National Center for Risk and Economic Analysis of Terrorism Events
University of Southern California

THE IMPACT ON THE U.S. ECONOMY OF CHANGES IN WAIT TIMES AT PORTS OF ENTRY

by

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Report to U.S. Customs and Border Protection

Final Report

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EXECUTIVE SUMMARY

ES.1 STUDY OVERVIEW

This study estimates the impacts on the U.S. economy of changes in wait times at major Ports of Entry (POEs) due to changes in Customs and Border Protection (CBP) staffing, both increases and decreases. The impacts begin with changes in tourist and business travel expenditures and with changes in freight transportation costs. These changes, in turn, translate into ripple, or multiplier, effects in port regions and the overall U.S. economy. The total impacts of these changes are measured in terms of:

- Gross Domestic Product (GDP)
- Value of time (opportunity costs), and
- Employment, at both regional and national levels

Increases in economic indicators from reduced wait times stemming from the addition of CBP staff represent the benefits in a benefit-cost analysis.

The results are presented in Tables ES-1 for an additional CBP staff member (+1 case) at each of 17 major passenger land crossing POEs, 12 major freight crossing POEs, and 4 major passenger airport POEs, a total of 33 staff added. The POEs were selected by CBP as representing those most likely to be impacted by changes in staffing, and are listed in Table ES-2. In summary, the impacts on the U.S. economy as a whole for this increased staffing scenario of 33 additional primary inspection officers are in total and in terms of +1 staff changes:

- $65.8 million total increase in Gross Domestic Product (GDP) = $2 million per CBP staff added
- $21.2 million total in value of time savings = $640,000 per staff member added
- 1,094 annual jobs added = 33 jobs per CBP staff member added

The results in Tables ES-1 are for the U.S. only, and are presented separately for each of the listed components because they involve different estimating methods, data, assumptions, and stakeholder groups. This enables us to sum the appropriate results for the impacts on the U.S. economy separately from the impacts on other countries. Detailed results for individual ports, U.S. trade balance, and for industries impacted are presented in the main body of the report, as are impacts on the economies of Canada and Mexico.

The ratio of economy-wide employment gains to additional CBP staff might appear high at first, but is reasonable when placed in perspective. The ratio presented for CBP staffing changes is less like a standard industry multiplier for ordinary business activity and more like an action at a pressure point in the economy, in this case to alleviate a bottleneck. Hence, we would expect it to have a higher than average “multiplier.” The situation is more akin to investment analysis in critical facilities. For example, a recent congressional study evaluating FEMA hazard mitigation grants found a benefit-cost ratio of more than 100 for a few million dollars of investment in burying electric power lines underground to avoid hundreds of millions of dollars of business interruption losses from a major electricity outage caused by damage from severe storms.

The impact of a subtracting a CBP staff member (-1 case) at each of the 33 POEs naturally leads to a loss of GDP, loss of jobs and an increase in lost time value due to prolonged waiting. CBP staff is not necessarily optimally deployed at northern and some southern crossings in that officers from least congested hours cannot potentially be moved to the most congested hours without a change in the number of CBP officers. Also, even if infrastructure can accommodate an additional officer, it is not clear that a subtracted officer would be from the 8 least congested hours. Taking a mid-point perspective on this uncertainty, it is therefore reasonable to assume that -1 officer results are -1/2 of the +1 officer results.

TABLE ES-1. ECONOMIC IMPACTS OF DECREASES IN WAIT TIMES AT SELECTED U.S. LAND AND AIR PORTS OF ENTRY (+1 CBP Primary Inspection Officer at each POE, 33 CBP Officers total)

		GDP (million 2011$)	Value of time saved (million 2011$)	Employment (jobs)
Ground Passenger Travel	Value of lowered wait time for U.S. residents	n.a.	$17.0	n.a.
	Net impact on port region and U.S. GDP and employment	$61.8	n.a.	1,053
Air Passenger Travel	Value of lowered wait time for U.S. residents	n.a.	$4.2	n.a.
Truck Freight Transportation	Net impact on U.S. GDP and employment	$4.0	n.a.	41
TOTAL U.S.		**$65.8**	**$21.2**	**1,094**

n.a. – not applicable

TABLE ES-2. BORDER CROSSINGS

A. PASSENGER LAND CROSSINGS

Port	Crossing
Calexico	Calexico/East
	Calexico/West
El Paso	Ysleta
	Paso Del Norte
	Bridge of the Americas
Laredo	Lincoln-Juarez
	Convent St.
Nogales	Mariposa
	Deconcini
San Ysidro	San Ysidro
Buffalo-Niagara Falls	Rainbow Bridge
	Lewiston Bridge
	Peace Bridge
Blaine	Peace Arch
	Pacific Highway
Detroit	Windsor Tunnel
	Ambassador Bridge

B. TRUCK LAND BORDER CROSSINGS

Port	Crossing
Southern Border	
Calexico	Calexico/East
El Paso	Ysleta
	Bridge of the Americas
Laredo	Columbia Solidarity
	World Trade Bridge
Nogales	Mariposa
Otay Mesa	Otay Mesa
Northern Border	
Blaine	Pacific Highway
Buffalo-Niagara Falls	Lewiston Bridge
	Peace Bridge
Detroit	Windsor Tunnel
	Ambassador Bridge

C. AIRPORTS

Airport Sites
ORD
JFK
LAX
MIA

Most of the economic gains and losses from CBP staffing changes will accrue to the regions surrounding the POEs. For example, adding one CBP officer at each of the 17 passenger land crossings is projected to lead to an increase in GDP of $61.8 million and employment gains of 1,053 jobs in the U.S. as a whole. However, 80% of the GDP gains and 94% of employment gains are captured by the POE regions alone. The regional gains are a relatively high proportion despite the fact that the multiplier values are higher for national impacts. The main reason for this outcome is the diversion of some spending to other countries stemming from the increased attractiveness of foreign travel to U.S. residents from decreased wait times. This subtraction to yield net impacts is nationwide and not just limited to the POE regions.

The POEs examined in this study were selected on the basis of:

- Review of CBP workload, diverse environments, ports constantly in the forefront of wait-time issues, and the bulk of major crossings, accounting for nearly 80% of the total wait time for land crossings
- Balanced distribution of Northern and Southern POEs
- Large volumes of passenger and freight
- Repeated challenges of staffing vs. wait times
- Small ports likely to have minor impacts were omitted

ES.2 METHODOLOGY OVERVIEW

This study has established analytical methodologies, shown in Figure ES-1 and discussed in detail in the main report that, with further development and additional necessary data, can be used to support decision-making on optimal staffing deployment and investment in infrastructure and technology, analysis of port resources and their impact on risks and law enforcement outcomes, and development of simulation models for ports of entry.

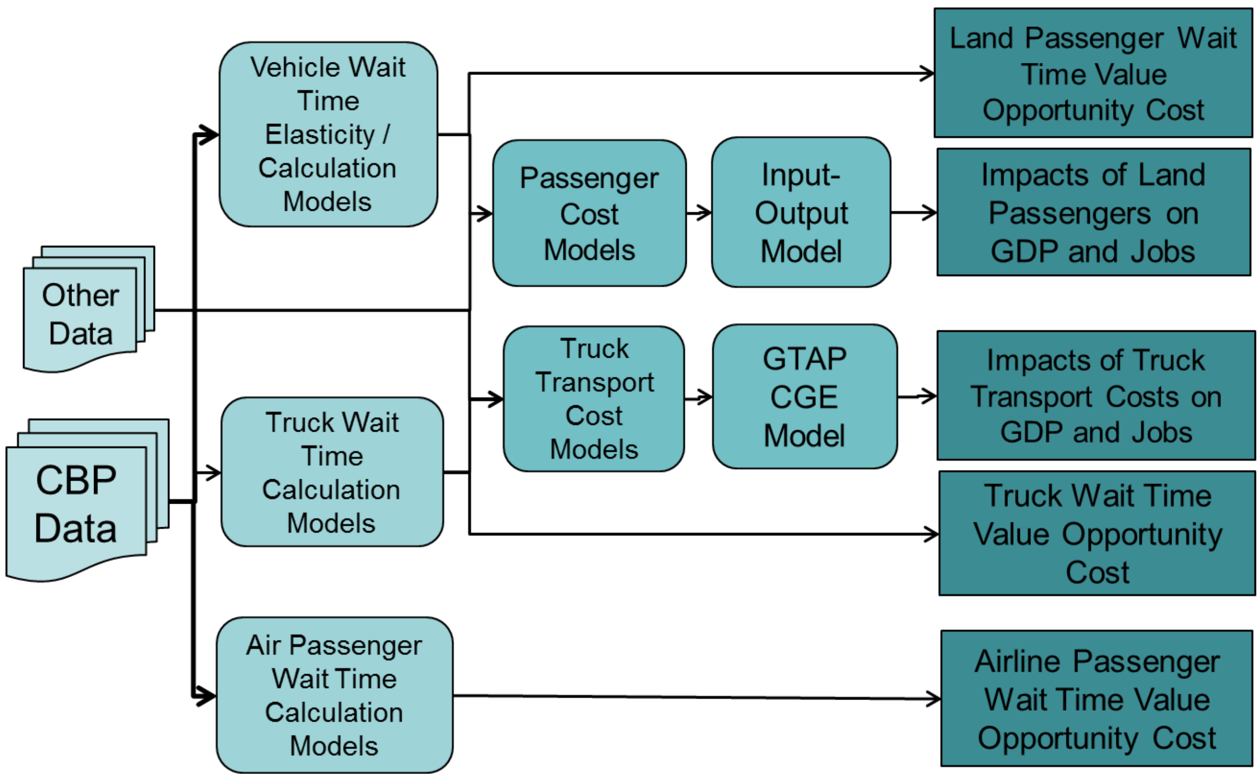

Figure ES-1. Economic Impact Calculation Components and Methods

The economic impacts were traced through an analysis of how a change in staffing affects wait times and hence freight transportation costs and travel demand of both businesses and travelers. On the freight side, the analysis begins with consideration of changes in transportation costs and how this affects international trade competitiveness and the macroeconomy of the U.S. economy in terms of output and jobs. On the passenger side, the analysis begins with changes in the number of tourism and business travels into the U.S. and how this affects the associated travel spending and the macroeconomy of the port region and U.S. economies. The value of wait time itself for individual travelers and truck drivers does not show up in the formal national income accounts, but was inferred by estimating the opportunity cost of their time.

Operations research and economic analysis methods were used to translate changes in security expenditures into changes in wait times and then to business transportation costs and to the value of an individual's time. We utilized a computable general equilibrium (CGE) model to analyze competiveness and macroeconomic impacts for the U.S. CGE is considered the state-of-the-art approach to analyzing such issues as international trade policy and macroeconomic impact analysis. We used an input-output (I-O) analysis approach to estimate the impacts of changes in passenger vehicle travel demand on the port region economies and the economy of the U.S. as a whole. I-O is a less sophisticated approach than CGE but is adequate to the task at hand because of the absence of price changes and competitiveness effects associated with changes in passenger travel expenditures.

ES.2.1 MICROECONOMIC AND OPERATIONS RESEARCH ANALYSES

In the first step of this study, the microeconomic analysis at the level of individual POEs was completed primarily with the use of CBP data and operations research and economic analysis methods. Two key parameters are needed: the degree to which wait time falls (or rises) as extra processing capacity (e.g., number of primary inspection booths) is increased (or decreased), and the degree to which passenger vehicle traffic increases (or decreases) at a border crossing as wait time falls (or rises). We take two approaches to quantify the first parameter. First, we quantify the impact on wait time of a staffing experiment at the San Ysidro POE in July 2012 that substantially increased processing capacity by staffing primary booths with more CBP officers to test the impact on staffing on wait times.[1] Second, we develop a methodology based on queuing theory that can be applied to any POE. The outcomes of the July experiment at San Ysidro are consistent with what would have been predicted using this methodology, in part validating the developed methodology. We also use the July experiment at San Ysidro to quantify the degree to which passenger vehicle traffic *increases* as wait time falls, and we found that a significant rebound effect of this type did take place. The size of this increase is consistent with estimates in the literature of the impact of travel time on passenger vehicle trip demand.

The changes in wait times are translated into the dollar value of lost time to passengers. They are also converted into an estimate of the changes in passenger vehicle traffic via an elasticity of vehicle trips to wait time and then in turn into changes in tourist and business travel expenditures on the basis of average per person-visit spending by Canadian and Mexican visitors to the U.S. (elasticity refers to the mathematical relationship between changes in vehicle trips and changes in wait time). Note that we measure only the impact on the U.S. economy, i.e., only changes in traffic by foreign visitors entering the country. However, we did take into consideration the offsetting effects of changes in domestic

[1] The controlled experiment ran from 4 pm on the afternoon of Friday July 20, 2012 to 6:30 am on the morning of Monday July 23, 2012 and during which the number of booths open was increased significantly. This increase was in addition to any natural increase or decrease associated with normal management of the crossing. See discussion and graphs in appendix 2A for more details.

spending by the Americans when they increase or decrease their travels to Canada or Mexico because of the reduction or increasing of border crossing wait time.

A logistical analysis of the inspection process is then used to estimate the effect of explicit transportation costs (e.g., customs broker fees and trucker fees), other out-of-pockets (e.g., increased purchases), and implicit spillover costs (e.g., the value of lost time). These various costs are estimated using data from the literature, combined with information from interviews with personnel at CBP, customs broker firms, and trucking carriers. Estimates of the rate at which carriers value their time are available in the literature, along with information related to the logistics of how fright moves through the border. Interviews with subject matter experts (e.g., customs brokers) were then used to fill in any data gaps. And because of the many significant uncertainties in the specification of the transportation-related costs, sensitivity analysis is used to explore the implications of changes to significant input variables.

ES.2.2 MACROECONOMIC ANALYSIS

For the macroeconomic analysis, we first used an input-output (I-O) analysis approach to the evaluation of the regional and national impacts of changes in tourist and business spending associated with the changes in wait times. I-O characterizes the economy as a set of integrated, linear supply chains. It is the most frequently used tool of economic impact analysis at the regional level. The empirical version of the I-O models was obtained from the Impact Analysis for Planning (IMPLAN) System, the most widely used source of I-O tables and related data.

The methodology involves translating additional or reduced passenger vehicle traffic into estimates of increased or decreased numbers of Canadian and Mexican travelers, and then translating their direct spending into individual product and service categories ranging from restaurants to hotels. The I-O model then translates this direct stimulus into total economic activity by computing all of the rounds of supply-chain effects. The sum total is a multiple of the direct stimulus; hence, the term "multiplier" effect. .

A similar approach is applied to analyzing the national economic impacts of travel spending by foreigners, but, in this case, the stimulus is to the economy of the entire U.S. The multiplier for most goods and services at the regional level is only about 1.5 to 2.0 because of relatively large spending on imports in these smaller, relatively less self-sufficient economies. That is, any spending on imported goods along the supply-chain (from foreign countries or from the rest of the U.S.) at the regional level represents a permanent leakage from the spending stream, so that it does not generate any further stimulus to the regional economy. The multipliers for goods and services in the U.S. economy as a whole are on the order of 3 to 4 because leakages are limited to foreign imports. Hence, the national economic impacts of decreasing wait times at any one border crossing are about twice the size of any regional impacts because the multiplier is twice as high at the national level.

The impacts of changes in wait times on freight transportation are estimated with the use of a computable general equilibrium (CGE) model. This refers to a multi-market model of behavioral responses of individual producers and consumers to price signals within the limits of available labor, capital and natural resources. CGE is a state-of-the-art approach to economic consequence analysis. It overcomes the major limitations of I-O because it allows for non-linearities such as input substitution, has behavioral content, and provides an explicit role for prices and markets.

