone differences, as well as a decomposition of distance into a North-South and an East-West component. Table 1 presents some summary statistics.

The Carr-Markusen-Maskus model

While in the trade literature the gravity model has good theoretical foundations, the use of this model for the case of FDI is somewhat ad-hoc. For this reason, in addition to the gravity model, we will also work with an alternative specification, which follows more closely the recent theoretical work on multinational activity.

Early theoretical work on the determinants of FDI produced two very different models of multinational activity: the vertical and the horizontal models of FDI. The first models of vertical FDI were proposed by Helpman (1984) and Helpman and Krugman (1985). In these models, the prototypical firm has a corporate sector (which may produce management services and R&D) and a production facility, and these two activities can be separated geographically without incurring further costs. As the corporate sector is more capital intensive than the production sector, firms localize each "stage" of production to take advantage of the differences in factor prices. The model ignores trade costs, and the

[9] Following previous literature, in some cases other more centrally located cities were used in place of the capitals. For example, Chicago in the United States in place of Washington DC, or Shanghai in China instead of Beijing.
[10] We construct the variable based on standard time zones, abstracting from the issue of daylight savings.

production facility produces for both the domestic market and the source country market. An implication of this model is that one would only expect to observe this type of (vertical) FDI taking place between countries with sufficiently different factor endowments, so as to ensure that factor prices do not equalize. No FDI would be observed between countries with similar endowments, an implication that is obviously at odds with the international experience. While in its stylized version the vertical model incorporates just the firm's headquarters and a single plant, the concept can be extended to encompass all forms of multinational activity involving vertical integration across international borders.

Early models of horizontal FDI can be found in Markusen (1984) and Horstmann and Markusen (1987, 1992). More recent general-equilibrium extensions are Markusen and Venables (1998, 2000). While in the vertical model multinationals are single-plant firms with headquarters located in a different country, in the horizontal model multinationals are firms with multiple production facilities producing a homogeneous good, where one of the facilities is located together with the company's headquarters. Each production facility supplies the domestic market. A key assumption in the horizontal model is the presence of economies of scale at the level of the firm (associated with the fact that they do not need multiple corporate sectors), which is the source of the advantage of multinational firms over domestic ones. In contrast to the vertical model, in the pure horizontal models of FDI, differences in factor proportions are ignored.

Given that firm-level scale economies exist, multinational activity in the horizontal model depends on the interplay between trade costs and plant-level economies of scale. In the absence of trade costs, there would be no reason for multinational production, since firms could concentrate their production in the home country, taking advantage of economies of scale, and serving the foreign market through trade. As trade costs increase, multinational production arises as long as plant-level economies of scale are not too high. In this sense, one can think of horizontal multinational activity as a "tariff-jumping" strategy. For a given level of trade costs, multinational activity will arise across countries of similar sizes. Otherwise, a domestic firm in a large country will have an advantage in serving the smaller country through trade (since trade costs are incurred on a small trade volume), compared to a multinational which has to bear the fixed costs of producing in two locations.

More recently Markusen (1997, 2001) developed the so-called knowledge-capital model, in an attempt to bring the vertical and horizontal approaches into a unified framework. In this model, the type of FDI that is observed between two countries is determined endogenously within a two-country, two-factor, two-good general equilibrium framework. The types of firms that can arise in this context are: horizontal firms with plants in both countries and headquarters in one, vertical firm that have a single production facility in one country and headquarters in the other country, and national firms that maintain headquarters and the production plant in only one country and may serve the other market through trade. One good (A) is produced in a competitive industry with constant returns to scale using unskilled labor, while the other good (B) is produced under imperfect competition with increasing returns to scale at the firm level (due to

R&D and management services) as well as at the plant level. A key assumption of the model is related to the relative factor intensity of the different production facilities. Headquarters activities are the most skilled-labor intense, followed by the firm that produces good B and has headquarters in the same location, followed by a production plant in sector B, which is more skilled-labor intensive than a plant in sector A.

Within this model, the type and volume of FDI between the two countries depends on the size of each economy, differences in the size between the host and the source country, relative factor endowments, trade costs and investment costs. When countries differ in size, but not in factor endowments, there is no vertical FDI, and horizontal FDI follows an inverted U-shape, reaching its highest point when the size of the two countries is similar. In this sense, the empirical specification should include the difference in size and its squared value in order to properly account for this relationship. Vertical FDI takes place if the difference in the size of the economies is significant and the small country is skilled labor intensive, so that the production facility tends to be installed abroad. Since headquarters location decisions are based on factor prices and plant location on the basis of factor prices and market size, an interaction term between both variables should be included in the empirical specification of the model.[11]

Furthermore, trade costs in the host country encourage horizontal FDI (as in the pure horizontal model), trade costs in the source country restrict vertical FDI, while investment restrictions in the host country discourage all forms of multinational activity. Since trade costs in the host favor horizontal (but not vertical) FDI, and horizontal FDI increases if factor endowments are similar, Carr et al (2001) include in the specification an interaction between trade costs and the squared endowment differences.[12]

Considering the previous discussion, we use the empirical specification used by Carr et al (2001), and embed in it the time zone difference variables discussed above. The specification is as follows:

$$
\begin{aligned}
\ln(FDI_{ij}) &= \beta_0 + \beta_1\left[\ln(GDP_i) + \ln(GDP_j)\right] + \beta_2\left[\ln(GDP_i) - \ln(GDP_j)\right]^2 \\
&+ \beta_3\left[\ln(GDP_i) - \ln(GDP_j)\right] \times \left|skill_i - skill_j\right| + \beta_4\left|skill_i - skill_j\right| \\
&+ \beta_5 \ln(Distance_{ij}) + \beta_6 tradecost_j + \beta_8 tradecost_j \times \left|skill_i - skill_j\right|^2 \\
&+ \beta_9 investmentcost_j + \beta_{10} tradecost_i + \beta_{11} timezone_{ij} + \varepsilon_{ij}
\end{aligned} \tag{2}
$$

As a measure of endowment differences, we use the absolute difference in the percentage of the population with (at least) complete secondary schooling, which we obtain from the Barro and Lee (2000). In order to capture investment costs we use the summary index of institutional quality by Kaufmann et al (1999), since Stein and Daude (2001) have found that this variable plays a very important role in the location of FDI. Trade costs are measured by average tariff data between 1990 and 1996 from the Worldbank.[13] Table 1 presents summary statistics for each of these variables.

