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Time zone differences as trade barriers

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ABSTRACT

This paper estimates the impact of time zone differences between trading locations on trade costs and trade in general equilibrium. Using homogeneous bilateral trade data between US states and Canadian provinces, time zone differences are found to reduce bilateral trade by 11% on average, which amounts to about one-sixth of the international border effect between the US and Canada.

1. Introduction

Aggregate bilateral trade depends negatively on geographical distance (see Eaton and Kortum, 2002; Anderson and van Wincoop, 2003; henceforth referred to as AvW) and on international borders (see McCallum, 1995; AvW). This paper illustrates that also time zone differences affect trade flows negatively in general equilibrium. Larger time zone differences reduce opportunities of direct personal interaction (via the telephone, the internet through conference calls, etc.).[1] We illustrate time zone difference effects by employing data on bilateral trade among individual states of the US and individual provinces of Canada, where cultural, economic, institutional, and geographical determinants of trade are much more homogeneous than in typical cross-country studies. This data-set has been used for that reason to estimate international border effects between the US and Canada *conditional on geographical distance* (see McCallum, 1995; AvW).

Fig. 1 illustrates time differences in the US and Canada relative to American Samoa (which is set to zero). For each pair of US state and Canadian province we utilize the information underlying Fig. 1 to determine their (weighted) absolute average time difference and,[2] conditional on distance and international borders, assess

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[1] That time zones are important for international transactions is widely acknowledged in business (see, e.g., the website http://ezinearticles.com/?Forex-Trading-Time-Zone-Basics&id=2102349). There is even recognition of time zones in international economic theory (see Kikuchi, 2006, 2011). To the best of our knowledge, the present paper is the first one to quantify the *total effects* of time zones on bilateral goods trade. It does so by assessing their economic importance for trade in general equilibrium. See the empirical studies on the *partial effects* of time zones as impediments to bilateral international services trade by Stein and Daude (2007), Christen (2011) and Dettmer (2011). Consistent with this notion, American Samoa decided to skip December 30 in 2011 in order to not distort its trade with Australia and New Zealand (see http://www.telegraph.co.uk/news/worldnews/australiaandthepacific/samoa/8980665/Samoa-prepares-to-skip-Dec-30.html).

[2] Some time zones cross through states or provinces (e.g., Florida, Indiana, Kentucky, Ontario, Tennessee, and Wisconsin). The trade data vary only by state and province. We carefully weighted the respective zones for each state properly by using fractions of the covered area in one or the other zone.

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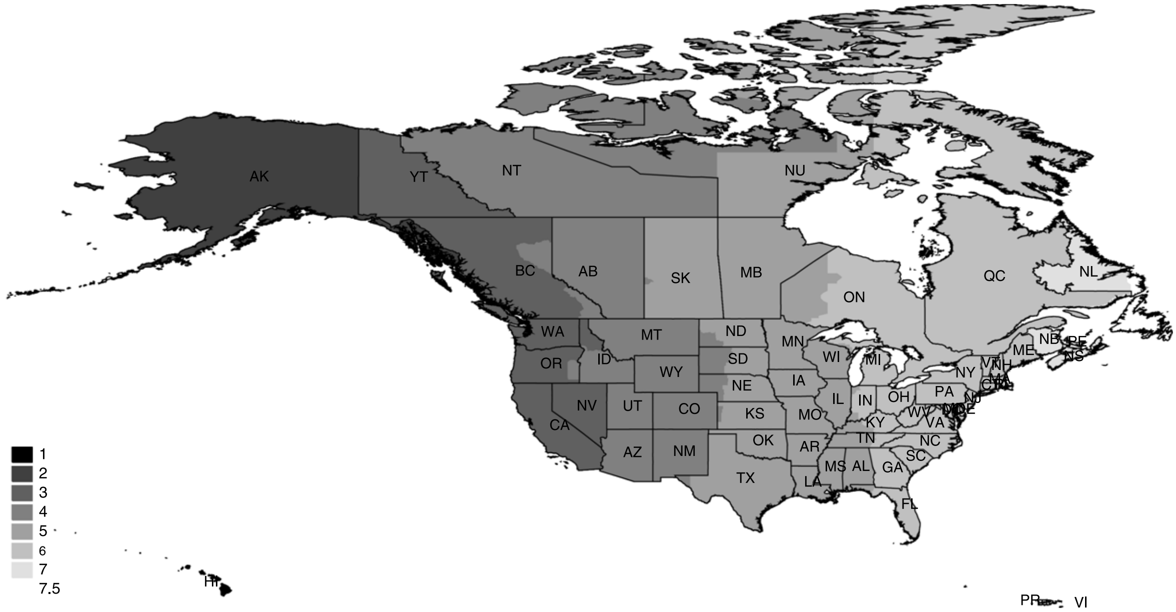

Fig. 1. Time differences to American Samoa of US states and Canadian provinces (American Samoa is normalized to zero).

its impact on bilateral goods trade in general equilibrium. The average time difference amounts to 1.4 h among all possible 51 US states (including District of Columbia) and 12 Canadian provinces (excluding Nunavut).