We utilize the Global Trade Analysis Project (GTAP) CGE model. GTAP was developed in conjunction with the U.S. International Trade Commission (ITC) and the World Trade Organization (WTO) and is the most widely used international CGE model today. The model consists of 129 countries each comprised of 57 industry commodity groupings, and incorporates the import/export trade linkages between them.

In the second part of the macroeconomic analysis, the more sophisticated CGE approach is necessitated by the complexities of international trade. Changes in wait times translate into changes in transportation costs, which, in turn, translate into changes in relative competitiveness of U.S. imports and exports. Ironically, reduced wait times of goods entering the U.S. make them relatively cheaper and spur U.S. imports. This has the effect of advantaging Canada and Mexico relatively more than the U.S. at first. However, the vast majority of the imports are unfinished (intermediate) goods, i.e., goods used in the production of finished (final, or consumer) goods. Hence, they have the effect of lowering the cost of production in the U.S. and making our exports, not only to Canada and Mexico but to all countries, more competitive. This stimulates U.S. exports worldwide and causes an increase in U.S. GDP, personal income, and employment. The extent to which the negative effect of increased import competitiveness for our major trading partners is offset by the effect of increased U.S. export competitiveness requires the use of a sophisticated model.

ES.3 IMPORTANT CAVEATS AND LIMITATIONS

It is important to note that the microeconomic and operations research analyses are subject to several caveats and limitations, which can be addressed in future research, regarding the range of impacts that are included and how our results can be used, including:

- We quantify the impact on wait time of adding or subtracting one officer at each of the 33 primary inspection sites included in the study. Our results thus pertain only for adding or subtracting these officers at these sites. Also, using the average per-officer impact results calculated in this study to estimate the impacts of a given increase or decrease in CBP staff greater or less than +33 or -33 officers, respectively, is subject to important limitations. First, the relationship between the change in officers and wait time is not linear and is also not symmetric for additions and subtractions. Multiplying average impact values based on +1 officer scenarios by an increase in staff by more than +1 at various crossings will lead to an overestimate of true impact values because of diminishing returns; and multiplying average impact values based on -1 officer scenarios by an decrease in staff by more than -1 at various crossings will lead to an underestimate in the case of subtracting officers.[2] The only way to measure exact impact values is to actually analyze how wait time changes at crossings when more than 1 officer is added or subtracted. The degree of overestimate or underestimate might be small initially, but it will grow as the number of officers added or subtracted increases. Second, how large increments or reductions in CBP staff at ports of entry affect wait time requires a careful description of how staff changes impact the number of officers provided to primary inspection, secondary inspection, and other duties. CBP must decide how a given change in staff at a crossing will be allocated to these different functions;
- All results obtained in this study are based on the assumption that the number of cross-border trips equals their FY 2012 levels. In particular, it is assumed that the number of passenger and commercial vehicles entering the U.S. across land border crossings, and the number of international flight passenger arrivals at U.S. airports, do not rise or fall due to factors such as continued economic recovery, change in gasoline price, and other determinants of travel volumes. If volumes

[2] Consider adding officers to a particular border crossing. The first additional officer will reduce wait time the most, because the officer will be assigned to the most congested hours of the day. The second additional officer will reduce wait time somewhat less, because the most congested hours of the day that this officer will be assigned to will have somewhat lower wait time due to the addition of the first officer. The third additional officer will reduce wait time by less than the second additional officer, and so on for successive additional officers. At some point, adding an extra officer will make wait time equal zero for all hours of all days, and adding any officers past this point will have no impact on wait time.

rise above FY 2012 levels, then our results underestimate the economic impacts of wait time, and if they fall below FY 2012 levels, they overestimate these impacts;

- Although we quantify how the number of passenger vehicle trips at a land border crossing changes in response to change in wait time, we do not quantify how the number of international air trips changes in response to wait time. A longer or shorter wait at passport inspection sites at international airports may deter or encourage more international travelers to visit the U.S., and more US residents to travel abroad;
- We do not quantify how increased passport inspection capacity at an airport might increase the flight processing capacity of the airport, and thus the scheduling of new flights. This is a complex analytical challenge that is beyond the scope of this study;
- We do not quantify the formation of new businesses or closing of existing businesses in the border region if wait time falls or rises, respectively. Change in wait time for commercial vehicles may encourage or discourage business formation. This is quite apart from the increase and decrease of business activity that we do measure; we are just not able to predict whether an increase, for example, stems from the expansion of existing businesses or the formation of new ones;
- We do not quantify the impact of lower wait time on cross-border supply chain productivity by, for example, reducing the need to hold inventories, or by capturing or losing economies of scale. Improved supply chain performance would reduce total costs of production.

Note the following caveats and limitations regarding the macroeconomic results:

- Our regional macroeconomic impact analysis of passenger vehicle activity is undertaken by a linear model. The macroeconomic impacts of expenditures on business and personal travel is reasonably linear over the broad range of increases or decreases in economic activity likely to arise from changes in POE staffing. However, the direct change in the number of passengers is non-linear, as noted in the previous sub-section. Hence, the product of the two numbers is non-linear as well.
- Our national and international macroeconomic impact analysis of passenger vehicle and freight activity is undertaken using a non-linear model. However, we have evaluated them only at the level of unit changes in staffing and cannot draw any inferences about the shape of the non-linarites of larger staffing changes. Moreover, the overall impacts at these levels are also the product of these macroeconomic effects and the microeconomic impacts of staffing changes, as is the case with the regional economic impacts.

ES.4 DATA

Data were obtained from CBP, other government sources, businesses, and consultants, on wait times, freight and passenger volume, tourist and business travel spending, and transportation costs. This was supplemented by a synthesis of the existing peer-reviewed literature on the topic.

We analyzed the economic impacts of changes in wait times at major land and air POEs. These include thirteen crossings at six major land ports along the southern border of the U.S. and seven crossings at three major land ports along the northern border, as well as four major airports. A majority of the land crossings process both passenger vehicles and commercial vehicles. Pedestrian crossings and their economic impacts are not analyzed in this study.

Data from CBP consist of passenger vehicle, commercial vehicle and airport statistics for all land border crossings, passenger and commercial vehicles and international airports in the U.S. The passenger vehicle data set is from fiscal year 2010 through 2012 for each of 3 lane types and 2 results from primary inspection. The data set consists of hourly observations of vehicles, passengers, wait time and other variables. We limited our analysis to regular lanes because wait times for READY and SENTRI/NEXUS lanes were already at or near zero for most hours. Data for commercial vehicles came in two sets, also for fiscal year 2010 through 2012 and were matched by hourly observations. Because the commercial vehicle data sets do not distinguish the total number of trips for regular lanes and FAST lanes, we chose to focus on regular lane wait times, used the total number of trips and lanes as a proxy for the number of regular lane trips and regular lanes open. Finally, airport data consists of observations by flight, with data for the number of passengers, wait time, booths open, and other information. Nearly all of the macroeconomic data used was incorporated into the IMPLAN I-O models and the GTAP CGE Model.

ES.5 INNOVATIONS OF THIS STUDY

This study differs from and improves on previous similar studies in a number of important aspects:

- First study to use integrated CBP data, correlate it to wait times, and analyze the extended relationship to economic impact
- Corroborated CBP data with other available, peer-reviewed data
- Developed comprehensive models of impact of wait times on truck freight costs
- Used advanced economic models of greater sophistication than previous studies
- CGE-based GTAP model enabled study of national and international stimulus and competitiveness impacts for all commodities
- Developed approach that can be applied at any other port
- Provided an independent analysis
- Demonstrated value of operations research analysis for CBP operations

ES.6 RECOMMENDATIONS FOR FOLLOW-ON EFFORTS

Notwithstanding the rigor of the current effort, additional activities could be undertaken to improve the range of applicability of the results and increase the robustness of the models. These include:

(a) Develop the analytical model used to derive wait time-officer elasticities more fully to address the linearity of the extrapolation of the results
(b) Based on results of (a), select a few border crossings and develop a complete relationship between number of officers and wait time levels. This will give greater insight into how results can best be extrapolated to +N/-N scenarios
(c) Expand the air travel component to factor in deterrence of long wait time, for example, developing better wait time-officer elasticity estimates by fully developing the analytical model on which they are based, specifically by using all data related to clustered flights, analyzing the value of additional/increased flights at off-hours, and developing the deterrence model
(d) Examining the observed risk/security vs. wait time results and analysis to account for CBP's established wait-time-based procedures, such as suspending certain operations and exercising certain steps subject to the discretion of the POE's operating procedures, and associated risk analysis studies related to the effect of lower wait times on security
(e) Further improve the freight impact estimates

Additional efforts beyond the current study could include:

- Economic impact analysis of changes in border infrastructure in terms of rate of return on investment for introducing new technologies
- Quantification of the marginal benefits and costs of adding or subtracting more than one primary inspection officer at a crossing, with an emphasis on testing for non-linearities. Optimization analysis of staff deployment at each crossing by hour and day.
- Optimization analysis of staff deployment across crossings.
- Evaluation of staffing requirements to achieve a standard of wait time not to exceed 30 minutes

- Controlled experiments at border crossings to provide more extensive results on wait time-booth and trip demand elasticities
- More formal analysis of the July 2012 experiment at San Ysidro
- Completion of the methodology for analyzing processing of air travelers in terms of all flights in a cluster, intermingling of passengers from different flights in a queue, etc.
- Study of the relationship between congestion, staffing, and enforcement outcomes
- Development of a simulation model that CBP can use to analyze scenarios involving changes in staffing levels, traffic levels, etc.

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CHAPTER 1. OVERVIEW

by

Adam Rose

I. INTRODUCTION

Inspection of people and vehicles at U.S. border crossings are vital to homeland security. The benefits of these activities are the avoided losses in terms of lives, property and economic activity resulting from a terrorist attack. At the same time, inspections incur various types of cost. Their construction and operation is a significant federal expenditure. Moreover, inspections generate various spillover effects relating to the delays in the flows of passengers and cargo across U.S. borders. On the passenger side, they decrease the amount of tourism and business travel into the Country, and thus an associated loss of spending stimulus. Those people that do make the trip incur delays that cost them time. On the freight side, delays translate into increases in various explicit transportation costs, such as additional fuel, as well as implicit costs such as the value of lost time. Reducing wait times at Ports of Entry (POEs), through the addition of CBP officers, will reduce these negative spillover effects, though it will at the same time incur additional demands on the federal budget.

This study estimates the macroeconomic impacts on the U.S. economy of changes in wait times at major border crossings. In addition to the changes in the direct spillover costs previously noted, it also examines various types of economic ripple effects of changed wait times. These include multiplier effects from tourist and business travel expenditures, which are about 1.5 and 2 times the direct stimulus at the regional and 3 to 4 times the direct stimulus at the national level. It also includes freight cost general equilibrium effects, which refer to complex interactions in relation to competitive changes in imports and exports of intermediate (unfinished) and final (finished) goods.

The analysis is based on extensive primary data provided by U.S. Customs and Border Protection (CBP), federal government publications, commercial vendors, and the professional literature on the topic. The study applies state of the art tools, such as queuing theory, econometric, and general equilibrium analysis where the data are extensive and the issues are complex, as well as more practical tools, such as input-output analysis, where the subject of inquiry is less demanding. Given the short-time frame of the study, results should be considered indicative rather than definitive.

II. METHODOLOGICAL OVERVIEW

A. Microeconomic level analysis

The analysis at the level of individual POEs was completed primarily with the use of CBP data and operations research and economic analysis methods. Two key parameters are needed: the degree to which wait time falls (or rises) as extra processing capacity (e.g., number of primary inspection booths) is increased (or decreased), and the degree to which passenger vehicle traffic increases (or decreases) at a border crossing as wait time falls (or rises). We take two approaches to quantify the first parameter. First, we quantify the impact on wait time of a staffing experiment at the San Ysidro POE in July 2012 that substantially increased processing capacity by staffing primary booths with more CBP officers to test the impact on staffing on wait times.[3] Second, we develop a methodology based on queuing theory that can be applied to any POE. The outcomes of the July experiment at San Ysidro are consistent with what would have been predicted using this methodology, thereby, in part, validating the developed methodology. We also use the July experiment at San Ysidro to quantify the degree to which passenger vehicle traffic *increases* as wait time falls, and we found that a significant rebound effect of this type did take place. The size of this increase is consistent with estimates in the literature of the impact of travel time on passenger vehicle trip demand.

The changes in wait times are translated into the dollar value of lost time to passengers. They are also converted into an estimate of the changes in passenger vehicle traffic via an elasticity of vehicle trips to wait time and then in turn into changes in tourist and business travel expenditures on the basis of average per person-visit spending by Canadian and Mexican visitors to the U.S. (elasticity refers to the mathematical relationship between changes in vehicle trips and changes in wait time). Note that we measure only the impact on the U.S. economy, i.e., only changes in traffic by foreign visitors entering the country. However, we did take into consideration the offsetting effects of changes in domestic spending by the Americans when they increase or decrease their travels to Canada or Mexico because of the reduction or increasing of border crossing wait time.

A logistical analysis of the inspection process is then used to estimate the effect of explicit transportation costs (e.g., customs broker fees and trucker fees), other out-of-pockets (e.g., increased purchases), and implicit spillover costs (e.g., the value of lost time). These various costs are estimated using data from the literature, combined with information from interviews with personnel at CBP, customs broker firms, and trucking carriers. Estimates of the rate at which carriers value their time are available in the literature (e.g., NCHRP, 1999), along with information related to the logistics of how fright moves through the border. Interviews with subject matter experts (e.g., customs brokers) were then used to fill in any data gaps. And because of the many significant uncertainties in the specification of the transportation-related costs, sensitivity analysis is used to explore the implications of changes to significant input variables.

It is important to note that our analysis is subject to several caveats and limitations, which can be addressed in future research, regarding the range of impacts that are included and how our results can be used, including:

- We quantify the impact on wait time of adding or subtracting one officer at each of the 33 primary inspection sites included in the study. Our results thus pertain only for adding or subtracting these officers at these sites. Also, using the average per-officer impact results calculated in this study to estimate the impacts of a given increase or decrease in CBP staff greater or less than +33 or -33 officers, respectively, is subject to important limitations. First, the relationship between the change in officers and wait time is not linear and is also not symmetric for additions and subtractions. Multiplying average impact values based on +1 officer scenarios by an increase in staff by more than +1 at various crossings will lead to an overestimate of true impact values; and multiplying average impact values based on -1 officer scenarios by an decrease in staff by more than -1 at various

[3] The controlled experiment ran from 4 pm on the afternoon of Friday July 20, 2012 to 6:30 am on the morning of Monday July 23, 2012 and during which the number of booths open was increased significantly. This increase was in addition to any natural increase or decrease associated with normal management of the crossing. See discussion and graphs in appendix 2A for more details.

crossings will lead to an underestimate in the case of subtracting officers.[4] The only way to measure exact impact values is to actually analyze how wait time changes at crossings when more than 1 officer is added or subtracted. The degree of overestimate or underestimate might be small initially, but it will grow as the number of officers added or subtracted increases. Second, how large increments or reductions in CBP staff at ports of entry affect wait time requires a careful description of how staff changes impact the number of officers provided to primary inspection, secondary inspection, and other duties. CBP must decide how a given change in staff at a crossing will be allocated to these different functions;

- All results obtained in this study are based on the assumption that the numbers of cross-border trips equal their FY 2012 levels. In particular, it is assumed that the number of passenger and commercial vehicles entering the U.S. across land border crossings, and the number of international flight passenger arrivals at U.S. airports, do not rise or fall due to factors such as continued economic recovery, change in gasoline price, and other determinants of travel volumes. If volumes rise above FY 2012 levels, then our results underestimate the economic impacts of wait time, and if they fall below FY 2012 levels, they overestimate these impacts;
- Although we quantify how the number of passenger vehicle trips at a land border crossing changes in response to changes in wait time, we do not quantify how the number of international air trips changes in response to wait time. A longer or shorter wait at passport inspection sites at international airports may deter or encourage more international travelers to visit the U.S., and US residents to travel abroad, but we do not have adequate data to evaluate this consideration at this time;
- We do not quantify how increased passport inspection capacity at an airport might increase the flight processing capacity of the airport, and thus the scheduling of new flights. This is a complex analytical challenge that is beyond the scope of this study;
- We do not quantify the formation of new businesses or closing of existing businesses in the border region if wait time falls or rises, respectively. Change in wait time for commercial vehicles may encourage or discourage business formation. This is quite apart from the increase and decrease of business activity that we do measure; we are just not able to predict whether an increase, for example, stems from the expansion of existing businesses or the formation of new ones;
- We do not quantify the impact of lower wait time on cross-border supply chain productivity by, for example, reducing the need to hold inventories, or by capturing or losing economies of scale. Improved supply chain performance would reduce total costs of production.