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[11] See Carr et al (2001) for further discussion.

[12] The reason is that, if differences in factor prices are sufficiently large (for a given level of trade costs), it will be more convenient to produce in the country with better comparative advantage, and supply the other country through trade.

[13] The database is available at http://www1.worldbank.org/wbiep/trade/TR_Data.html.

III. Empirical Results

In the first column of Table 2 we present our Tobit estimates for the standard gravity equation without including the time zone variable. Most variables are significant and show the expected sign. In particular, the distance between both countries has a negative and significant impact on FDI. Its coefficient suggests that when distance increases by one percent, bilateral stock of FDI falls by about 0.8 percent, an effect that is slightly higher than that usually obtained in gravity models of bilateral trade.[14]

In the next column we include our time zone variable in our gravity equation. While the magnitude and significance of all other regressors remains unchanged, the effect of distance is cut to -0.14, and is no longer statistically significant. More importantly, the time zone variable has a negative and significant effect on FDI. A time zone difference of one hour reduces the bilateral FDI stock by 24 percent.[15]

In the third column of Table 2, we present our estimates for the CMM model excluding the time zone variable.[16] The estimates of the control variables show the same signs as those of Carr et al (2001) and Blonigen et al (2002). Distance has a negative and significant impact on the FDI stock, slightly larger than its estimated impact using the

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[14] Leamer and Levinsohn (1995), for example, report a consensus elasticity of trade to distance of –0.6.

[15] Notice that in the gravity equations we included the dummy Same FTA, which takes a value of one when the source and host countries belong to the same free trade area. Levy Yeyati, Stein and Daude (2002) show that common membership in a FTA increases bilateral FDI. If FTAs tend to happen between countries that are in similar time zones, and FTAs increase bilateral FDI, then the exclusion of this variable could bias the time zones results. In contrast to Levy Yeyati et al (2002), who work with panel data, in our cross section regressions same FTA does not come out as significant. However, in the panel regressions reported in Table 6, the coefficient for same FTA is positive and significant.

[16] While the CMM model is more appealing on theoretical grounds, in comparison with the gravity model

gravity model. As in the gravity model, once we include the time zone variable, distance is no longer significant. Meanwhile, the coefficient for the time zone variable is highly significant, and suggests that each additional hour of time zone difference reduces bilateral FDI stocks by 23 percent. This shows that independently of the model we use, we get very similar results regarding our variables of interest. Time zone differences have a negative and significant impact on FDI, and substantially reduce the impact of distance on bilateral FDI. We will now discuss the robustness of these results.

IV. Robustness

In this section, we test the robustness of our results in two different ways. First, we consider different measures of time zone differences. Second, we check whether our results change when we use alternative estimation methods.

Tables 3a and 3b present the results of the regressions using alternative specifications to capture the time difference effects, for the gravity and CMM models, respectively. In the first column of each of the tables, we reproduce the regressions from Table 2, using our basic time zone difference variable, in order to facilitate the comparison of the results. In columns 2 and 3, we consider alternative variables to capture the time zone effect. First, we use the minimum time difference between both countries, in order to address the problem posed by countries with multiple time zones. In column 3, we consider the number of office hours overlap, assuming a standard workday from 9AM-5PM in each of

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we lose more than 20 percent of the observations.

the locations.[17] Both of these variables yield similar results to our basic time zone variable, regardless of the specification used.[18]

Finally, we decompose the distance into a latitudinal and a longitudinal component, and include both together in our regressions. Let the capital of the source country be located at (La_s, Lo_s) and that of the host country at (La_h, Lo_h), denoting longitude and latitude in gradients, respectively. We define latitudinal (or North-South) distance as the logarithm of the great circle distance in miles from (La_s, Lo_s) to (La_h, Lo_s), i.e. holding constant the longitude at the source country's coordinate. Notice that this distance would be exactly the same if we held the longitude constant at the host country's coordinate instead. The measurement of longitudinal (or East-West) distance is not as straightforward; a given difference in longitude can represent a long distance, if countries are close to the equator, or a very short distance, if they were close to the pole. Thus, the measure of longitudinal distance would differ according to whether we hold latitude constant at the source coordinate, or at the host coordinate. Our measure of longitudinal distance is just the average of the two.[19]

[17] This variable varies between 0 and 8 and, in contrast with the time zone difference variable, is expected to have a positive coefficient.

[18] We also added a quadratic time zone term to the basic regression of column (1), to test for non-linear effects. In both models, the quadratic term was not significant, suggesting that non-linearities do not play an important role.

[19] It is convenient here to clarify this with an example: The coordinates for Oslo, the capital of Norway, are (59º54'N, 10º45'E), while those of Bogotá, the capital of Colombia, are (4º37'N, 47º5'W). The longitudinal distance between Oslo and Bogotá is calculated as follows: we first compute the great circle distance between (59º54'N,10º45'E) and (59º54'N,47º5'W). This turns out to be 2729 miles. Next, we repeat the exercise, now computing the great circle distance between (4º37'N,10º45'E) and (4º37'N,47º5'W), i.e., holding the latitude constant at the coordinate of Bogotá. This distance turns out to be 5834 miles. Not surprisingly, the second value is much greater than the first, since Oslo is (relatively) close to the North Pole, while Bogotá is very close to the equator. Our measure of longitudinal distance between Norway and Colombia is simply the average of these two values: 4281.5.

