Economic costs of critical infrastructure failure in bi-national regions and implications for resilience building: Evidence from El Paso–Ciudad Juárez

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1. Introduction

Cross-border trade with Mexico forms the backbone of economic growth of the United States (US). Freight volumes across the US–Mexico border are expected to increase to 2035 to a total of 25.5 million tons with a value of $111 billion (Cambridge Systematics, Inc., 2011). Nearly all of this volume (78% by weight, 90% by value) will be transported by truck, increasing overall volumes at the region’s 22 commercial crossings (on connections to warehousing and distribution facilities) and along the region’s 23 major trade corridors (primarily I-10 and US 54). Of the several existing POEs along the border, the ones located in the El Paso–Juárez region are considered to be among the most critical and important for the movement of people and freight. Laredo, El Paso and Hidalgo are among the top three trade related POEs (Bureau of Transportation Statistics; Vadali & Kang, 2013). The El Paso–Juárez international border crossings are a system of regional, statewide, and national significance. This system provides a critical link between maquiladora factories, primarily located in Ciudad Juárez, and distribution centers and consumer markets located in metropolitan El Paso, Texas, southern New Mexico, and beyond. In 2009, trucks were the predominant mode of trade through the Texas’ El Paso–Juárez region POEs which accounted for 16%. In 2010, more than $71 billion moved through El Paso POEs. This represents a 50% increase in total truck related trade over 2009. Furthermore, $89.5 billion in truck trade value flowing through El Paso POEs in 2012 (Vadali & Kang, 2013). Transportation connectivity in border regions like El Paso has led to joint dependence and synergies in businesses and industries in the regional economies, not unlike other border pairs along US–Mexico or US-Canadian borders. This joint dependence is known to influence the economies of both regions and nations through several economic channels, including employment, wages, and income and production sharing relations between companies. In the US–Mexico context, the cross border travel linked to trade, tourism, recreation and work commute is known to be vital to the economic development on both sides of the border (Wilson, 2011; Villareal, 2015; Canas, Coronado, Gilmer, & Saucedo, 2011; Lee & Wilson, 2012).

According to the International Trade Administration, trade between the United States and its North American Free Trade Agreement (NAFTA) partners has soared since the agreement entered into force. It has been pointed out that accommodating the increase in freight due to trade will entail important and timely strategic planning at all existing POEs located along the borders (Brogan & Ahern, 2012). As trends in near sourcing, reverse globalization increase due to NAFTA, freight...
Most of the bridges show-cased are state owned. Five of them are federal bridges at the POE. While this paper does not statistically determine the hazard rate, both the maps suggest that disruption anywhere is certainly a possibility. BOTA is used as a case example. This POE and the associated approach transport infrastructure are considered to be a critical portion of the bi-national transportation network connecting both the US and Mexico markets in the region. The disruption was modeled at a critical interchange in the vicinity of the POE using a model developed and calibrated for the bi-national region. The dynamic traffic assignment (DTA) model was developed for the bi-national network using an open source tool (Dynus-T; Chiu et al., 2012) and was used as a test bed for a simulation of the temporal trend of travel effects before-and-after the disruption (both on traffic volumes and travel times). Since disruptions can vary in severity, the simulation assumed that it was large enough to warrant port closure.

A second objective of this paper is to use the travel effects to identify and estimate the direct first order economic costs (non-administrative) accruing to the private sector and the community at large. The third objective of this paper is to utilize the results to suggest some transportation and non-transportation actions that agencies can consider knowing that the effects of major disruptions can cascade and be costly. Specific transportation mitigation strategies are not the subject of this study and are left for future research as also the use of input–output or Computable General Equilibrium (CGE) models for addressing the magnitude and spread of cascading effects. This paper contributes to the literature by demonstrating how a specially calibrated DTA model for the entire network can provide insights into the spread of a disruption impact across the network. It differs from the other studies in that it strives to use the analysis to inform public agencies about the magnitude and extent of direct costs to suggest the implications for resilience planning in integrated border-pairs, other strategies and suggestions for future research. Past studies have addressed impacts resulting from infrastructure disruptions; however, not specifically in the context of bi-national trade between the US and Mexico. Few, if any, have used DTA models to explore economic costs as the literature review suggests.

The remaining sections of this paper are organized as follows. The next section presents a literature review on the following themes: i) disruption traffic impact assessment literature and use of DTA models; ii) economic costs and resilience linked to disruptions; iii) propagation of disruption effects in supply chains and iv) transportation disruption and economic impact studies; v) the DTA model and its use in traffic mitigation and finally, vi) general role of resilience strategies. Section 3 discusses the model for the case study region and also presents the framework for analyzing direct costs to carriers and shippers from the model. Section 4 analyzes the results. Section 5 presents a discussion on potential implications of this study on transportation

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1 Functionally obsolete means that the design of a bridge is not suitable for its current use, such as lack of safety shoulders or the inability to handle current traffic volume, speed, size, or weight. Bridges — A report card for America’s infrastructure. http://www.infrastructurereportcard.org/. The inventory data identifies bridge ownership as well as whether it is structurally deficient or functional obsolete.
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