B. Macroeconomic Analysis

We used an input-output (I-O) analysis approach to the evaluation of the regional and national impacts of changes in tourist and business spending associated with the changes in wait times. I-O models the economy as a set of integrated, linear supply chains (Rose and Miernyk, 1989). I-O was developed by Nobel laureate Wassily Leontief and is the most frequently used tool of economic impact analysis at the regional level (Miller and Blair, 2009).

[4] Consider adding officers to a particular border crossing. The first additional officer will reduce wait time the most, because the officer will be assigned to the most congested hours of the day. The second additional officer will reduce wait time somewhat less, because the most congested hours of the day that this officer will be assigned to will have somewhat lower wait time due to the addition of the first officer. The third additional officer will reduce wait time by less than the second additional officer, and so on for successive additional officers. At some point, adding an extra officer will make wait time equal zero for all hours of all days, and adding any officers past this point will have no impact on wait time.

The methodology involves translating additional or reduced passenger vehicle traffic into estimates of increased or decreased numbers of Canadian and Mexican travelers, and then translating their direct spending into individual product and service categories ranging from restaurants to hotels. The I-O model then translates this direct stimulus into total economic activity by computing all of the rounds of supply-chain effects. The sum total is a multiple of the direct stimulus; hence, the term "multiplier" effect. We limit our analysis to demand-side, or upstream linkage, effects of suppliers to hotels, restaurants, etc. Supply-side, or downstream, linkages are not applicable to the final goods and service associated with consumer expenditures, because they are "final", i.e. require no further processing.

A similar approach is applied to analyzing the national economic impacts of travel spending by foreigners, but, in this case, the stimulus is to the economy of the entire U.S. The multiplier for most goods and services at the regional level is only about 1.5 to 2.0 because of relatively large spending import from these smaller, relatively less self-sufficient economies. That is, any spending on imported goods along the supply-chain (from foreign countries or from the rest of the U.S.) at the regional level represents a permanent leakage from the spending stream, so that it does not generate any further stimulus to the regional economy. The multipliers for goods and services in the U.S. economy as a whole are on the order of 3 to 4 because leakages are limited to foreign imports. Hence, the national economic impacts of decreasing wait times at any one border crossing are about twice the size of any regional impacts because the multiplier is twice as high at the national level.

The empirical version of the I-O models we used was obtained from the Impact Analysis for Planning (IMPLAN) System (MIG, 2012). This system consists of an extensive economic database, algorithms for generating I-O models for any county or county group, and algorithms for performing impact analysis. IMPLAN is the most widely used source of I-O tables and related data.

The impacts of changes in wait times on freight transportation are estimated with the use of a computable general equilibrium (CGE) model. This refers to a multi-market model of behavioral responses of individual producers and consumers to price signals within the limits of available labor, capital, natural resources (Rose, 1996). CGE is a state-of-the-art approach to economic consequence analysis. It overcomes the major limitations of I-O because it allows for non-linearities such as input substitution, has behavioral content, and provides an explicit role for prices and markets (Dixon and Rimmer, 2002).

The more sophisticated CGE approach is necessitated by the complexities of international trade. Changes in wait times translate into changes in transportation costs, which, in turn, translate into changes in relative competitiveness of U.S. imports and exports. Ironically, reduced wait times of goods entering the U.S. make them relatively cheaper and spur U.S. imports. This has the effect of advantaging Canada and Mexico relatively more than the U.S. at first. However, the vast majority of the imports are unfinished (intermediate) goods, i.e., goods used in the production of finished (final, or consumer) goods. Hence, they have the effect of lowering the cost of production in the U.S. and making our exports, not only to Canada and Mexico but to all countries, more competitive. This stimulates U.S. exports worldwide and causes an increase in U.S. GDP, personal income, and employment. The extent to which the negative effect of increased import competitiveness for our major trading partners is offset by the effect of increased U.S. export competitiveness requires the use of a sophisticated model.

We utilize the Global Trade Analysis Project (GTAP, 2012) CGE model. GTAP was developed in conjunction with the U.S. International Trade Commission (ITC) and the World Trade Organization

(WTO) and is the most widely used international CGE model today. The model consists of 129 countries each comprised of 57 industry commodity groupings, and incorporates the import/export trade linkages between them.

Note the following caveats and limitations regarding the macroeconomic results:

- Our regional macroeconomic impact analysis of passenger vehicle activity is undertaken by a linear model. The macroeconomic impacts of expenditures on business and personal travel is reasonably linear over the broad range of increases or decreases in economic activity likely to arise from changes in POE staffing. However, the direct change in the number of passengers is non-linear, as noted in the previous sub-section. Hence, the product of the two numbers is non-linear as well.
- Our national and international macroeconomic impact analysis of passenger vehicle and freight activity is undertaken using a non-linear model. However, we have evaluated them only at the level of unit changes in staffing and cannot draw any inferences about the shape of the non-linarites of larger staffing changes. Moreover, the overall impacts at these levels are also the product of these macroeconomic effects and the microeconomic impacts of staffing changes, as is the case with the regional economic impacts.

III. DATA

Data were obtained from CBP, other government sources, businesses, and consultants, on wait times, freight and passenger volume, tourist and business travel spending, and transportation costs.

We analyzed the economic impacts of changes in wait times at major land and air POEs. These include thirteen crossings at six major land ports along the southern border of the U.S. and seven crossings at three major land ports along the northern border, as well as four major airports. A majority of the land crossings process both passenger vehicles and commercial vehicles. Pedestrian crossings and their economic impacts are not analyzed in this study.

Data from CBP consist of passenger vehicle, commercial vehicle and airport statistics for all land border crossings, passenger and commercial vehicles and international airports in the U.S. The passenger vehicle data set is from fiscal year 2010 through 2012 for each of 3 lane types and 2 results from primary inspection. The data set consists of hourly observations of vehicles, passengers, wait time and other variables. We limited our analysis to regular lanes because wait times for READY and SENTRI/NEXUS lanes were already at or near zero for most hours. Data for commercial vehicles came in two sets, also for fiscal year 2010 through 2012 and were matched by hourly observations. Because the commercial vehicle data sets do not distinguish the total number of trips for regular lanes and FAST lanes, we chose to focus on regular lane wait times, used the total number of trips and lanes as a proxy for the number of regular lane trips and regular lanes open. Finally, airport data consists of observations by flight, with data for the number of passengers, wait time, booths open, and other information. Nearly all of the macroeconomic data used was incorporated into the IMPLAN I-O models and the GTAP CGE Model.

IV. ESTIMATES OF WAIT TIME CHANGES

For land border crossings and airports, we develop estimates of how wait time changes with the addition of an extra primary inspection booth manned by one officer. These estimates are based on mathematical analysis of the relationship between wait time and processing capacity for a border crossing at which a queue has built up and wait time is greater than zero. We assume that an additional officer adds an additional inspection booth to a crossing for eight hours of the day in 153 days of the year. This number of days accounts for the yearly-averaged time an inspection officer is assigned to other duties, such as training, which is not directly related to inspection at a queue. We also assume that the additional officer is deployed to the eight hours of the day when a crossing is most congested with traffic and wait times are the longest. Our estimates of how wait time changes with the addition of one booth reflect these assumptions. Finally, we assume that a crossing's infrastructure can physically support deployment of an additional booth.

Table 1-1 below presents the average wait time at 17 passenger land border crossings across all hours in FY 2012 for three types of lanes: regular, READY, and SENTRI/NEXUS. Crossings on the southern border generally have significantly higher average wait times than crossings on the northern border, with the San Ysidro crossing having the highest average wait times.

Table 1-2 presents results for how wait time changes in percentage terms with the addition of one officer in the eight most congested hours of the day, and also the subtraction of one officer in the eight least congested hours of the day, and the eight most congested hours of the day. In the case of adding one officer, there is a correlation between the percentage change in wait time and the level of the wait time, with more congested crossings with longer average wait times seeing smaller percentage falls. The percentage changes in wait times must be combined both with the corresponding actual wait times and with the corresponding throughput volumes to obtain the overall impact of all the crossings and their contribution to the overall value of an officer. Analysis also revealed that it would always be optimal to deploy an extra officer at a crossing to regular lanes rather than READY or SENTRI/NEXUS lanes, so we only consider adding an officer to regular lanes in all scenarios.

Table 1-3 presents average wait times in passport control queues for U.S. citizens (USC), U.S. legal permanent residents (LPR), and non-immigrant foreign nationals (NIM) at 15 inspection sites in four airports. Average wait times are lowest for U.S. citizens, higher for legal permanent residents, and highest for non-immigrant foreign nationals. Estimates of percentage change in wait time after the addition of an inspection booth are also given. As in the case of land border crossings, these estimates show change in wait time for the eight most congested hours of the day.

TABLE 1-1. AVERAGE WAIT FOR PASSENGER VEHICLES AT LAND BORDER CROSSINGS

		Average wait time per vehicle in minutes in FY 2012		
	Lane Type	**Regular**	**READY**	**SENTRI/ NEXUS**
Port	**Crossing**			
Calexico	Calexico/East	41	16	1
	Calexico/West	48		4
El Paso	Ysleta	26	8	2
	Paso Del Norte	28	11	

	Bridge of the Americas	33	14	
Laredo	Lincoln-Juarez	23	22	1
	Convent St.	21		
Nogales	Mariposa	20		
	Deconcini	23	3	0
San Ysidro	San Ysidro	74	47	7
Buffalo-Niagara Falls	Rainbow Bridge	7		0
	Lewiston Bridge	14		
	Peace Bridge	7	0	1
Blaine	Peace Arch	18	1	3
	Pacific Highway	17		2
Detroit	Windsor Tunnel	5		4
	Ambassador Bridge	4	2	4

TABLE 1-2. WAIT TIME-OFFICER ELASTICITIES FOR PASSENGER VEHICLES AT LAND BORDER CROSSINGS

	Time Period	**FY 2012**		
	Lane Type	**Regular**		
	Officers Added	**+1**	**-1**	**-1**
	Targeted 8 hours	**Most congested**	**Least congested**	**Most congested**
Port	**Crossing**			
Calexico	Calexico/East	-35%	74%	64%
	Calexico/West	-16%	35%	21%
El Paso	Ysleta	-37%	252%	62%
	Paso Del Norte	-37%	252%	60%
	Bridge of the Americas	-31%	176%	24%
Laredo	Lincoln-Juarez	-28%	76%	37%
	Convent St.	-48%	70%	82%
Nogales	Mariposa	-55%	N/A	91%
	Deconcini	-46%	170%	89%
San Ysidro	San Ysidro	-8%	25%	10%
Buffalo-Niagara Falls	Rainbow Bridge	-33%	4%	45%
	Lewiston Bridge	-38%	13%	54%
	Peace Bridge	-39%	30%	55%
Blaine	Peace Arch	-49%	6%	76%
	Pacific Highway	-62%	54%	109%
Detroit	Windsor Tunnel	-73%	44%	96%
	Ambassador Bridge	-63%	25%	82%

TABLE 1-3. WAIT TIME-OFFICER ELASTICITIES AND AVERAGE WAIT TIMES AT AIRPORT INSPECTION SITES

	Wait Time-Officer Elasticity: 8 Most Congested Hours in FY 2012	**Average Wait Time in Minutes in FY 2012**		
Airport Site	+1 Officer	US Citizens	US Immigrants	Non-Immigrant Foreign Nationals
Chicago (ORD)	-4.7%	17.3	21.7	33.8
JFK				
American	-5.7%	16.4	24.5	39.6
British	-7.6%	14.3	24.8	34.0
Delta	-6.4%	21.9	27.1	38.6
Terminal 1	-4.9%	18.2	23.9	43.6
Terminal 4	-3.5%	22.3	28.9	38.8
LAX				
Satellite 2	-6.6%	15.3	18.5	28.1
Satellite 5	-9.4%	14.9	22.4	31.2
Satellite 7	-9.2%	12.7	16.5	28.1
Terminal 4	-13.7%	13.8	17.7	27.2
Tom Bradley	-3.1%	13.0	18.8	24.2
MIA				
Central Terminal	-2.7%	16.0	21.9	32.7
General Aviation	-100.0%	5.5	4.0	5.7
South Terminal	-5.7%	15.9	17.9	33.5
North Terminal	-2.4%	17.1	24.4	33.5

V. RESULTS

Simulations were run for both an increase and decrease in CBP staffing at key border sites. The basic units of analysis are: +1 and -1 CBP staff, each working eight hours per day and 153 days of the year. The results of the analysis are presented in the tables below in the following categories:

1. Ground passenger travel
   a. Value of time for U.S. residents
   b. Value of time for Canadian and Mexican residents
   c. Net impact on port region and U.S. GDP and employment

2. Air passenger travel
   a. Value of time for U.S. residents
   b. Value of time for foreign travelers

3. Truck Freight Transportation
    a. Value of time for U.S. truckers
    b. Value of time for Canadian and Mexican truckers
    c. Net impact on U.S. GDP and employment
    d. Net impacts on the Canadian and Mexican economies.

Note that the results are presented separately for each of the components because they involve different estimating methods, data, assumptions, and stakeholder groups. This enables us to sum the appropriate results for the impacts on the U.S. economy and its residents separately from the impacts on other countries.

The results are presented in Tables 1-4 and 1-5 for impacts on the U.S., as well as for Canada and Mexico (see italicized entries)

The impacts on the U.S. economy as a whole for the +1 staffing case are:

GAINS:

- **$65.8 million in GDP**
- **1,094 annual jobs**
- **$21.2 million in value of time gained**

The impacts on the U.S. economy for the -1 staffing case are:

LOSSES:

- **- $32.9 million in GDP**
- **- 547 annual jobs**
- **- $10.6 million in value of time lost**

Three major conclusions are, first, that the value of wait time saved in the +1 staffing case is approximately $640,000 per staff member on average for the land ports and the airports as a whole evaluated in this study. Second, given that each of the two tables represents the addition of 33 staff members (one at each of 17 land passenger ports, 12 land freight ports, and 4 passenger airports), each new staff member on average generates 33 additional jobs throughout the U.S. economy. Third, losses in the -1 staffing case equal exactly half of the gains in the +1 staffing case. The reasons for this are explained in detail in chapter 2, section D below.

The ratio of economy-wide employment gains to one additional CBP staff might appear high at first, but is reasonable if placed in perspective. The ratio presented for CBP staffing changes is less like a standard industry multiplier for ordinary business activity and more like an action at a pressure point in the economy, in this case to alleviate a bottleneck. Hence, we would expect it to have a higher than average "multiplier." The situation is more akin to investment analysis in critical facilities. For example, a recent congressional study evaluating FEMA hazard mitigation grants found a benefit-cost ratio of more than 100 for a few million dollars of investment in burying electric power lines underground to avoid hundreds of millions of dollars of business interruption losses from a major electricity outage due to severe storms (MMC, 2004).