The results using the decomposition of distance in its North-South and East-West components are presented in column 4 of Tables 3a and 3b. While longitude distance is highly significant in both cases, North-South distance becomes insignificant. Furthermore, the difference between the East-West and the North-South components is, in both cases, statistically significant. Taking all the previous results together, our findings are clearly robust to different measures of time zone differences, both in the case of the gravity model, as in that of the CMM framework. Time zones matter a lot, and the effect of distance is, at least, substantially reduced.

While we are convinced that the Tobit estimates deal in a better way with the left-hand truncation of the data, next we show that considering OLS we obtain essentially the same results. The first three columns present the results for the gravity model, while the last three correspond to the CMM model. In the first column of Table 4 we present the standard gravity model equation, without adding any time zone difference variable. Notice that the coefficient for distance is –0.51, much smaller than the one estimated with Tobit. However, if we rescale the OLS coefficient according to the methodology proposed by Greene (1981), the estimated impact is once again –0.78.[20] In column 2 of Table 4 we add our time zone differences variable. Once again, the inclusion of time zone differences reduces the impact of the distance to less than half, and makes its impact statistically insignificant. The rescaled coefficient for time zone difference is –0.18,

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[20] Greene (1981) shows that the bias of OLS estimates can be substantially reduced by dividing the point estimates by the proportion of non-censored observations, in our case 642/982 = 0.653 for the gravity model. Thus, the rescale coefficient for distance would be –0.51/0.653 = -0.781, similar to the one obtained with the Tobit estimation.

somewhat smaller than that using Tobit.[21] The same happens if we consider the CMM model, where the rescaled coefficient for time zones is –0.17.[22] In both cases, the estimated effect of time zones is negative and significantly different from zero. While in the gravity model distance is not significant, in the CMM case distance remains statistically significant. However, in both specifications the coefficient of distance is substantially reduced. Additionally, as shown in columns 3 and 6, the decomposition of the distance between the source and the host into its longitudinal and latitudinal components confirms the previous results.

V. Extensions

In this section, we consider two extensions of our results. First, we repeat the exercise for bilateral trade, rather than bilateral FDI stocks. While we expect that time zones might be important for trade as well, we expect the impact to be smaller than that in the case of FDI. The reason is that trade transactions are not as demanding in terms of real time interaction between the parties as is generally the case for FDI. In the second extension, we study the impact of time zone differences as it evolves over time. This second extension is perhaps more fundamental, as it may provide some clues regarding the channel through which time zone differences matter. We expect the impact to change over time, as the development of communications and Internet technologies facilitate long distance real time interaction.

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[21] -0.115/0.653 = 0.176.

[22] In this case, the share of non-censored observations is 573/776=0.738

Time zones and bilateral trade

The OLS results using trade instead of FDI are presented in Table 5.[23] For obvious reasons, in this case we work exclusively with the gravity model. In the first column, we report the results of the basic gravity equation, without the time zones variable. The effect of distance is smaller than that found for FDI, but perfectly consistent with the impact found in the empirical trade literature. An increase in distance of 1 percent reduces bilateral trade by approximately 0.6 percent. In column 2 we include our basic time zone difference variable. The coefficient for the time zone difference is negative, although not significant at conventional levels. In columns 3 and 4, however, we show that the impact of time zone differences becomes significant when we use either of our alternative definitions of time zones. There are, however, important differences between the impact of time zones for trade and investment. First, the impact of time zones on trade is smaller than the impact on FDI. While an additional hour of time difference reduces bilateral FDI by nearly 20 percent, the impact on trade ranges between 4.5 and 8 percent, depending on the specification used. Second, and not surprisingly, distance itself continues to be significant after controlling for time zone differences.

In spite of these weaker results, the importance of time zones is clearly confirmed in the last regression of the table. While both East-West and North-South distance have a negative and significant effect, the coefficient for longitudinal distance is significantly larger than that corresponding to latitudinal distance. In summary, time zones also matter

[23] The data on trade is taken from the IMF Direction of Trade Statistics database. In this case, there are only 45 observations, corresponding to about three percent of the sample, in which trade takes a value of zero.

for trade, although the effects are quite a bit smaller than those on FDI.

Communication technologies and the evolution of the time zone effect

We now turn our attention to the evolution over time of the time zone effect. One of the reasons to do this exercise is to study the impact that the development -- or widespread adoption -- of new communications technologies might have on the relative cost of doing business in different locations. Over the period under study, technologies such as the Internet or videoconference became close substitutes to face-to-face communication, allowing cheaper and more fluid interaction in real time among people in distant locations. While the Internet dates from the early 1970s, it was not until the beginning of the 1990s that its use - especially for business activities - spread widely around the world.[24] Similarly, while technologies for teleconference and videoconference were available before the 1990s, the introduction of ISDN telephone lines in the early 1990s substantially increased their reliability, and reduced their cost. But as important as these technologies are to reduce the cost of real time interaction, they cannot overcome the problem on which we focus here: if time zones are very different, one or both parties in the interaction will have to work beyond regular business hours. Thus, these technologies should have differential effects on transaction costs, reducing those among North-South parties more than those involved in East-West interaction.

Thus, it is not as important to rescale the coefficient in order to get an approximate idea of its impact.

[24] Hobbes internet timeline (www.zakon.org/robert/internet/timeline) identifies the year 1991 as the year in which the World Wide Web was released by CERN (the European Organization for Nuclear Research), and the year 1993 as the year in which "business and media really take notice of the internet."

In order to address this, we estimate the gravity equation using panel data from 1988 through 1999, but we include in the regression the interaction of the time zone difference with each of the year dummies. In this way, the coefficient for our variable of interest is allowed to change over time. The model includes time, source and host fixed effects, in order to account for the huge increase in FDI over time, and for country characteristics that are invariant over time, and might be difficult to observe. In addition to the gravity variables used in the cross section analysis of the previous sections, here we include the GDP of the source country, as well as the GDP per capita in each of the countries.[25] Since we are already controlling for distance, a differential impact of communications technologies as discussed above would result in an increase over time in the yearly time zone coefficients.