2. Hours of time zone difference in the gravity equation

We employ the structural gravity model as developed by AvW and augment it by the area-weighted absolute time zone difference in hours between states/provinces i and j (HOURS_{ij}) beyond log geographical distance (DISTANCE_{ij}) and international border (BORDER_{ij}). Then, we may formulate bilateral trade costs on exports from i to j as

$$t_{ij} = e^{f(\text{HOURS}_{ij})+g(\text{DISTANCE}_{ij})+\beta\text{BORDER}_{ij}}, \tag{1}$$

where $f(\text{HOURS}_{ij})$ and $g(\text{DISTANCE}_{ij})$ may be linear or a nonlinear in HOURS_{ij} and DISTANCE_{ij}, respectively. Following AvW, the gravity model of aggregate bilateral exports between i and j reads

$$X_{ij} = t_{ij}^{1-\sigma}\mu_i m_j Y u_{ij}, \quad \mu_i = \frac{Y_i}{Y\sum_{j=1}^{J} t_{ij}^{1-\sigma} m_j},$$

$$m_j = \frac{Y_j}{Y\sum_{i=1}^{J} t_{ij}^{1-\sigma}\mu_i}, \tag{2}$$

where $1-\sigma$ is the elasticity of trade with respect to trade costs, μ_i and m_j capture multilateral effects of trade costs and market size, Y_i and $Y = \sum_{i=1}^{J} Y_i$ are country i's and all J countries' GDP together, respectively, and u_{ij} is an error term. Respecting the definition of (μ_i, m_j) in (2) (market clearing), this model allows for a quantification of comparative static time zone effects in general equilibrium, which is novel.

3. Quantifying time zone difference effects

We utilize the data-set employed by AvW, but augment it by time zone difference data as in Fig. 1. As in AvW, the data utilized for *estimation* cover $40 = 30 + 10$ rather than $63 = 51 + 12$ states/provinces,[3] while all 51 US states and 10 Canadian provinces (except Northwest and Yukon Territories) are used for comparative static analysis. Among the former 40 units, the mean of $\text{HOURS}_{ij} \in [0, 6.5]$ is 1.2 rather than 1.4.

Table 1 summarizes parameter estimates at the top and comparative static effects of setting $\text{HOURS}_{ij} = 0$ and, for comparison, $\text{BORDER}_{ij} = 0$ for all ij at the bottom. We present five empirical models: a pure AvW model which assumes that $f(\text{HOURS}_{ij})$ is absent in Column (1) so that $t_{ij} = e^{\delta\text{DISTANCE}_{ij}+\beta\text{BORDER}_{ij}}$[4]; the model as in (2) assuming $f(\text{HOURS}_{ij}) = \eta_1\text{HOURS}_{ij} + \eta_2\text{HOURS}_{ij}^2$ in (1) in Column (2); a specification which assumes $f(\text{HOURS}_{ij}) = e^{\gamma_1(H_{ij}^{\text{low}}+H_{ij}^{\text{medium}})+\gamma_2 H_{ij}^{\text{high}}}$ in Column (3); a specification which assumes $f(\text{HOURS}_{ij}) = e^{\zeta_1 H_{ij}^{\text{low}}+\zeta_2 H_{ij}^{\text{medium}}+\zeta_3 H_{ij}^{\text{high}}}$ in (1) for a different functional form of a nonlinear time zone effect in Column (4) relative to Column (3); and a specification using distance quintiles in order to capture possible nonlinearities in the distance effect per se in Column (5). In specifications (3) and (4), H_{ij}^{ℓ} is a binary indicator variable which is unity if HOURS_{ij} falls into bin $\ell = \{\text{low, medium, high}\}$ with *low* referring to $\text{HOURS}_{ij} \in [0, 1.5)$, *medium* to $\text{HOURS}_{ij} \in [1.5, 3)$, and *high* to $\text{HOURS}_{ij} \in [3, 4.5]$. Table 1 suggests that time zone differences matter.

4. Comparative static effects of time zone differences on trade in the United States and Canada

The parameter estimates in Table 1 do not allow for any quantitative statements, since trade cost effects are generally nonlinear and heterogeneous across units in new trade models such as (2). However, we can obtain estimates of the effects of an abolition of time differences in comparison to, say, an abolition of the US–Canadian border from a counterfactual analysis

[3] Omitting Alaska, Arkansas, Colorado, Connecticut, Delaware, District of Columbia, Hawaii, Iowa, Kansas, Mississippi, Nebraska, Nevada, New Mexico, Oklahoma, Oregon, Rhode Island, South Carolina, South Dakota, Utah, West Virginia, and Wyoming in the US, and Northwest Territories and Yukon Territories in Canada.

[4] The corresponding parameter estimates are exactly identical to the ones in Specification (viii) of Table 6 in AvW.