Most of the economic gains and losses from CBP staffing changes will accrue to the regions surrounding the POEs. For example, adding one CBP officer at each of the 17 passenger land crossings is projected to lead to an increase in GDP of $61.8 million and employment gains of 1,053 jobs in the U.S. as a whole. However, 80% of the GDP gains and 94% of employment gains are captured by the POE regions alone. The regional gains are a relatively high proportion despite the fact that the multiplier values are higher for national impacts. The main reason for this outcome is the diversion of some spending to other countries stemming from the increased attractiveness of foreign travel to U.S. residents from decreased wait times. This subtraction to yield net impacts is nationwide and not just limited to the POE regions.

Detailed results for individual ports, U.S. trade balance, and for industries impacted will be presented in the subsequent individual chapters. Some of the impacts on the economies of Canada and Mexico will also be reported.

TABLE 1-4. ECONOMIC IMPACTS OF DECREASES IN WAIT TIMES AT SELECTED U.S. LAND AND AIR PORTS OF ENTRY (+1 at each POE)

		GDP (million 2011$)	Employment (jobs)	Value of time saved (million 2011$)
Ground Passenger Travel	**Value of lowered wait time for U.S. residents**	n.a.	n.a.	$17.0
	Value of lowered wait time for Canadian and Mexican residents	n.a.	n.a.	*$10.2*
	Net impact on port region and U.S. GDP and employment	$61.8	1,053	n.a.
Air Passenger Travel	**Value of lowered wait time for U.S. residents**	n.a.	n.a.	*$4.2*
	Value of lowered wait time for foreign travelers	n.a.	n.a.	$4.6
Truck Freight Transportation	**Value of lowered wait time for U.S. truckers**	n.a.	n.a.	n.c.
	Value of lowered wait time for Canadian and Mexican truckers	n.a.	n.a.	*$117.4*
	Net impact on U.S. GDP and employment	$4.0	41	n.a.
	Net impacts on the Canadian and Mexican economies	*$18.7*	n.c.	n.a.
	Total Canadian and Mexico	*$18.7*	n.a.	*$131.8*
	TOTAL U.S.	$65.8	1,094	$21.6

n.a. – not applicable; n.c. – not calculated

TABLE 1-5. ECONOMIC IMPACTS OF INCREASES IN WAIT TIMES AT SELECTED U.S. LAND AND AIR PORTS OF ENTRY (-1 at each POE)

		GDP (million 2011$)	Employment (jobs)	Value of time lost (million 2011$)
Ground Passenger Travel	Value of lowered wait time for U.S. residents	n.a.	n.a.	-$8.5
	Value of lowered wait time for Canadian and Mexican residents	n.a.	n.a.	*-$5.1*
	Net impact on port region and U.S. GDP and employment	-$30.9	-527	n.a.
Air Passenger Travel	Value of lowered wait time for U.S. residents	n.a.	n.a.	-$2.1
	Value of lowered wait time for foreign travelers	n.a.	n.a.	*-$2.3*
Truck Freight Transportation	Value of lowered wait time for U.S. truckers	n.a.	n.a.	n.c.
	Value of lowered wait time for Canadian and Mexican truckers	n.a.	n.a.	*$58.7*
	Net impact on U.S. GDP and employment	-$2.0	-20	n.a.
	Net impacts on the Canadian and Mexican economies	*-$9.4*	n.c.	n.a.
Total Canadian and Mexico		*-$9.4*	n.a.	*-$66.1*
TOTAL U.S.		-$32.9	-547	-$10.6

n.a. – not applicable; n.c. – not calculated

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CHAPTER 2. IMPACTS OF CBP CHANGES IN STAFFING ON WAIT TIMES FOR PASSENGER VEHICLES AND TRUCKS AT U.S. LAND BORDER CROSSINGS

by

Bryan Roberts

I. INTRODUCTION

This project analyzes the economic impacts of adding or subtracting one primary inspection officer at passenger vehicle lanes at land border crossings, commercial vehicle lanes at land border crossings, and passport control sites at airports at U.S. Ports of Entry (POEs). In order to quantify economic impacts, it is first necessary to determine how the addition or subtraction of an officer impacts wait time in primary inspection queues, and how change in wait time affects the level of passenger traffic.

Table 2-1 summarizes the land ports of entry on the southern and northern US borders for which we analyze economic impacts associated with staffing changes. Some ports of entry contain only one border crossing, but others encompass two or more distinct crossings. Many crossings process both passenger and commercial vehicles, although some specialize in one or the other. Some crossings that process commercial vehicles do not process trucks, but do process buses and/or vans: these crossings are excluded from our analysis of commercial-vehicle crossings.

TABLE 2-1. PORTS AND CROSSINGS COVERED BY THE STUDY

Land Port of Entry	Border Crossing	Passenger Vehicles	Commercial Vehicles
Calexico	Calexico/East	Y	Y
	Calexico/West	Y	Y
El Paso	Ysleta	Y	Y
	Paso del Norte	Y	Y[3]
	Bridge of the Americas	Y	Y
Laredo	Lincoln-Juarez (Bridge #2)	Y	Y[3]
	Convent St. (Bridge #1)	Y	Y[3]
	Colombia Solidarity (Bridge #3)	N[1]	Y
	World Trade Bridge (Bridge #4)	N	Y
Nogales	Mariposa	Y	Y
	Deconcini	Y	Y
Otay Mesa	Otay Mesa	N	Y
San Ysidro	San Ysidro	Y	N
Buffalo-Niagara Falls	Whirlpool	N[2]	Y[3]
	Rainbow Bridge	Y	Y[3]
	Lewiston Bridge	Y	Y
	Peace Bridge	Y	Y
Blaine	Peace Arch	Y	Y[3]
	Pacific Highway	Y	Y

Detroit	Windsor Tunnel	Y	Y[3]
	Ambassador Bridge	Y	Y

1. Crossing has very low levels of vehicle traffic and few instances of positive wait times.
2. Crossing has very low levels of vehicle traffic and almost no wait times greater than zero recorded.
3. Crossing is designated as processing commercial vehicles; these might only be buses and/or vans.

CBP collects data that are specific to border crossings and passport control sites, not ports of entry, which can encompass multiple crossings or passport control sites. Staffing and management decisions are also made at the level of a crossing or site. Our analysis is therefore carried out for individual crossings and passport control sites.

Pedestrians enter the U.S. at many of the crossings in table 2-1, and the number of pedestrian crossings is quite significant at some of them. The impact of wait time on pedestrian crossings and resulting economic impacts are not analyzed in this study.[5]

II. Passenger Vehicle Processing at Land Border Crossings

CBP has collected hourly data on the time waited by passenger vehicles in primary inspection queues since April 2003.[6] Since November 2009, CBP has collected data on the number of vehicles inspected in a given hour, the number of passengers in these vehicles, the number of primary inspection processing booths open, and the average time that an officer spends inspecting a vehicle (the average processing time.) These data are also collected separately by type of lane at the border crossing: regular lanes, READY lanes, and SENTRI/NEXUS lanes. Regular lanes are for general traffic, SENTRI/NEXUS lanes are for vehicles whose passengers participate in trusted traveler programs that subject these individuals to a background screening process and READY lanes are for vehicles whose passengers have RFID-enabled identification documents.[7]

A. Change in Wait Time Resulting From the Addition of a CBP Officer

No previous research has established an analytical framework that can be used to quantify how wait time changes with processing capacity at a land border crossing or an airport's passport control site. Appendix 2A reviews key issues and challenges involved with developing such a framework, and reviews in depth the two approaches that we take to quantifying this relationship. First, we take advantage of a controlled experiment at the San Ysidro land border crossing in July 2012 that significantly increased the

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[5] The SANDAG (2006) study does include pedestrian crossings in its study of the economic impacts of wait time at ports of entry in the San Diego region. This study assumes that pedestrian entries and entries by passengers in cars and buses are identical with respect to key parameters such as amount of spending in the U.S. by the typical passenger and the elasticity of the number of trips with respect to wait time.

[6] Wait time is estimated through one of two methods. First, up to ten vehicles processed in an hour are queried as to how long they waited in minutes, and responses are averaged after dropping the highest and lowest values. Second, a CBP officer visually inspects where a queue ends in geographic space and estimates how long the wait time is on the basis of this inspection. Both of these approaches involve measurement error and are approximations to the true wait time vehicles experience on average in an hour.

[7] SENTRI is the trusted traveler program for passenger vehicles on the southern border, and NEXUS is the equivalent program on the northern border. READY lanes only began to be introduced at border crossings in late 2011, and some crossings do not yet have dedicated READY lanes.

number of processing booths available for passenger vehicles. Second, we develop an algebraic approach to quantifying how wait time changes with processing booths for saturated queuing systems such as land border crossings during rush hours. The appendix shows that the predictions of the algebraic approach and the outcomes of the July 2012 experiment at San Ysidro are very close, which is a useful validation of the algebraic approach.

In order to determine the percentage change in wait time resulting from the addition of one officer, it is necessary to identify what hours of the day that officer is deployed to. All results developed in this project are based on the assumptions that an additional officer works for 153 days in the year, and on each day worked, creates an additional 8 hours of primary processing capacity, so that an extra booth can be opened for those 8 hours. Our analysis assumes that necessary equipment and infrastructure is available to permit opening an extra booth at a given crossing.[8] We further assume that an extra booth is open over eight consecutive hours, and that these hours are the most congested hours of any day when capacity is added. We analyze historical hourly data for each day in FY 2012 to identify the eight most congested hours for each day.[9] We then determine how the wait time decreases in each of these hours if one primary inspection booth is added by using a simple algebraic methodology that is described in detail in Appendix 2A. Finally, we average over all of the hourly estimates for FY 2012 to get an average percentage change in wait time resulting from the addition of one officer.[10] We then evaluate the percentage change in wait time resulting from the subtraction of one officer. Our initial assumption was to remove an officer from the eight least congested hours of the day at a crossing.

Table 2-2 shows that adding an officer to the eight most congested hours of the day reduces wait time for regular lanes significantly at all crossings.[11] For "super-saturated" border crossings like San Ysidro and Calexico West that essentially have significant queues at all hours of all days, the percentage fall in wait time is relatively small. For crossings that have smaller traffic volumes, wait time falls more significantly. For one crossing, Stanton Street in the El Paso port of entry, adding one officer eliminates wait time entirely due to quite small traffic load and wait times. As it will never be justified on a cost-benefit basis to add an officer to this crossing, Stanton Street will not be considered further in this study.

Table 2-2 also shows that removing an officer from the 8 least congested hours of the day produces relatively large percentage increases in wait time at crossings on the southern border, but smaller increases at crossings on the northern border. We further considered removing one officer from the eight most congested hours of the day, for which results are also given in the table.

[8] At some border crossings, infrastructure constraints are not an issue, as extra booths can be opened through opening closed lanes or stacking booths when all lanes are being utilized. At other crossings, infrastructure constraints may be come into play, such that it is not possible to add an extra booth unless the crossing's infrastructure is developed in a significant way.

[9] The criterion used is total time waited by vehicles in eight consecutive hours.

[10] We do not determine which days are most optimal for deployment of an additional officer, but average over all days of the year. This approach recognizes that there are staffing constraints such that it might not be possible to deploy an extra officer only to the most optimal days.

[11] As will be discussed further below, we do not develop results for adding or subtracting an officer to READY or SENTRI/NEXUS lanes.

TABLE 2-2. WAIT TIME-OFFICER ELASTICITIES AT LAND BORDER CROSSINGS

	Time Period	FY 2012		
	Lane Type	Regular		
	Officers Added	+1	-1	-1
	Targeted 8 hours	Most congested	Least congested	Most congested
Port	Crossing			
Calexico	Calexico/East	-35%	74%	64%
	Calexico/West	-16%	35%	21%
El Paso	Ysleta	-37%	252%	62%
	Paso Del Norte	-37%	252%	60%
	Bridge of the Americas	-31%	176%	24%
	Stanton St.	-100%	N/A	N/A
Laredo	Lincoln-Juarez	-28%	76%	37%
	Convent St.	-48%	70%	82%
Nogales	Mariposa	-55%	N/A	91%
	Deconcini	-46%	170%	89%
San Ysidro	San Ysidro	-8%	25%	10%
Buffalo-Niagara Falls	Rainbow Bridge	-33%	4%	45%
	Lewiston Bridge	-38%	13%	54%
	Peace Bridge	-39%	30%	55%
Blaine	Peace Arch	-49%	6%	76%
	Pacific Highway	-62%	54%	109%
Detroit	Windsor Tunnel	-73%	44%	96%
	Ambassador Bridge	-63%	25%	82%

Source: Calculated by applying methodology developed in Appendix 2A to hourly data in FY 2012.

It is important to note that our analysis quantifies the wait time impact of adding or subtracting one marginal officer to or from a border crossing. The impacts of adding or subtracting a second officer will differ from the impact of adding or subtracting the first officer. Consider the case of adding officers. The first additional officer is assigned to the eight most congested hours given existing staffing, and this officer will have a significant impact on wait time. The second additional officer is assigned to the eight most congested hours given existing staffing and the first additional officer, and the second officer will have a smaller impact on wait time than the first officer did. Each extra officer added to a crossing will have a smaller wait time impact than the previous extra officer.[12] At some point, an extra officer will cause wait time at a crossing to essentially go to zero for all hours of the day. We consider in this study only the impact of the first officer added to or subtracted from a crossing.[13]

[12] The relationship between extra officers and fall in wait time may be approximately linear over some portion of the relationship.

[13] It should be possible to quantify the number of officers required at a crossing to bring wait time values, such as average wait time or wait time in a particular hour, down to a particular level. It should also be possible to determine for a crossing the level of staffing at which the marginal economic benefit that an extra officer brings

B. Change in Vehicle Traffic Resulting From the Addition of a CBP Officer

The need to wait at a border crossing acts as a disincentive to make a trip across the border, as the time spent waiting is in effect a cost that the traveler must pay to make the trip. There is an opportunity cost associated with this wait, as the traveler could be using the time for other purposes, such as working or enjoying leisure activities.[14] The monetary value of this opportunity cost must be added to the other monetary costs associated with making the trip, such as expenditures on gasoline, tolls paid, and the opportunity cost of travel time on roads. Because the wait time at a border crossing in effect increases the cost of making a trip, some number of potential trips across the border will not be made as a result of the increase in cost that the wait at the border brings about.

Adding an officer to a border crossing and lowering wait time brings about two significant economic impacts. First, falling wait time lowers the opportunity cost of waiting for *existing* traffic: even if no new trips were induced by falling wait time, travelers already crossing the border will benefit from a lower wait burden. Second, falling wait time induces *new* cross-border traffic flows: some potential travelers who would not cross the border prior to the fall in wait time would choose to cross the border after the fall. New cross-border traffic will induce additional economic activity and increase income and employment in affected regions. We quantify both the reduced opportunity cost for existing traffic and increased economic activity induced by new traffic in this study.

In order to evaluate the impacts of new traffic, it is necessary to determine how the number of cross-border trips change as wait time falls. We use an elasticity approach to quantify this change. The percentage change in wait time resulting from adding an officer can be denoted as dW/W. The percentage change in the number of cross-border trips that results from this wait time change is:

$$\frac{dV}{V} = \frac{dW}{W} * \varepsilon_{V,W}$$

where V is the number of cross-border trips and $\varepsilon_{V,W}$ is the trip-wait time elasticity. We use the FY 2012 number of trips as the base for calculating the number of trips after the addition of the officer and reduction in wait time:

$$V* = \left[1 + \left(\frac{dW}{W} * \varepsilon_{V,W}\right)\right] * V_{FY2012}$$

where V_{FY2012} is the number of trips (vehicles processed) in FY 2012 and V* is the number of trips after the change in wait time. It is very important to note that the results developed in this study are based on assuming that volumes of traffic are based on evaluating marginal changes from FY 2012 levels. Changes in traffic volumes due to change in demand for border crossing trips due to factors such as a strengthening or weakening economy, change in exchange rates, and/or change in gasoline prices are not taken into account in study results.

about equals the marginal cost of adding that officer. Such analysis could be carried out recognizing constraints, such as scheduling requirements.