The results are presented in Table 6. The first column presents the Tobit estimates, using all available observations. A comparison of the yearly coefficients of time zones shows that there is a gradual increase in the effect of this variable. A problem with the regression in column 1 is that the number of country pairs included in the sample changes from year to year. In the next two columns, we include only those country pairs for which data is available in every one of the years considered. While we lose about 40 percent of the observations, this ensures that the results are not driven by changes in the sample. Column 2 presents the Tobit results, while column 3 presents the results using OLS. The increase in the yearly coefficient over time is confirmed in both models, and can be seen

[25] In the cross section regressions, we had excluded GDP and GDP per capita of the source, since both were already captured in the source dummy. GDP per capita in the host country replaces our measure of institutional quality, for which we do not have a time series. Notice that GDP host is also included in the panel model.

clearly in Figure 1, which presents the evolution of the time zone coefficient over time, as estimated in column (2). The increase is particularly visible until 1993, although the impact continues to increase more gradually after that year. In Table 7 we test whether the change over time in the yearly time zone coefficients is statistically significant and find evidence that the impact of time zones in the late 1990s is statistically different from its impact in the late 1980s. These results are consistent with our hypothesis that technological change is not likely to do away with the transactions costs imposed by time zone difference. If anything, technological change may increase the importance of this factor for the location decisions of multinational businesses.

VI. Conclusions

In this paper we have examined the effects of time zone differences on the location of FDI around the world. We found that time zone differences between the source and host countries have a negative impact on bilateral FDI. This impact is both statistically significant and economically important. Furthermore, once we control for the time zone effect, the coefficient of the distance between the source and the host is no longer significant. This indicates that in the case of FDI the most relevant component of distance is the East-West component, since transaction costs in activities that require real-time interaction between a firm's headquarters and its foreign affiliates are increasing in this dimension. Our results are robust to different measures of time zone differences, as well as different estimation procedures

These results suggest that empirical research on bilateral FDI should account for this effect in order to obtain consistent estimates for their parameters of interest. They may also be helpful to understand the patterns of competition to attract FDI. Specifically, host countries would be more exposed to competition from other countries in proximate same time zones, and less exposed to competition from potential host countries in more distant time zones.

Finally, our results suggest that the problem posed by time zone differences has become more relevant over time, with the introduction and widespread dissemination of new information technologies. This link between technology and the impact of time zones is more than mere speculation. It is a pattern that we observe more and more in everyday life, and is supported by numerous examples: like that of an acquaintance, who works for a business located in Washington DC, but telecommutes from Buenos Aires; or that of the chief economist for Latin America at the World Bank, who is currently based in Bogotá. These cases would have been unthinkable just ten years ago. And it would be hard to imagine the World Bank's chief economist for Asia working from Bangkok. Interaction with the staff would be, literally, a nightmare.

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Appendix

The OECD International Direct Investment Statistics database presents some problems regarding the reporting of zeros and missing values. In particular, source countries are not required to report values for hosts for which FDI is zero. For this reason, the data on bilateral FDI stocks required some adjustments. We used the following criteria to distinguish the zero values from the true missing observations:

(i) if a source country reports missing values to a particular host country, but had reported positive values during a previous year, then those missing values were considered to be truly missing.

(ii) if a source country reports missing values to a given host country, but the OECD dataset on bilateral *flows* of FDI shows that there was FDI activity from that source to that host in previous years, then the missing values are considered to be truly missing.

(iii) if a source country starts reporting bilateral stocks and flows of FDI to a given host in the same year, and the first positive value for the stock is significantly larger than that of the flow, we considered all previous observations for that country pair to be truly missing.

(iv) if neither of the three previous conditions applies, and a source reports positive values of FDI to some hosts, but missing values to others, those missing values are considered to be zeros. As an example, if Germany reports positive values to Chile, but missing values to Argentina (and there is no evidence, either from previous stocks or flows or the comparison between them, that there was some prior bilateral multinational activity) then the missing values reported to Argentina are considered to be zeros.

There are some exceptions to criteria (iv), however. In particular, if a source country, having reported stocks to some countries in the sample in previous years, suddenly begins reporting FDI to a block of new host countries at the same time, we used our discretion to determine whether the previous missing observations should be truly missing, or zeros. As an example, in 1993 Netherlands began reporting positive values to 26 host countries for which each of the previous observations had been coded as missing. We determined that such an abrupt change was more likely to reflect a change towards more detailed information disclosure rather than a genuine change in investment. Thus, all the missing values prior to 1993 were coded as truly missing. To provide an example that goes the other way, several source countries began reporting positive values of bilateral stocks to the transition economies, right after the fall of the Berlin Wall. In this case, we considered the previous missing values as zeros, since we determined that they were more likely to reflect the absence of investments.

Table 1
Summary Statistics

Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Ln (FDI Stock+1)	982	3.83	3.53	0	11.95
Ln(Exports+Imports+1)	1416	5.58	2.50	0	12.68
Ln(GDP Host)	982	11.82	1.46	8.89	15.93
Ln(GDP Source)	982	12.73	1.59	8.89	15.93
Ln(GDP per capita Source)	982	9.87	0.59	8.15	10.49
Ln(GDP per capita Host)	982	8.83	1.24	6.01	10.49
Ln(Sum of Host and Source GDP)	982	13.46	1.25	9.68	16.33
Square Difference of Ln(GDP)	982	5.77	7.74	0.00	59.07
Skill Difference	843	21.92	15.93	0.10	73.80
Tariff Host	846	8.21	7.42	0	45.66
Tariff Source	975	5.80	1.92	1.66	11.80
Institutions	982	0.56	0.78	-1.46	1.71
Ln(Distance)	982	7.95	1.04	3.56	9.42
Same FTA	982	0.15	0.36	0	1
Border	982	0.04	0.20	0	1
Common Language	982	0.08	0.28	0	1
Colonial Links	982	0.01	0.10	0	1
Time Difference	982	4.31	3.58	0	12
Minimum Time Difference	982	4.13	3.56	0	12
Hours of office overlaping	982	3.96	3.17	0	8
Ln(Latitude Distance)	982	6.99	1.31	0	8.89
Ln(Longitude Distance)	982	7.53	1.29	2.18	9.13