[14] The time spent waiting in a primary inspection queue is, from the point of view of the traveler, what economists call a “deadweight welfare loss.”

This approach requires having an estimate of the trip-wait time elasticity $\varepsilon_{V,W}$, which determines the percentage change in passenger vehicle trip resulting from a percentage change in wait time. There are two sources of information available on the trip-wait time elasticity. First, the July 2012 experiment at the San Ysidro border crossing that reduced wait time resulted in an immediate significant increase in the number of vehicles processed at the crossing. Appendix 2A reviews these results in detail and shows that the trip-wait time elasticity was roughly 0.5.[15] Another source is previous studies that have estimated the travel time elasticity of travel demand for passenger vehicle traffic.[16] Previous studies have estimated how the number of trips or miles traveled by passenger vehicles changes as the time required to make a trip changes. Meta-studies that review the results of many individual studies and attempt to draw conclusions on the value of this elasticity generally suggest that the short-run time elasticity of travel demand is between 0 and -1, with -0.5 being a plausible value.[17] These reviews also suggest that the long-run elasticity is roughly twice the short-run elasticity, reflecting the fact that in the longer run, the number of trips made is plausibly more sensitive to the time required to make them.[18] Given that the elasticity value resulting from the San Ysidro experiment, which is for the ultra-short-run, equals the value suggested by the literature of -0.5, we will use this elasticity value to generate short-run change in the number of passenger vehicle trips resulting from a given change in wait time for the San Ysidro border crossing. We will also use a long-run elasticity value equal to -1 for this crossing. Finally, we will not use different elasticity values for trips made for business purposes (e.g. commuting, going to school) versus pleasure purposes (e.g. shopping, visiting friends or family, recreational activities).[19]

For other crossings, change in wait time presumably has less of an impact on generating new trips, because the level of wait time is significantly less than at San Ysidro (see Table 2-3). We do not have any controlled experiments available for other border crossings, and we do not have a formal methodology that permits an analytical approach to deriving elasticities for other crossings. In the absence of experiments and a formal methodology, we assume that trip-wait time elasticity at another border crossing is directly proportional to the ratio of the average wait time at that crossing to the average wait time at San Ysidro. Table 2-3 gives the short-run and long-run trip-wait time elasticities by crossing that are used in this study.

Table 2-3 also shows that average wait times for READY lanes are often much less than those for regular lanes, and average wait times for SENTRI/NEXUS lanes are negligible. Our analysis suggests that it will always be optimal for CBP to deploy an extra officer at a given border crossing to regular lanes as

[15] The Appendix also discusses potential limitations and concerns on using the San Ysidro experiment to estimate this elasticity value. Some of these concerns do not appear to be significant.
[16] A third source that is sometimes used is surveys of travelers that ask them how their travel behavior would respond to hypothetical changes in variables such as travel time. The SANDAG (2006) study takes this approach to evaluate how the number of passenger vehicle and pedestrian trips would increase if wait time was decreased to zero at border crossings in the San Diego region, for example. We rely in this study on estimates that are based on observation of how behavior actually changed after travel time changed.
[17] Litman (2012); 46-48), reviews passenger vehicle travel elasticities with respect to travel time for the U.S. and the U.K. Wardman (2012) reviews several hundred such elasticities for the U.K. and provides a useful summary in Table 3 on p.470.
[18] See Litman (2012) and Wardman (2012) for a comparison of short-run and long-run values.
[19] The literature does not give clear evidence on whether these elasticities are higher or lower for business travelers as opposed to leisure travelers.

opposed to READY or SENTRI/NEXUS lanes. All results of the study for passenger vehicles at land border crossings are therefore for addition or subtraction of an officer to regular lanes.

A final issue that should be taken into account in analysis of new trip flows is the "rebound" effect. When wait time and trip cost falls, the resulting increase in trips across the border increases processing pressure at the border crossing. This reduces the initial fall in wait time that an additional officer brings about, which would in turn reduce the increase in new trip flow.[20] We do not attempt to control for the rebound effect in this analysis. It is important to note this regard that the results for the San Ysidro experiment incorporate the rebound effect, because the change in wait time is consistent with the rise in trip demand that took place in the experiment. This emphasizes the utility of controlled experiments for gaining an understanding of how outcomes of complex systems change if key input variables such as processing capacity are changed

TABLE 2-3. AVERAGE WAIT TIMES AND TRIP-WAIT TIME ELASTICITIES

		Average wait time per vehicle in minutes in FY 2012			As percentage of San Ysidro value	Trip-Wait Time Elasticities	
						Short Run	Long Run
	Lane Type	Regular	READY	SENTRI/ NEXUS	Regular	Regular	Regular
Port	**Crossing**						
Calexico	Calexico/East	41	16	1	55%	-0.28	-0.55
	Calexico/West	48		4	66%	-0.33	-0.66
El Paso	Ysleta	26	8	2	35%	-0.17	-0.35
	Paso Del Norte	28	11		38%	-0.19	-0.38
	Bridge of the Americas	33	14		44%	-0.22	-0.44
Laredo	Lincoln-Juarez	23	22	1	31%	-0.16	-0.31
	Convent St.	21			28%	-0.14	-0.28
Nogales	Mariposa	20			27%	-0.13	-0.27
	Deconcini	23	3	0	31%	-0.16	-0.31
San Ysidro	San Ysidro	74	47	7	100%	-0.50	-1.00
Buffalo-Niagara Falls	Rainbow Bridge	7		0	9%	-0.05	-0.09
	Lewiston Bridge	14			19%	-0.10	-0.19
	Peace Bridge	7	0	1	9%	-0.05	-0.09
Blaine	Peace Arch	18	1	3	24%	-0.12	-0.24
	Pacific Highway	17		2	23%	-0.12	-0.23
Detroit	Windsor Tunnel	5		4	6%	-0.03	-0.06
	Ambassador Bridge	4	2	4	5%	-0.03	-0.05

Source: Calculated from CBP data.

[20] The rebound effect has been analyzed primarily with respect to how increasing fuel efficiency in passenger vehicles causes an increase in the demand for travel and thus gasoline. See Blair et al. (1984), Greene et al. (1999), and Barla et al. (2009).

C. Vehicle and Passenger Flows Broken Down by Residency

In order to estimate flows of new traffic needed for subsequent economic impact analysis, it is necessary to estimate flows of those resident in Mexico or Canada into the U.S. and flows of those resident in the U.S. into Mexico or Canada separately. Vehicles processed by CBP at a border crossing include both flows. CBP has collected data on the nationality of passenger vehicle passengers for ports of entry since 2009 and has provided a breakdown of processed passengers into US citizens, legal permanent residents, and non-immigrant foreign nationals. We assume that U.S. citizens and legal permanent residents approximate the flow of those resident in the U.S. into Mexico or Canada, and that non-immigrant foreign nationals approximate the flow of those resident in Mexico or Canada into the U.S.[21]

The change in the number of vehicles resulting from adding or subtracting one officer at a crossing is estimated using the changes in wait time given in Table 2-2, the elasticity values given in Table 2-3, and the number of vehicles processed in FY 2012 that represents the initial level of traffic flow.[22] Values for the average number of passengers per vehicle in FY 2012 are used to convert change in the number of vehicles to change in the number of passengers. Finally, change in the number of passengers is converted into change in the number of Mexican or Canadian passengers going into the U.S., and change in the number of American passengers going into Mexico or Canada. Table 2-4 gives values for the former, and Table 2-5 gives values for the latter.

[21] This is only an approximation. Some US citizens and legal permanent residents actually reside in Mexico or Canada, and the increase in the number of trips that they make into the U.S. would stimulate economic activity in the U.S. rather than their country of residence.

[22] To stay consistent with assumptions on how staffing changes processing capacity at a crossing, the initial value for the number of vehicles processed in FY 2012 is the average level processed in the eight most or least congested hours for a typical day multiplied by 153 days.

TABLE 2-4. NUMBER OF ADDITIONAL MEXICAN/CANADIAN PASSENGERS RESULTING FROM REDUCED WAIT TIME

	Time Period	**Increase on FY 2012 Level**					
	Lane Type	**Regular**					
	Officers Added	**+1**		**-1**		**-1**	
	Allocated to 8 hours that are:	**Most congested**	**Most congested**	**Least congested**	**Least congested**	**Most congested**	**Most congested**
		Short run	**Long run**	**Short run**	**Long run**	**Short run**	**Long run**
Port	**Crossing**						
Calexico	Calexico/East	20,268	40,536	-1,768	-3,536	-37,353	-74,707
	Calexico/West	14,480	28,960	-16,639	-33,278	-18,396	-36,792
El Paso	Ysleta	16,228	32,456	-19,498	-38,996	-26,863	-53,725
	Paso Del Norte	17,380	34,761	-28,249	-56,498	-28,455	-56,909
	Bridge of the Americas	26,747	53,495	-40,549	-81,098	-20,542	-41,084
Laredo	Lincoln-Juarez	14,421	28,841	-592	-1,184	-19,242	-38,484
	Convent St.	9,246	18,493	-202	-404	-15,727	-31,454
Nogales	Mariposa	16,592	33,185	NA	NA	-27,336	-54,673
	Deconcini	16,106	32,212	-7,978	-15,956	-31,273	-62,545
San Ysidro	San Ysidro	12,315	24,631	-14,262	-28,524	-15,056	-30,112
Buffalo-Niagara Falls	Rainbow Bridge	10,659	21,318	0	0	-14,751	-29,503
	Lewiston Bridge	19,565	39,129	-4	-8	-27,472	-54,943
	Peace Bridge	11,442	22,884	-8	-16	-15,972	-31,944
Blaine	Peace Arch	32,562	65,125	-42	-85	-50,565	-101,130
	Pacific Highway	27,697	55,394	-345	-689	-48,494	-96,989
Detroit	Windsor Tunnel	5,404	10,807	-124	-249	-7,152	-14,304
	Ambassador Bridge	5,316	10,631	-28	-57	-6,928	-13,856

TABLE 2-5. NUMBER OF ADDITIONAL AMERICAN PASSENGERS RESULTING FROM REDUCED WAIT TIME

	Time Period	Increase on FY 2012 Level					
	Lane Type	Regular					
	Officers Added	+1		-1		-1	
	Allocated to 8 hours that are:	Most congested	Most congested	Least congested	Least congested	Most congested	Most congested
		Short run	Long run	Short run	Long run	Short run	Long run
Port	**Crossing**						
Calexico	Calexico/East	26,185	52,370	-2,284	-4,569	0	-96,517
	Calexico/West	21,973	43,946	-25,249	-50,498	0	-55,831
El Paso	Ysleta	14,976	29,953	-17,994	-35,989	0	-49,581
	Paso Del Norte	16,040	32,079	-26,070	-52,140	0	-52,520
	Bridge of the Americas	24,684	49,369	-37,421	-74,843	0	-37,915
Laredo	Lincoln-Juarez	15,971	31,941	-656	-1,311	-21,310	-42,620
	Convent St.	10,240	20,480	-224	-447	-17,417	-34,834
Nogales	Mariposa	12,517	25,034	NA	NA	-20,622	-41,244
	Deconcini	12,150	24,300	-6,018	-12,037	-23,592	-47,183
San Ysidro	San Ysidro	38,578	77,155	-44,675	-89,349	-47,162	-94,325
Buffalo-Niagara Falls	Rainbow Bridge	5,955	11,909	0	0	-8,241	-16,481
	Lewiston Bridge	10,930	21,859	-2	-4	-15,347	-30,694
	Peace Bridge	6,392	12,784	-4	-9	-8,923	-17,845
Blaine	Peace Arch	21,708	43,417	-28	-57	-33,710	-67,420
	Pacific Highway	18,465	36,930	-230	-460	-32,330	-64,659
Detroit	Windsor Tunnel	8,372	16,745	-193	-386	-11,081	-22,163
	Ambassador Bridge	8,236	16,473	-44	-88	-10,735	-21,469

D. Value of Time Waited in Primary Inspection Queues by Passenger-Vehicle Passengers

Time waited in border crossing queues by passengers in passenger vehicles can be monetized by using an appropriate value of time for these passengers. Appendix 3B describes the construction of the value of an hour of time spent waiting in a land border crossing queue by a passenger in a vehicle. The values are based on an approach based on the median wage rate that is used by US government agencies.[23] Values for time spent on business and personal travel are developed separately and then aggregated into a composite value of time based on the breakdown of cross-border travelers by purpose of trip.[24]

Table 2-6 gives the value of time waited by all passengers in passenger vehicles in primary inspection queues broken down by nationality for the 17 border crossings analyzed in this study. San Ysidro dominates all other crossings by a very substantial degree in this regard.

The change in the value of time waited by existing traffic levels can also be calculated using results from Table 2-2. The deployment or subtraction of an additional officer at a crossing affects traffic in only the eight most or least congested hours of the day, and for only 153 days out of the year. Table 2-7 gives the value of change in wait time for the FY 2012 level of traffic. In the case of adding an officer, the value ranges from a minimum of $0.8 million for the Convent Street crossing in the Laredo port of entry and the Windsor Tunnel in the Detroit port of entry to $3.7 million for the Peace Arch crossing in the Blaine port of entry. As noted earlier, it is very important to note that these results are based on analyzing marginal change from FY 2012 traffic volumes. Rises or falls in demand for border crossing trips due to factors such as a strengthening or weakening economy, change in exchange rates, or change in gasoline prices are not taken into account.

For subtracting an officer, results differ substantially if an officer is removed from the eight least congested hours of the day versus the eight most congested hours of the day. The results of tables 2-4, 2-5, and 2-7 raise an important issue regarding the removal of an officer. For some crossings on the southern border and all crossings on the northern border, removing an officer from the eight least congested hours has almost no impact in terms of generating new traffic flows or reducing time waited by existing traffic. This suggests that at these crossing, existing staff is currently not optimally deployed, as an existing officer could be redeployed from the eight least-congested hours to the eight most-congested hours, and wait time outcomes would improve significantly in the latter hours at almost no cost to the former hours. Because current staff is not optimally deployed, crossing managers may face constraints in staffing decisions that affect how they are able to deploy existing resources and how they would reduce staff if required cut their workforce.[25] This makes it difficult to determine how a reduction in staff would actually be carried out at these crossings, and which hours of the day a reduction would actually impact.

Given this, we will quantify the economic impacts of reducing a crossing's staff by one officer using the results of the +1 officer scenario multiplied by -1/2. This approach is conservative, because these results are less than taking the average of the -1 officer scenarios for the least and most congested eight hours.

[23] A factor is applied to the standard approach to capture the disutility of waiting in queues.
[24] See Appendix 3B for details.
[25] For example, staffing of crossings at low-volume hours may take into account the possibility of unanticipated increases in traffic and build in a buffer of processing capacity in these hours. Managers may also face constraints associated with union rules.