Table 2
Tobit Estimation
Dependent Variable: Ln(Stock of Bilateral FDI)

	Gravity Model		CMM Model	
	(1)	(2)	(3)	(4)
GDP	1.537	1.564		
	(9.581)***	(9.914)***		
Common Language	2.043	2.033		
	(3.810)***	(3.858)***		
Border	-0.115	0.367		
	(0.188)	(0.545)		
Colonial	2.296	2.532		
	(4.058)***	(4.737)***		
Same FTA	0.399	0.224		
	(1.004)	(0.553)		
Institutions	1.257	1.394	0.844	0.996
	(3.307)***	(3.685)***	(4.402)***	(5.073)***
Sum of Host and Source GDP			2.765	2.818
			(26.479)***	(27.076)***
Square Difference of GDP			-0.244	-0.252
			(9.705)***	(9.691)***
Skill Difference			-0.016	-0.021
			(1.265)	(1.599)
GDP Difference*Skill Difference			0.009	0.01
			(2.189)**	(2.476)**
Tariff Host			0.031	0.026
			(1.142)	(0.957)
Tariff Host* Square Skill Difference			-0.001	-0.001
			(1.447)	(1.072)
Tariff Source			-0.616	-0.621
			(10.456)***	(10.632)***
Distance	-0.796	-0.138	-0.959	-0.258
	(4.060)***	(0.453)	(9.402)***	-1.283
Time Difference		**-0.237**		**-0.234**
		(3.675)***		**(3.963)*****
Constant	-12.047	-16.758	-22.014	-27.294
	(5.120)***	(6.295)***	(12.999)***	(12.706)***
Observations	982	982	776	776
Censored Observations	340	340	203	203
Uncensored Observations	642	642	573	573

Notes: Year 1997. Source dummies included in the Gravity Model.
Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3 (a)
Tobit Estimation, Gravity Model
Dependent Variable: Ln(Stock of Bilateral FDI)

	(1)	(3)	(4)	(5)
GDP	1.564	1.558	1.577	1.548
	(9.914)***	(9.860)***	(10.064)***	(9.761)***
Common Language	2.033	2.089	2.009	2.023
	(3.858)***	(3.884)***	(3.819)***	(3.803)***
Border	0.367	0.27	0.382	0.45
	(0.545)	(0.410)	(0.555)	(0.677)
Colonial	2.532	2.525	2.38	1.937
	(4.737)***	(4.756)***	(4.519)***	(3.701)***
Same FTA	0.224	0.266	0.166	0.582
	(0.553)	(0.666)	(0.411)	(1.346)
Institutions	1.394	1.369	1.391	1.327
	(3.685)***	(3.643)***	(3.747)***	(3.522)***
Distance	-0.138	-0.242	-0.082	
	(0.453)	(0.859)	(0.262)	
Time Difference	-0.237			
	(3.675)***			
Minimum Time Difference		-0.203		
		(3.596)***		
Hours of office overlaping			0.284	
			(3.694)***	
Latitude Distance				0.127
				(0.969)
Longitude Distance				-0.596
				(3.603)***
Constant	-16.758	-16.212	-19.527	-15.277
	(6.295)***	(6.198)***	(6.084)***	(6.859)***
Test Latitude Distance = Longitude Distance				
chi2(1)				10.150
Prob > chi2				[0.0014]***
Observations	982	982	982	982
Censored Observations	340	340	340	340
Uncensored Observations	642	642	642	642

Notes: Year 1997. Source dummies included.
Robust t statistics in parentheses, P-values in square brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3 (b)
CMM Model
Dependent Variable Ln(Stock of Bilateral FDI)

	(1)	(3)	(4)	(5)
Institutions	0.996	0.964	0.973	0.964
	(5.073)***	(4.982)***	(5.016)***	(4.996)***
Sum of Host and Source GDP	2.818	2.806	2.836	2.823
	(27.076)***	(27.034)***	(26.864)***	(26.120)***
Square Difference of GDP	-0.252	-0.25	-0.251	-0.243
	(9.691)***	(9.711)***	(9.733)***	(9.225)***
Skill	-0.021	-0.021	-0.019	-0.017
	(1.599)	(1.602)	(1.489)	(1.269)
GDP Difference*Skill Difference	0.01	0.009	0.01	0.008
	(2.476)**	(2.400)**	(2.450)**	(1.887)*
Tariff Host	0.026	0.027	0.031	0.033
	(0.957)	(0.997)	(1.155)	(1.229)
Tariff Host* Square Skill Difference	-0.001	-0.001	-0.001	-0.001
	(1.072)	(1.124)	(1.383)	(1.423)
Tariff Source	-0.621	-0.626	-0.623	-0.622
	(10.632)***	(10.745)***	(10.609)***	(10.477)***
Distance	-0.258	-0.365	-0.238	
	(1.283)	(1.969)**	(1.162)	
Time Difference	-0.234			
	(3.963)***			
Minimum Time Difference		-0.204		
		(3.772)***		
Hours of office overlaping			0.27	
			(4.063)***	
Latitude Distance				-0.025
				(0.274)
Longitude Distance				-0.668
				(6.813)***
Constant	-27.294	-26.378	-29.778	-25.272
	(12.706)***	(12.880)***	(11.437)***	(14.456)***
Test Latitude = Longitude				
chi2(1)				15.91
Prob > chi2				[0.0001]***
Observations	776	776	776	776
Censored Observations	203	203	203	203
Uncensored Observations	573	573	573	573

Notes: Year 1997.
Robust t statistics in parentheses, P-values in square brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4
OLS Estimation
Dependent Variable: Ln(FDI Stock + 1)

	Gravity Model			CMM Model		
	(1)	(2)	(3)	(4)	(5)	(6)
GDP	1.044	1.053	1.051			
	(12.36)***	(12.55)***	(12.70)***			
Common Language	1.639	1.616	1.624			
	(4.38)***	(4.37)***	(4.36)***			
Border	0.62	0.877	1.018			
	(1.42)	(1.84)*	(2.13)**			
Colonial	1.56	1.676	1.316			
	(4.69)***	(5.58)***	(4.11)***			
Same FTA	0.482	0.408	0.628			
	(1.75)*	(1.46)	(2.09)**			
Institutions	0.781	0.849	0.818	0.557	0.637	0.633
	(3.92)***	(4.27)***	(4.16)***	(4.47)***	(5.02)***	(5.08)***
				2.067	2.091	2.102
Sum of Host and Source GDP				(32.49)***	(33.05)***	(31.84)***
Square Difference of GDP				-0.196	-0.199	-0.195
				(13.76)***	(13.70)***	(13.09)***
Skill Difference				-0.021	-0.023	-0.022
				(2.34)**	(2.50)**	(2.39)**
GDP Difference*Skill Difference				0.01	0.011	0.01
				(3.95)***	(4.12)***	(3.65)***
Tariff Host				0.016	0.013	0.017
				(0.82)	(0.68)	(0.87)
Tariff Host* Square Skill Difference				-0.001	-0.001	-0.001
				(1.55)	(1.30)	(1.52)
Tariff Source				-0.456	-0.459	-0.462
				(12.35)***	(12.53)***	(12.61)***
Distance	-0.511	-0.184		-0.705	-0.327	
	(4.50)***	(0.86)		(9.79)***	(2.27)**	
Time Difference		-0.115			-0.123	
		(2.46)**			(3.03)***	
Latitude Distance			0.106			-0.028
			(1.08)			(0.42)
Longitude Distance			-0.383			-0.472
			(3.97)***			(6.79)***
Constant	-6.229	-8.487	-8.508	-14.595	-17.402	-16.934
	(4.39)***	(4.86)***	(6.55)***	(13.04)***	(12.19)***	(14.86)***
	Test Latitude Distance = Longitude Distance					
chi2(1)			9.67			15.07
Prob > chi2			[0.003]***			[0.000]***
Observations	982	982	982	776	776	776
R-squared	0.71	0.713	0.709	0.68	0.684	0.67

Notes: Year 1997. Source dummies included in the Gravity Model.
Robust t statistics in parentheses, P-values in square brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5
OLS Estimate: Dependent Variable Ln(Exports+Imports+1)

	(1)	(2)	(3)	(4)	(5)
Ln(GDP Host*GDP Source)	0.902	0.905	0.904	0.907	0.893
	(46.280)***	(47.036)***	(46.595)***	(47.257)***	(45.207)***
Ln(GDP per cap Host*GDP per cap Source)	0.044	0.046	0.045	0.049	0.045
	(1.834)*	(1.921)*	(1.874)*	(2.032)**	(1.816)*
Common Language	0.995	0.984	0.985	0.97	1.016
	(7.267)***	(7.269)***	(7.264)***	(7.197)***	(7.356)***
Border	0.303	0.412	0.407	0.458	0.523
	(0.765)	(1.055)	(1.044)	(1.175)	(1.335)
Colonial Links	0.928	0.958	0.969	0.959	0.907
	(4.496)***	(4.704)***	(4.739)***	(4.699)***	(4.445)***
Same FTA	0.038	0.054	0.058	0.041	0.172
	(0.197)	(0.281)	(0.303)	(0.211)	(0.871)
Distance	-0.587	-0.438	-0.44	-0.363	
	(10.585)***	(3.441)***	(3.802)***	(2.706)***	
Time Difference		-0.044			
		(1.479)			
Minimum Time Difference			-0.044		
			(1.665)*		
Hours of office overlaping				0.077	
				(2.099)**	
Latitude Distance					-0.091
					(2.299)**
Longitude Distance					-0.346
					(8.779)***
Constant	-12.049	-13.164	-13.099	-14.356	-13.541
	(19.537)***	(13.179)***	(14.446)***	(11.151)***	(22.544)***
Test Latitude Distance = Longitude Distance					
F					16.99
Prob > F					[0.000]***
Observations	1417	1417	1417	1417	1416
R-squared	0.624	0.625	0.626	0.626	0.618

Note: Same country pairs as in FDI sample; Year 1997
Robust t statistics in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%
P-values in square brackets * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6
Panel Estimates
Dependent Variable: Ln(Stock of Bilateral FDI)

	Tobit All obs	Tobit Sample 1988-1999	OLS Sample 1988-1999
GDP Host	1.071	-0.113	0.134
	(9.622)***	-(0.806)	-(1.578)
GDP Source	0.264	0.232	0.274
	-(0.802)	-(0.630)	-(1.118)
GDP per capita Host	-3.272	0.179	0.847
	(9.851)***	-(0.368)	(2.705)***
GDP per capita Source	4.233	4.39	2.855
	(6.064)***	(6.000)***	(6.002)***
Same FTA	0.194	0.646	0.882
	-(1.630)	(3.878)***	(8.195)***
Common Language	1.05	1.413	1.245
	(9.462)***	(10.615)***	(12.998)***
Border	0.205	-0.545	0.2
	-(1.320)	(3.320)***	(1.658)*
Colonial Links	2.101	2.281	1.595
	(10.669)***	(8.988)***	(9.231)***
Distance	-0.738	-0.702	-0.406
	(8.755)***	(6.650)***	(5.753)***
Time Difference*1988	-0.193	-0.115	-0.036
	(5.549)***	(2.931)***	-1.402
Time Difference*1989	-0.19	-0.132	-0.057
	(5.396)***	(3.417)***	(2.234)**
Time Difference*1990	-0.184	-0.136	-0.062
	(5.414)***	(3.517)***	(2.389)**
Time Difference*1991	-0.202	-0.169	-0.091
	(6.591)***	(4.737)***	(3.781)***
Time Difference*1992	-0.212	-0.178	-0.104
	(7.140)***	(5.128)***	(4.401)***
Time Difference*1993	-0.232	-0.189	-0.117
	(8.287)***	(5.439)***	(4.908)***
Time Difference*1994	-0.216	-0.186	-0.118
	(7.663)***	(5.267)***	(4.940)***
Time Difference*1995	-0.238	-0.193	-0.126
	(8.052)***	(5.580)***	(5.267)***
Time Difference*1996	-0.255	-0.205	-0.137
	(8.837)***	(5.912)***	(5.663)***
Time Difference*1997	-0.263	-0.211	-0.14
	(9.328)***	(6.033)***	(5.711)***
Time Difference*1998	-0.25	-0.2	-0.138
	(8.790)***	(5.617)***	(5.513)***
Time Difference*1999	-0.261	-0.207	-0.145
	(8.849)***	(5.690)***	(5.683)***
Observations	9624	5662	5662
Censored Observations	3550	2211	
Uncensored Observations	6074	3451	
R-squared			0.922