TABLE 2-6. MONETARY VALUE OF TIME WAITED BY PASSENGERS IN PASSENGER VEHICLES IN PRIMARY INSPECTION QUEUES IN FY 2012

		FY 2012 Level									
		Regular Lanes			READY Lanes			SENTRI/NEXUS Lanes			
	Wait time valuation for "best case" nationwide-wage	US nationals and LPRs	Mexican or Canadian nationals	TOTAL	US nationals and LPRs	Mexican or Canadian nationals	TOTAL	American nationals and LPRs	Mexican or Canadian nationals	TOTAL	*ALL-LANE TOTAL*
Port	**Crossing**										
Calexico	Calexico/East	$17.6	$2.8	**$20.4**	$4.6	$0.7	**$5.4**	$0.1	$0.0	**$0.1**	***$26.0***
	Calexico/West	$39.1	$5.4	**$44.5**	$0.0	$0.0	**$0.0**	$1.4	$0.2	**$1.6**	***$46.1***
El Paso	Ysleta	$9.9	$2.2	**$12.1**	$0.8	$0.2	**$1.0**	$0.3	$0.1	**$0.4**	***$13.5***
	Paso Del Norte	$11.5	$2.6	**$14.1**	$0.7	$0.2	**$0.8**	$0.0	$0.0	**$0.0**	***$14.9***
	Bridge of the Americas	$21.2	$4.8	**$26.0**	$1.3	$0.3	**$1.6**	$0.0	$0.0	**$0.0**	***$27.7***
Laredo	Lincoln-Juarez	$13.2	$2.5	**$15.7**	$4.1	$0.8	**$4.9**	$0.4	$0.1	**$0.4**	***$21.0***
	Convent St.	$5.1	$1.0	**$6.0**	$0.0	$0.0	**$0.0**	$0.0	$0.0	**$0.0**	***$6.0***
Nogales	Mariposa	$4.3	$1.2	**$5.5**	$0.0	$0.0	**$0.0**	$0.0	$0.0	**$0.0**	***$5.5***
	Deconcini	$6.6	$1.8	**$8.4**	$0.1	$0.0	**$0.2**	$0.0	$0.0	**$0.0**	***$8.6***
San Ysidro	San Ysidro	$150.0	$10.0	**$160.0**	$43.0	$2.9	**$45.9**	$9.2	$0.6	**$9.8**	***$215.7***
Buffalo-Niagara Falls	Rainbow Bridge	$3.3	$6.4	**$9.8**	$0.0	$0.0	**$0.0**	$0.0	$0.0	**$0.0**	***$9.8***
	Lewiston Bridge	$5.4	$10.4	**$15.7**	$0.0	$0.0	**$0.0**	$0.0	$0.0	**$0.0**	***$15.7***
	Peace Bridge	$3.3	$6.3	**$9.6**	$0.0	$0.0	**$0.0**	$0.1	$0.1	**$0.2**	***$9.8***
Blaine	Peace Arch	$8.4	$13.6	**$22.0**	$0.0	$0.0	**$0.1**	$0.5	$0.8	**$1.3**	***$23.3***
	Pacific Highway	$5.6	$9.1	**$14.7**	$0.0	$0.0	**$0.0**	$0.2	$0.3	**$0.5**	***$15.2***
Detroit	Windsor Tunnel	$2.3	$1.6	**$4.0**	$0.0	$0.0	**$0.0**	$0.2	$0.1	**$0.3**	***$4.3***
	Ambassador Bridge	$2.5	$1.7	**$4.2**	$0.0	$0.0	**$0.0**	$0.3	$0.2	**$0.6**	***$4.8***

TABLE 2-7. CHANGE IN THE MONETARY VALUE OF TIME WAITED IN FY 2012 AFTER THE ADDITION OR SUBTRACTION OF AN OFFICER

	Time Period	**Change on FY 2012 Level**								
	Lane Type	**Regular**								
	Officers Added	**+1 Officer**			**-1 Officer**			**-1 Officer**		
	Targeted Eight Hours	**Most congested**			**Least congested**			**Most congested**		
	Value of wait time change, million $US	**US nationals and LPRs**	**Mexican or Canadian nationals**	**TOTAL**	**US nationals and LPRs**	**Mexican/ Canadian nationals**	**TOTAL**	**US nationals and LPRs**	**Mexican/ Canadian nationals**	**TOTAL**
Port	**Crossing**									
Calexico	Calexico/East	$1.6	$0.3	**$1.9**	-$0.2	$0.0	**-$0.2**	-$2.9	-$0.5	**-$3.4**
	Calexico/West	$1.3	$0.2	**$1.4**	-$1.0	-$0.1	**-$1.1**	-$1.6	-$0.2	**-$1.8**
El Paso	Ysleta	$0.9	$0.2	**$1.1**	-$0.7	-$0.2	**-$0.9**	-$1.5	-$0.3	**-$1.8**
	Paso Del Norte	$1.0	$0.2	**$1.2**	-$1.1	-$0.2	**-$1.3**	-$1.6	-$0.4	**-$1.9**
	Bridge of the Americas	$1.4	$0.3	**$1.8**	-$1.3	-$0.3	**-$1.6**	-$1.1	-$0.2	**-$1.3**
Laredo	Lincoln-Juarez	$1.0	$0.2	**$1.2**	-$0.1	$0.0	**-$0.1**	-$1.4	-$0.3	**-$1.7**
	Convent St.	$0.7	$0.1	**$0.8**	$0.0	$0.0	**$0.0**	-$1.1	-$0.2	**-$1.4**
Nogales	Mariposa	$0.8	$0.2	**$1.0**	$0.0	$0.0	**$0.0**	-$1.2	-$0.3	**-$1.6**
	Deconcini	$0.7	$0.2	**$0.9**	-$0.2	-$0.1	**-$0.3**	-$1.4	-$0.4	**-$1.8**
San Ysidro	San Ysidro	$2.4	$0.2	**$2.5**	-$1.8	-$0.1	**-$1.9**	-$2.9	-$0.2	**-$3.1**
Buffalo-Niagara Falls	Rainbow Bridge	$0.4	$0.8	**$1.3**	$0.0	$0.0	**$0.0**	-$0.6	-$1.1	**-$1.7**
	Lewiston Bridge	$0.8	$1.5	**$2.2**	$0.0	$0.0	**$0.0**	-$1.1	-$2.1	**-$3.1**
	Peace Bridge	$0.5	$0.9	**$1.4**	$0.0	$0.0	**$0.0**	-$0.7	-$1.3	**-$2.0**
Blaine	Peace Arch	$1.4	$2.3	**$3.7**	$0.0	$0.0	**$0.0**	-$2.2	-$3.5	**-$5.7**
	Pacific Highway	$1.2	$1.9	**$3.1**	$0.0	$0.0	**$0.0**	-$2.1	-$3.4	**-$5.4**
Detroit	Windsor Tunnel	$0.5	$0.3	**$0.8**	$0.0	$0.0	**$0.0**	-$0.6	-$0.4	**-$1.1**
	Ambassador Bridge	$0.5	$0.4	**$0.9**	$0.0	$0.0	**$0.0**	-$0.7	-$0.5	**-$1.1**

III. Commercial Vehicle Processing at Land Border Crossings

Commercial vehicle data came in two batches: (1) contained data on open lanes and wait times in minutes, for both CV (regular) lanes and Free and Secure Trade (FAST) lanes, summarized to hourly observations in local time zones; (2) total vehicle traffic for all lanes and total processing time in seconds summarized to hourly observation. However, the data does not separate total traffic volume down into CV lanes trips and Fast lanes trips. While CBP also provided an annual breakdown of CV lane and Fast lane trips for each border crossing for fiscal year 2012, we concluded that using an annual proportion to decompose total trips into CV lane trips and Fast lane trips at the hourly level introduced too much error into our analysis. We instead opted to use the total number of trips as a proxy for the number of CV lane trips, and used the total number of lanes (regular lanes and Fast lanes) as a proxy for the number of CV lanes to better correspond to the trip number approximation.

Change in wait time in primary inspection queues for commercial vehicles resulting from the addition of one officer is quantified using the same simple algebraic methodology that is used for passenger vehicles and is described in detail in Appendix 2A. We make identical assumptions on staffing: an extra officer works for 153 days out of the year and is assigned to the eight most congested hours of the day at a crossing.

Table 2-8 summarizes the average time waited by commercial vehicles and the total number of commercial vehicles processed at border crossings in FY 2012. Results on change in average wait time in the eight most congested hours show that wait time is generally highly responsive to adding an additional officer. Data from Table 2-8 will be used in the quantification of the economic impacts associated with improved processing of commercial vehicles in Chapter 4.

Unlike the case of passenger vehicles, we assume that the number of commercial vehicle trips across the southern and northern borders does not increase if wait time is reduced. It is not obvious how the impact of wait time on the number of commercial vehicle trips should be modeled. Shipping companies might plan a given number of trips regardless of wait time, so that the primary impact of an increase or fall in wait time is to impact shipping cost. At some point, an increasing wait time level will necessarily impact the number of commercial vehicle trips, but it is not clear that current levels are so high that this will be the case.[26] Unlike the case of passenger vehicles, no estimates of trip-wait time elasticities are available. Given these considerations, we have chosen to make the conservative assumption that the trip-wait time elasticity for commercial vehicles equals zero. Future research should evaluate in more detail how supply chains that cross the northern and southern borders as well as business location decisions respond to changes in wait time.

IV. Changes in Wait Time, Processing Time, and Referral to Secondary Inspection

This report focuses on the economic impacts of adding or subtracting primary inspection officers at ports of entry. The main purpose of primary inspection is to carry out enforcement of U.S. laws relating to the entry of people and goods into US territory, and to prevent and deter illegal entry of

[26] Very high levels of wait time could also have longer-run impacts on decisions about where to locate production plants and supply chain activity. We know of no empirical evidence on how changes in border wait times impact such decisions.

unauthorized migrants, illegal drugs, and other contraband. Although we do not analyze in any detail in this study how adding or subtracting primary inspection officers impacts law enforcement outcomes, we have found evidence that is suggestive that enforcement outcomes are impacted by increasing or decreasing inspection resources.

As traffic arrivals at a border crossing intensify, queues lengthen, and wait time rises, one response that can be made to speed up processing and reduce wait time is to lower the average time that an officer spends conducting primary inspection on a vehicle. Figure 2-1 shows the typical weekly profile of average wait time in minutes and average processing time in seconds for regular lanes at the San Ysidro border crossing in 2012.[27] There is a strong inverse correlation between wait time and processing time, which suggests that rising wait time does cause an adaptive response to lower processing time. A lower primary inspection processing time reduces the chance that a primary inspection officer will detect an attempt at illegal entry. Figure 2-2 shows that there is also a strong positive correlation between the average processing time and the percentage of vehicles that are referred to secondary inspection. Because many attempts at illegal entry are detected and prevented through secondary inspection, a falling secondary referral rate suggests that enforcement officers have less chance of preventing illegal entry in secondary inspection. Considered together, these correlations suggest that the reduced wait time that an extra officer in primary inspection brings about not only generates positive economic impacts, but also reduces pressure to lower the average primary inspection time and thus increases the chance of preventing illegal entry.

Although these correlations are suggestive, they do not conclusively establish causality. It would also be useful to examine data on enforcement outcomes at the ports directly and relate them to wait time and processing time through careful statistical analysis.

[27] The time spent conducting primary inspection on an individual passenger vehicle has been recorded at land border crossings since 2009. The time when a vehicle arrives at a booth and primary inspection begins is electronically recorded, and the time when the inspection ends is also recorded.

TABLE 2-8. WAIT TIME AND COMMERCIAL VEHICLE TRIPS AT LAND BORDER CROSSINGS

	Time Period	FY 2012								
	Lane Type	CV (Regular)								
	+1 Optimal Staffing	Average wait time per vehicle in FY 2012 (minutes)	Total Trips in FY 2012	Change in Wait Time During 8 Most Congested Hours	Average number of lanes open for 8 most congested hours in a day	Average wait time per vehicles in 8 most congested hours in a day	Std. Dev. of hourly WT values for 8 most congested hours	Std. Dev. of hourly WT values for FY 2012	Total number of WT observations for 8 congested hours in FY 2012	Total number of WT observations in FY 2012
Port	**Crossing**									
Calexico	Calexico/East	25.3	320,482	-70%	2.6	27.5	18.18	17.62	4168	4278
El Paso	Ysleta	10.1	360,470	-73%	3.5	11.9	10.46	9.47	2482	4646
	Bridge of the Americas	14.6	290,220	-58%	4.1	14.9	14.72	14.25	2397	3423
Laredo	Columbia Solidarity	7.4	215,701	-95%	2.9	7.5	6.78	6.27	1539	2653
	World Trade Bridge	23.8	1,356,418	-69%	6.9	24.8	20.49	19.63	2701	5108
Nogales	Mariposa	29.4	644,925	-55%	2.9	37.5	33.90	31.48	2769	3797
Buffalo-Niagara Falls	Lewiston Bridge	2.3	309,365	-71%	2.6	5.4	9.66	6.11	3140	8504
	Peace Bridge	5.3	625,651	-47%	4.7	7.1	17.82	11.31	4949	8754
Otay Mesa	Otay Mesa	30.4	298,730	-38%	8.0	32.0	21.21	19.64	2844	4637
Blaine	Pacific Highway	11.0	343,396	-83%	2.3	16.0	13.14	10.34	2934	8687
Detroit	Windsor Tunnel	3.5	39,056	-100%	1.0	4.2	3.51	3.47	2738	8400
	Ambassador Bridge	4.6	1,425,757	-61%	7.2	8.9	4.61	4.58	7928	8427

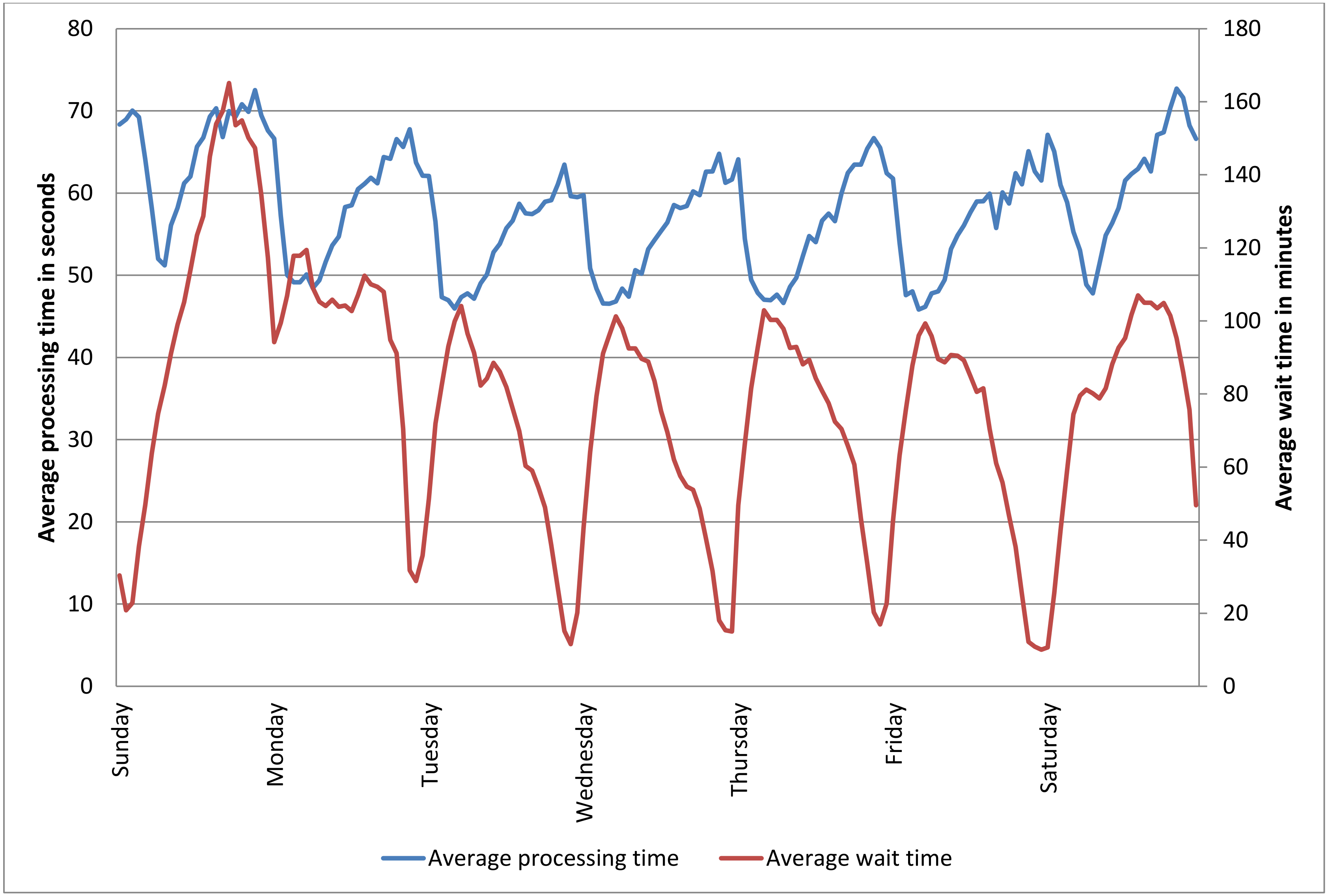

FIGURE 2-1. PASSENGER VEHICLE PROCESSING TIME AND WAIT TIME PROFILES: SAN YSIDRO CROSSING, REGULAR LANES, 12/21/11-10/31/12