Notes: Source, Host and Year dummies included.
Robust t statistics in parentheses, P-values in square brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7
Time Zone Effect Equality Tests Over Time
TOBIT model with year, host and source dummies

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989	0.118 (0.73)										
1990	0.186 (0.67)	0.008 (0.93)									
1991	1.422 (0.23)	0.710 (0.40)	0.562 (0.45)								
1992	1.971 (0.16)	1.105 (0.29)	0.912 (0.34)	0.041 (0.84)							
1993	2.754* (0.10)	1.724 (0.19)	1.474 (0.22)	0.229 (0.63)	0.081 (0.78)						
1994	2.455 (0.12)	1.501 (0.22)	1.274 (0.26)	0.153 (0.70)	0.039 (0.84)	0.007 (0.93)					
1995	3.038* (0.08)	1.978 (0.16)	1.710 (0.19)	0.333 (0.56)	0.150 (0.70)	0.011 (0.92)	0.035 (0.85)				
1996	3.992** (0.05)	2.783* (0.10)	2.459 (0.12)	0.729 (0.39)	0.452 (0.50)	0.152 (0.70)	0.223 (0.64)	0.082 (0.77)			
1997	4.457** (0.03)	3.206* (0.07)	2.861* (0.09)	0.969 (0.32)	0.653 (0.42)	0.279 (0.60)	0.372 (0.54)	0.181 (0.67)	0.020 (0.89)		
1998	3.485* (0.06)	2.368 (0.12)	2.084 (0.15)	0.538 (0.46)	0.303 (0.58)	0.075 (0.78)	0.126 (0.72)	0.030 (0.86)	0.012 (0.91)	0.060 (0.81)	
1999	3.951** (0.05)	2.762* (0.10)	2.436 (0.12)	0.754 (0.39)	0.480 (0.49)	0.177 (0.67)	0.249 (0.62)	0.102 (0.75)	0.002 (0.97)	0.009 (0.93)	0.021 (0.88)