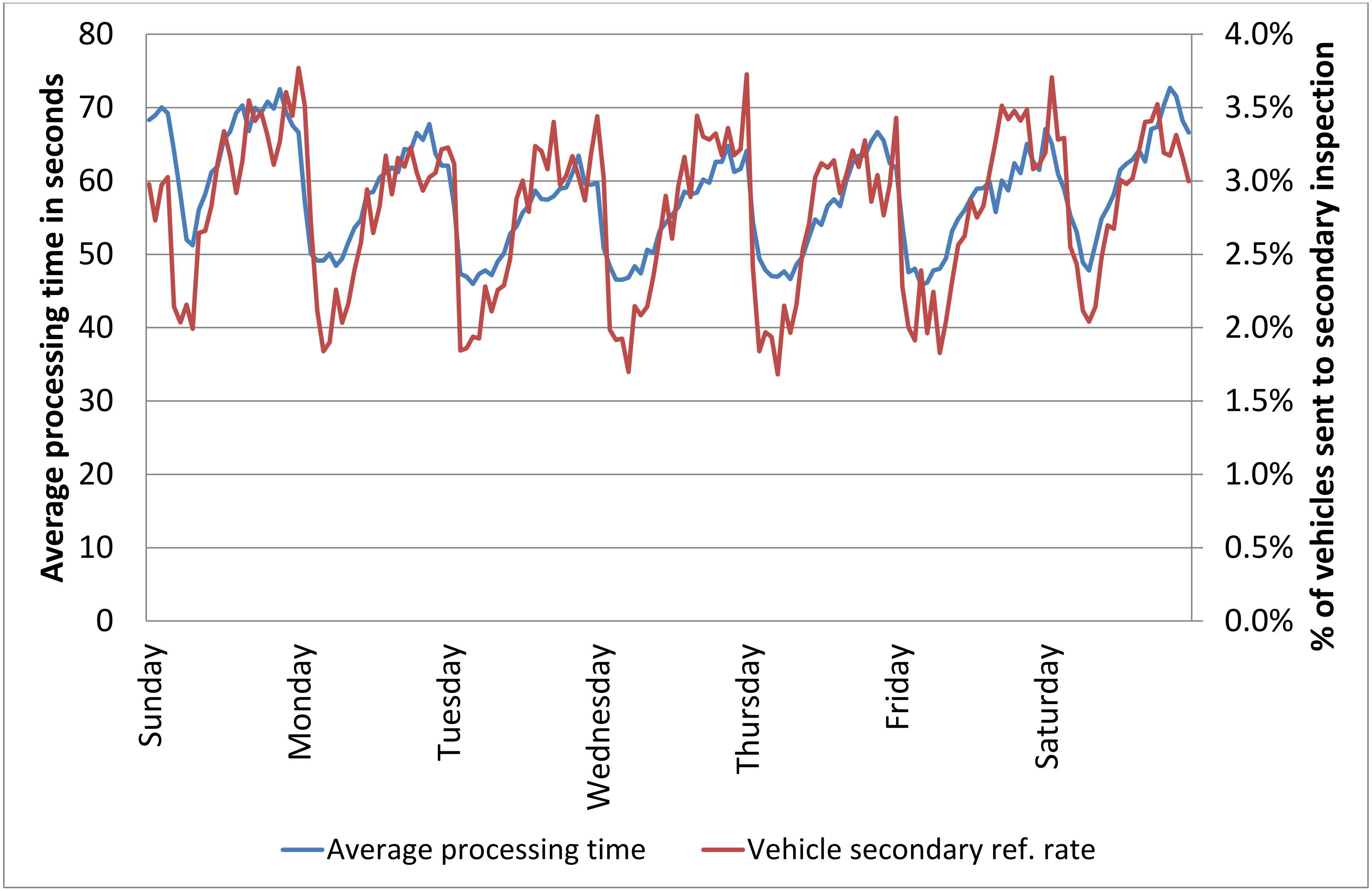

FIGURE 2-2. PROCESSING TIME AND VEHICLE REFERRAL RATE TO SECONDARY: SAN YSIDRO REGULAR LANES, TYPICAL WEEK AFTER 12/20/2011

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Appendix 2A: Wait Time Analysis for Land Border Crossings

Land border crossings are queuing systems. Incoming vehicle traffic arrives at a crossing and waits in a unified queue, and when a vehicle gets to the end of the queue, it is allocated to a primary inspection booth and subjected to primary inspection by a CBP officer. (If the rate of traffic arrival is small enough, no queue will build up behind the inspection booths, and vehicles will be inspected immediately upon arrival.) The wait time at a border crossing, which we denote by W, is a function of the level of traffic arriving to be processed (L), the number of processing booth open at the crossing (B), and the average processing time for a vehicle (P). The relationship between wait time and these variables can be expressed mathematically as:

$$W = f(L, B, P, \boldsymbol{w}),$$

where **w** denotes other variables that might affect wait time.

CBP has collected hourly data on W, B, P, and the number of vehicles and passengers in vehicles since November 2009. It does not collect data on L. If a functional form could be developed for the W = f(L,B,P,**w**) function, it might be possible to quantify the relationship between B and W by directly estimating this function.

One approach would be to use queuing theory to establish a functional form. Queuing theory develops analytical solutions for this function by assuming that the rate of arrival of vehicle traffic L, and the rate of processing of this traffic P, can be described with probability distributions in which the average rate of arrival is λ, and the average rate of processing is µ. Almost all results of queuing theory are developed under the assumption that λ is less than µ. In this framework, “steady state” queues randomly emerge when λ is randomly greater than µ. Traditional queuing theory does not permit deterministic buildups and builddowns of arriving traffic, which corresponds to rush hours. However, the dynamics of traffic at a border crossing are dominated by rush hour patterns (see Figures 2A-1 through 2A-3 and discussion below.) Although queuing theorists did consider saturated queuing systems with deterministic buildups and builddowns in the late 1960's, no general analytical results were developed that permits establishing a specification for the W = f(L,B,P,**w**) function .[28]

An even more challenging problem for analysis of a queuing system such as a border crossing is that the behavior of both the crossing operators and the arriving traffic is *endogenous*. As traffic arrivals increase and a queue builds up, the manager of a crossing will typically increase the number of booths open. Inspection officer may also lower the average processing time with which they inspect vehicles. Traffic arrivals may also respond to a rising wait time by diverting to alternative crossing locations or modes, or cancelling a trip across the border altogether. Endogenous behavior creates a situation in which wait time, booths open, average processing time, and average traffic arrival rate are functions of each other, and there is a set of simultaneous equations:

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[28] May and Keller (1967), Newell (1968a), Newell (1968b), and Newell (1968c) develop analysis of saturated queuing system with rush-hour buildups and builddowns. Chapter 9 of Newell (1982) provides the most thorough analysis of such queuing systems. It presumably would be possible to evaluate the relationship between wait time and processing capacity through simulations of saturated queuing systems, and May and Keller (1967) do provide such an exercise, but we have been unable to identify any other research that does such simulations.

$$W = f(L, B, P, \boldsymbol{w});$$
$$B = g(W, \boldsymbol{b});$$
$$P = h(W, \boldsymbol{p});$$
$$L = j(W, \boldsymbol{l}).$$

When wait time also influences the traffic level, number of booths open and processing time, it is not legitimate to relate W to L, B, and P without taking the simultaneity into account. In particular, carrying out regressions of W on these variables will produce misleading results that should not be used for analytical purposes.[29]

We take two approaches in this project to determining how increasing or decreasing booths open changes wait time. First, we take advantage of a controlled experiment that CBP did at the San Ysidro border crossing in July 2012 that increased the number of booths open far beyond the normal levels resulting from crossing management decisions. Second, we develop a simple algebraic approach for evaluating the impact of adding an extra booth to a saturated queuing system that can be applied to all border crossings being analyzed in this project. Finally, we can compare the results of the July 2012 experiment to what this simple algebraic approach would have predicted the results of the experiment to be in order to provide some validation of the algebraic approach.

A. A Controlled Experiment in July 2012 at the San Ysidro Border Crossing

The San Ysidro border crossing south of San Diego, California is one of the busiest land border crossings in the world. The San Ysidro crossing only processes passenger vehicles and pedestrians. As with other land border crossings, San Ysidro operates both regular lanes, which are for general traffic, and SENTRI lanes, which are for drivers and passengers who participate in the SENTRI trusted traveler program and have been subjected to a background screening process.[30] A third type of lane was introduced at San Ysidro on December 20, 2011, when READY lanes opened for vehicles whose occupants have RFID-enabled identification documents. READY lanes diverted vehicles out of regular lanes, and this change produced significant structural breaks in time series for wait time, booths open, and traffic levels for regular lanes. Because of these structural breaks, analysis of San Ysidro crossing data will be restricted to the post-December 20, 2011 period.

Figures 2A-1 through 2A-4 show what a typical weekly profile looks like for vehicles processed, wait time, booths open, and passengers per vehicle during the post-December 21, 2011 period. The values are unweighted averages for this period. For regular and READY lanes, San Ysidro is a "super-saturated"

[29] This problem is illustrated by results that are obtained from regressing CBP data for W on B and P. The coefficient on B is very significant both statistically and quantitatively, but the sign is positive, suggesting that increasing the number of processing booths open, B, actually increases wait time. This result simply reflects the fact that as wait time rises, a border crossing manager typically responds by increasing the number of booths open. Some method is required to control for this endogenous behavior in order to quantify the true relationship between wait time and booths open. The approach usually taken in the field of econometrics is to estimate the system of simultaneous equations for W, B, P, and L after identifying variables called instruments. We have not been able to identify any compelling instruments for this particular estimation challenge.

[30] SENTRI is the trusted traveler program for passenger vehicles on the southern border. On the northern border, the equivalent program is called NEXUS.

border crossing: a queue of zero length almost never exists for these lane types.[31] Regular and SENTRI lanes accounted for 37% and 36% of all vehicles processed respectively, whereas READY lanes accounted for 27%. Regular lanes have the highest average wait times, with READY lanes having somewhat less average wait times, and SENTRI lanes having very small average wait times. Profiles for regular and READY lanes are generally much more similar than either is with SENTRI lanes. Average wait times for regular and READY lanes peak on Sunday afternoon and evening, which might be due to large numbers of people returning from leisure activities or visiting friends and family in Mexico. Passengers per vehicle is also higher on the weekends as opposed to weekdays, which could reflect that people traveling on the weekends are more likely to be leisure travelers and have a higher probability of traveling in a group than commuting/business travelers.

CBP carried out a controlled experiment in July 2012 that ran from 4 pm on the afternoon of Friday July 20 to 6:30 am on the morning of Monday July 23 and during which the number of booths open was increased significantly. This increase was in addition to any natural increase or decrease associated with normal management of the crossing. In order to evaluate the impact of the experiment, we use daily-average data in order to simplify analysis.[32] We also evaluate only Saturday July 21 and Sunday July 22, as the experiment was run over all hours of these two days. In order to set a baseline against which experiment outcomes can be compared, we use data for the period March 16-October 31, 2012, and we take averages across all Saturdays or all Sundays in the pre- and post-experiment periods.[33]

Table 2A-1, 2A-2, and 2A-3 below give baseline values and experiment values for vehicles processed, wait time, total booth-hours, and average booths open for regular, READY, and SENTRI lanes respectively.[34] Values for Saturday and Sunday are given separately. We compare experiment values to both pre-experiment and post-experiment baseline values so as to control for any systematic changes in baseline values. For regular and READY lanes, processing capacity was increased by roughly 30-40% and 20-50% respectively on these two days, depending on the measure used (total booth-hours or average number of booths open) and whether experimental outcomes are compared to pre- or post-experiment baseline values. Wait time fell dramatically, by roughly 50-60%. It is straightforward to calculate values of the elasticity of wait time with respect to booths. For regular lanes, this elasticity is roughly -1.7. For READY lanes, this elasticity is roughly -2.2. These elasticity values can be used to estimate how much wait time changes if the average number of booths open during the day increases by one, or the total number of booth-hours increases by 24, which corresponds to adding three 8-hour shifts (equivalent to keeping one more booth open for the entire day): these results are given in the tables below.

The level of passenger vehicles processed during the experiment was also significantly higher than average levels in the baseline period, by roughly 30% for regular lanes and 20% for READY lanes. This is consistent with cross-border trip demand responding significantly to change in wait time even in the very short run. Given that CBP publicly posts hourly wait times on its website, thus creating the opportunity for the public to monitor wait time and respond quickly to any major change in it, this result

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[31] For regular lanes, 1% of hours had a wait time of less than 5 minutes. For READY lanes, 4.3% of hours had a wait time of less than 5 minutes.

[32] Daily-average data are weighted averages of hourly data, with weights being the number of vehicles processed.

[33] We do not include the period December 22 2011-March 15 2012 because there is some instability in values during this period that may be associated with the San Ysidro crossing adapting to the introduction of READY lanes.

[34] Vehicles processed and average wait time are daily average values. Total booth-hours is a sum of booths open across hours of the day, and average booths open is the unweighted average number of booths open across hours of the day.

is perhaps not surprising. For both regular and READY lanes, the implied elasticity of passenger vehicle trips with respect to wait time is roughly -0.4. This elasticity can be combined with previous results to estimate how the number of passenger vehicle trips rises if the number of booths is increased by one (results are given in the last line of the tables for regular and READY lanes.)

For SENTRI lanes, processing resources were increased significantly, and wait times did fall substantially, but this did not induce any significant change in vehicle trips. This is not surprising, because typical wait times in the SENTRI lanes are very low (almost always 10 minutes or less), and a large percentage change corresponds to small change in actual number of minutes waited, and thus a small change in trip demand.

B. Limitations of the Controlled Experiment

Insights from the July 2012 controlled experiment are subject to qualifications that mostly pertain to change in the number of vehicles processed:

- *Statistical significance.* We have not yet conducted formal statistical significance tests to determine if experimental values are significantly different from baseline values. Figure 2A-5 graphs the number of vehicles processed in regular lanes for Saturdays and Sundays in the baseline period. For Saturday values, the experiment value is clearly higher than other values during March-October and will be statistically significant. For Sunday values, the experiment value is also generally significantly higher than other values, although in the post-experiment period, there are two Sundays when the value came close to the experiment value. For READY lanes, the Saturday experiment value is higher than any other value in the baseline period, but the Sunday experiment value is exceeded by two other Sunday values. Developing a framework for significance testing for controlled experiments at border crossings, and applying this framework to the July 2012 experiment, is a useful task for future research.
- *Vehicle trip substitution across geographic space.* Passenger vehicle drivers may have decided to cross at San Ysidro rather than at another crossing when wait time fell on the July 2012 weekend. The only border crossing close enough to San Ysidro to qualify as a plausible substitution candidate is the Otay Mesa crossing, which is roughly 5 miles away and which does process a relatively small volume of passenger traffic. There is no obvious change in vehicle volume at Otay Mesa on this weekend.[35] A framework for significance testing for border crossing controlled experiments should include evaluation of substitution across space, as there are ports on the southern and northern borders that have two or more crossings in relatively close proximity to each other and for which such substitution is a practical possibility.
- *Vehicle trip substitution across time.* Some vehicle drivers may have decided to substitute a trip away from other days and to the July 21-22 weekend due to the change in wait time. An examination of vehicle volume in the week after July 21-22 reveals no obvious change in vehicle volumes. A framework for significance testing for border crossing controlled experiments should include evaluation of substitution across time.