Note: Chi2 statistics and p-values between parentheses

Figure 1
Effect on Stock of Bilateral FDI of Time Zones by Year
TOBIT Estimation

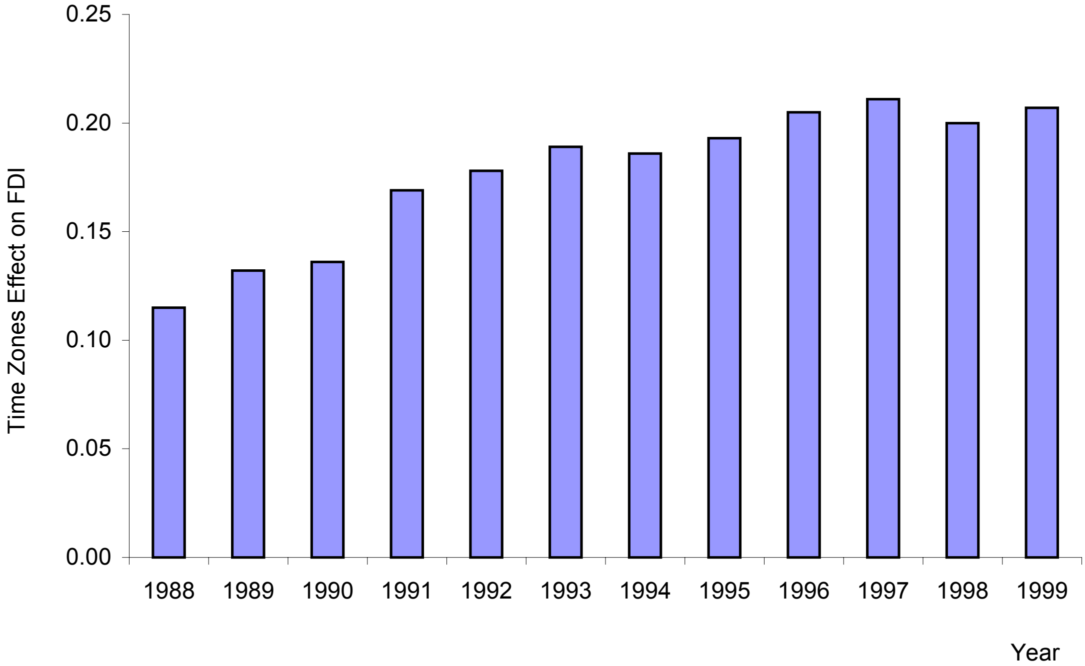

Table A.1. Data Sources

Variable	Details and Data Sources
Adjacency, Common Language, Colonial Links	Dummy variables that take a value one if the source and the host countries share a common border, common language or past colonial links, respectively. The variables have been constructed base on *The World Economic Factbook*, CIA website http://www.cia.gov/cia/publications/factbook/index.html
Average Tariff	Simple average between 1990-1996 mean tariff levels. Worldbank. http://www1.worldbank.org/wbiep/trade/TR_Data.html
Bilateral FDI Stock	Millions of current dollars. *International Direct Investment Statistics Yearbook*. Paris, France: Organization for Economic Cooperation and Development, 2000.
Bilateral Trade	Millions of current dollars of total merchandise trade. Trade between country *i* and country *j* is defined as: $Trade_{ij} = (X_{ij} + M_{ij} + X_{ji} + M_{ji})$, where X and M are exports and imports respectively. *Direction of Trade Statistics*, International Monetary Fund.
Coordinates (Latitude and Longitude)	http://www.world-gazetteer.com/home.htm and Britanica Atlas, Encycopedia Britanica Inc. 1994
Distance, Latitudinal Distance, Longitudinal Distance	Great Circle Distance (own calculations). See main text for detailed description of the construction of the latitudinal and longitudinal distances.
GDP	Millions of current dollars. *International Financial Statistics*, International Monetary Fund.
GDP per capita	Current dollars. *World Development Indicators*, Worldbank.
Institutions	Simple average of six institutional indices developed by Kaufmann et al.(1999): Voice and Accountability, Political Stability and Lack of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. http://www.worldbank.org/wbi/governance/datasets.htm
Time Zones	Britanica atlas, Encycopedia Britanica Inc. 1994
Same FTA	Dummy variable that takes a value of one if the source and the host countries are members of the same Free Trade Area. Based on Frankel (1997) and completed with other sources. See Levy Yeyati et al (2002) for more details.
Skilled Labor	Percentage of the population with completed secondary Education from Barro and Lee (2000). http://www.cid.harvard.edu/ciddata/ciddata.html

Table A.2
Time Zones, Latitudes and Longitudes

Country	City	Time City	Minimum Time	Maximum Time	Latitude	Longitude
Algeria	Algiers	1			36° 46' N	3° 2' E
Argentina	Buenos Aires	-3			34° 36' S	58° 22' W
Australia	Canberra	10	8	10	35° 18' S	149° 5' E
Austria	Vienna	1			48° 13' N	16° 22' E
Belgium-Luxembourg	Brussels	1			50° 49' N	4° 19' E
Brazil	Brasilia	-3	-3	-5	15° 46' S	47° 54' W
Bulgaria	Sofia	2			42° 41' N	23° 18' E
Canada	Toronto	-5	-5	-8	43° 38' N	79° 22' W
Chile	Santiago	-4			33° 27' S	70° 38' W
China	Shanghai	8			31° 13' N	121° 28' E
Colombia	Bogotá	-5			4° 37' N	74° 5' W
Costa Rica	San José	-6			9° 55' N	84° 4' W
Czech Republic	Prague	1			50° 4' N	14° 25' E
Denmark	Copenhagen	1			55° 40' N	12° 34' E
Egypt	Cairo	2			30° 3' N	31° 15' E
Finland	Helsinki	2			60° 10' N	24° 56' E
France	Paris	1			48° 51' N	2° 20' E
Germany	Berlin	1			52° 31' N	13° 22' E
Greece	Athens	2			37° 58' N	23° 43' E
Hong Kong	Hong Kong	8			22° 8' N	114° 5' E
Hungary	Budapest	1			47° 30' N	19° 4' E
Iceland	Reykjavik	0			64° 8' N	21° 55' W
India	New Delhi	5.5			28° 36' N	77° 13' E
Indonesia	Jakarta	7	7	9	6° 10' S	106° 49' E
Iran	Tehran	3.5			35° 40' N	51° 25' E
Ireland	Dublin	0			53° 19' N	6° 15' W
Israel	Jerusalem	2			31° 46' N	35° 13' E
Italy	Rome	1			41° 53' N	12° 30' E
Japan	Tokyo	9			35° 40' N	139° 46' E
Korea	Seoul	9			37° 33' N	126° 59' E
Kuwait	Kuwait	3			29° 19' N	47° 58' E
Libya	Tripoli	2			32° 52' N	13° 10' E
Malaysia	Kuala Lumpur	8			3° 9' N	101° 42' E
Morocco	Rabat	1			34° 1' N	6° 50' W
Mexico	Mexico	-6	-6	-8	19° 25' N	99° 8' W
Netherlands	Amsterdam	1			52° 22' N	4° 53' E
New Zealand	Wellington	12			41° 16' S	174° 46' E
Norway	Oslo	1			59° 54' N	10° 45' E
Panama	Panama	-5			8° 58' N	79° 31' W
Philippines	Manila	8			14° 37' N	120° 58' E
Poland	Warsaw	1			52° 15' N	21° 1' E
Portugal	Lisbon	0			38° 43' N	9° 8' W
Romania	Bucharest	2			44° 26' N	26° 6' E
Country	City	Time City	Minimum Time	Maximum Time	Latitude	Longitude

Saudi Arabia	Riyadh	3			24º 38' N	46º 46' E
Singapore	Singapore	8			1º 18' N	103º 50' E
Slovakia	Bratislava	1			48º 9' N	17º 7' E
Slovenia	Ljbljana	1			46º 3' N	14º 30' E
South Africa	Pretoria	2			25º 43' S	28º 13' E
Spain	Madrid	1			40º 25' N	3º 42' W
Sweden	Stockholm	1			59º 19' N	18º 4' E
Switzerland	Bern	1			46º 57' N	7º 26' E
Thailand	Bangkok	7			13º 43' N	100º 30' E
Turkey	Ankara	2			39º 55' N	32º 51' E
Ukraine	Kiev	2			50º 26' N	30º 31' E
United Arab Emirates	Abu Dhabi	4			24º 28' N	54º 22' E
United Kingdom	London	0			51º 31' N	0º 6' W
United States	Chicago	-6	-5	-8	41º 50' N	87º 40' W
Venezuela	Caracas	-4			10º 32' N	66º 55' W