[35] The next nearest border crossing open to passenger vehicles is at Tecate, which is 38 miles away but involves driving for 51 minutes over local roads. There is no obvious change in vehicle volume at Tecate on this weekend. After Tecate, the nearest border crossing is at Calexico, which is 130 miles and 2 hours away.

- *No weekday experimental values.* This experiment was done only over one weekend. The composition of travelers on the weekend and on weekdays might vary significantly (for example, weekdays might have a higher percentage of trips taken for business purposes), and responsiveness of different traveler groups to wait time may systematically vary such that change in trip volume to a given change in wait time might be different for weekdays as opposed to weekends. It would be useful if controlled experiments were carried out on weekdays at San Ysidro.
- *Experiment was not sustained.* The experiment was carried out over a two-day period, and change in trip volume reflects only a very short-run response to change in wait time. A sustained experiment would bring about longer-run behavioral responses. As discussed in chapter 2, the literature on response of travel to change in travel time suggests that permanent increases in processing capacity that lead to permanent falls in wait time will bring about larger percentage changes in trip volumes.
- *Applicability to other border crossings.* Elasticities of wait time and trip volume with respect to processing capacity resulting from the San Ysidro experiment may not hold at other border crossings. This concern leads to a requirement for a more theoretical approach that can be used for other crossings.

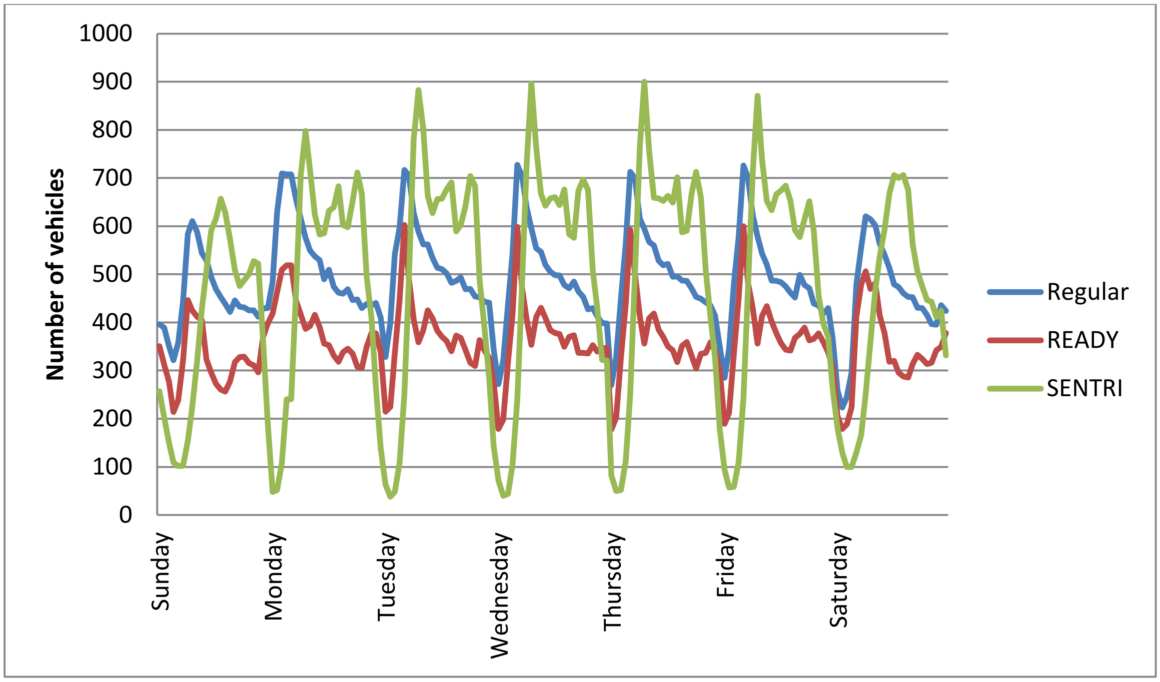

FIGURE 2A-1. PASSENGER VEHICLES PROCESSED BY HOUR AND LANE TYPE: TYPICAL WEEK DURING 12/21/2011-10/31/2012

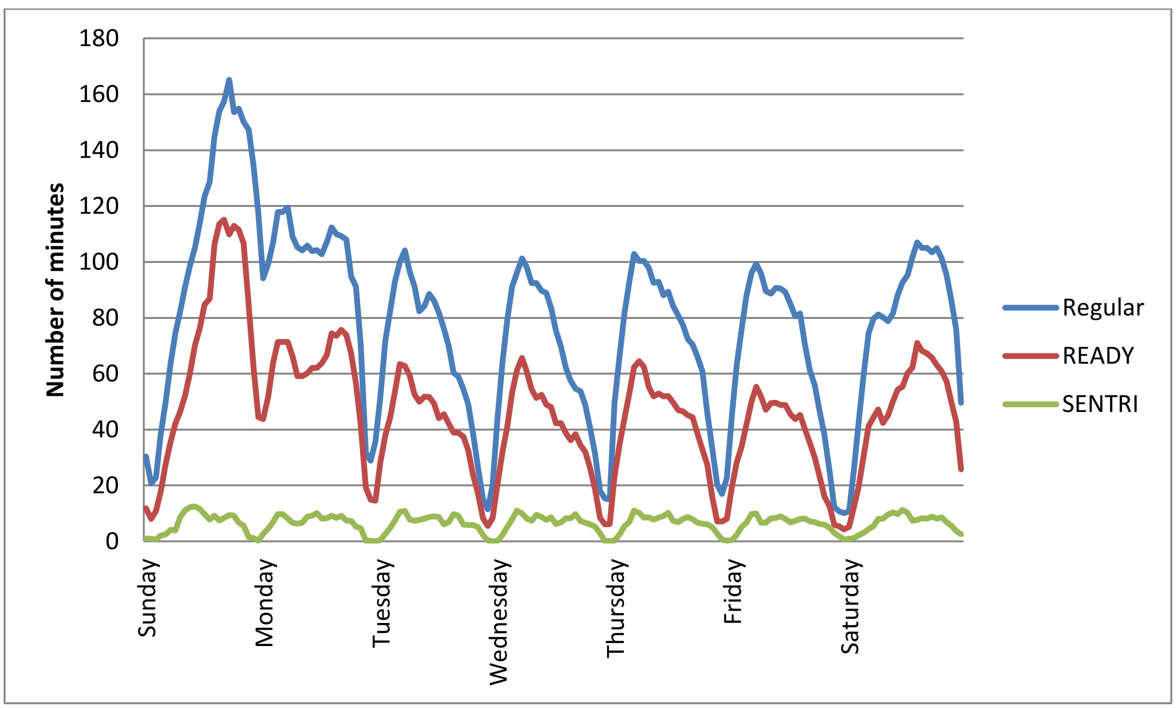

FIGURE 2A-2. WAIT TIME IN MINUTES BY HOUR AND LANE TYPE: TYPICAL WEEK DURING 12/21/2011-10/31/2012

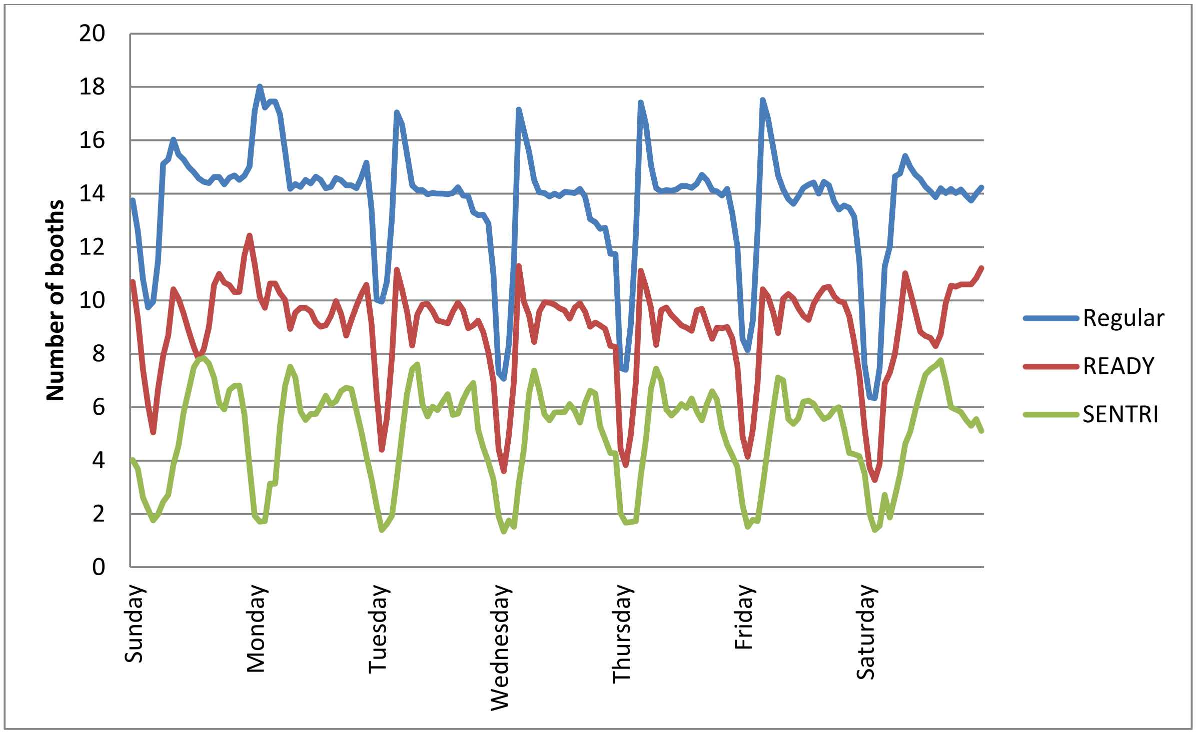

FIGURE 2A-3. NUMBER OF BOOTHS OPEN BY HOUR AND LANE TYPE: TYPICAL WEEK DURING 12/21/2011-10/31/2012

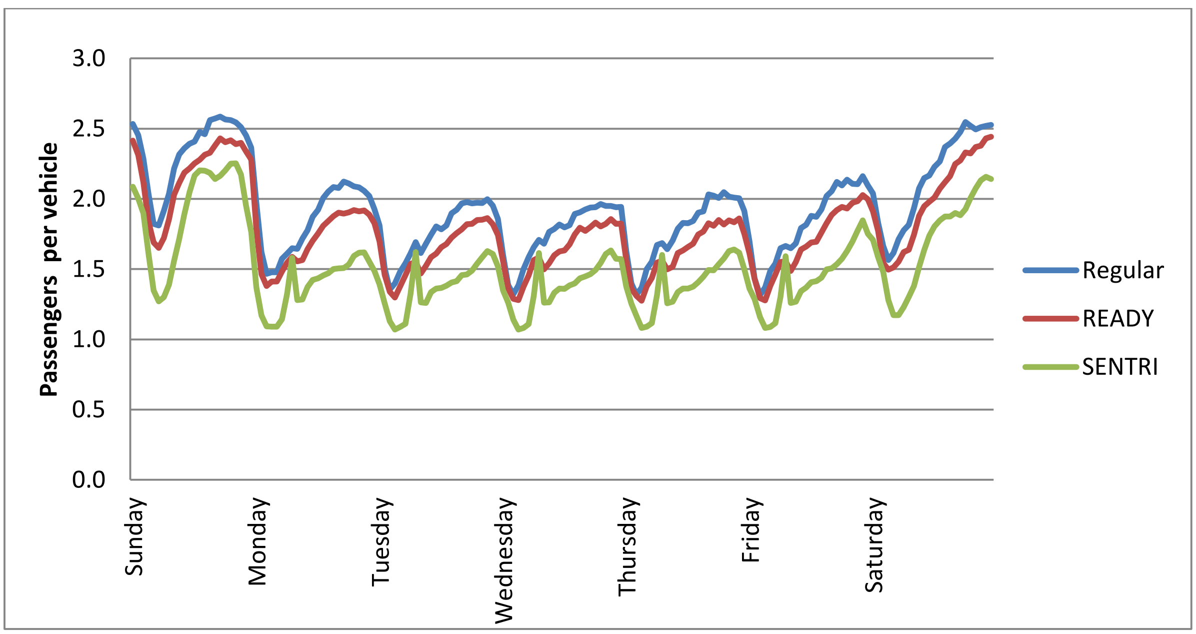

FIGURE 2A-4. AVERAGE PASSENGERS PER VEHICLE BY HOUR AND LANE TYPE: TYPICAL WEEK DURING 12/21/2011-10/31/2012

TABLE 2A-1. BASELINE AND EXPERIMENTAL VALUES FOR SAN YSIDRO, JULY 21-22, 2012: REGULAR LANES

	REGULAR LANES							
	Saturday				Sunday			
	Vehicles	Wait Time	Total booth-hours	Average booths open	Vehicles	Wait Time	Total booth-hours	Average booths open
Average daily values:								
-entire post-mid-March period	10216	87	308	13	10291	113	334	14
-before experiment	10350	89	308	14	10364	115	332	14
-after experiment	9836	88	301	13	9971	117	327	14
Experiment value	13129	34	411	18	13135	44	446	19
Experiment as % of:								
-before-experiment average	27%	-62%	33%	35%	27%	-62%	34%	35%
-after-experiment average	33%	-62%	36%	42%	32%	-62%	36%	39%
Implied vehicle trip-wait time elasticity value:								
-using before-experiment averages	-0.4				-0.4			
-using after-experiment averages	-0.5				-0.5			
Implied wait time-booths elasticity value:								
-using before-experiment averages			-1.9	-1.8			-1.8	-1.7
-using after-experiment averages			-1.7	-1.5			-1.7	-1.6
If the average number of booths open over the day is increased by one, average wait time falls by:								
-using before-experiment averages				-13%				-12%
-using after-experiment averages				-11%				-11%
If the total number of booth-hours open over the day is increased by three shifts (24 hours), average wait time falls by:								
-using before-experiment averages			-15%				-13%	
-using after-experiment averages			-14%				-13%	
If the total number of booth-hours open over the day is increased by three shifts (24 hours), passenger vehicle trips rise by:								
-using before-experiment averages			6%				6%	
-using after-experiment averages			7%				6%	

TABLE 2A-2. BASELINE AND EXPERIMENTAL VALUES FOR SAN YSIDRO, JULY 21-22, 2012: READY LANES

	READY LANES							
	Saturday				Sunday			
	Vehicles	Wait Time	Total booth-hours	Average booths open	Vehicles	Wait Time	Total booth-hours	Average booths open
Average daily values:								
-entire post-mid-March period	8372	54	219	10	8086	71	239	10
-before experiment	8317	50	211	9	7798	70	218	10
-after experiment	8297	61	226	10	8360	75	262	11
Experiment value	10416	24	275	12	9727	32	313	14
Experiment as % of:								
-before-experiment average	25%	-52%	30%	26%	25%	-54%	43%	47%
-after-experiment average	26%	-61%	22%	19%	16%	-57%	19%	24%
Implied vehicle trips-wait time elasticity value:								
-using before-experiment averages	-0.5				-0.5			
-using after-experiment averages	-0.4				-0.3			
Implied wait time-booths elasticity value:								
-using before-experiment averages			-1.7	-2.0			-1.2	-1.2
-using after-experiment averages			-2.8	-3.2			-3.0	-2.4
If the average number of booths open over the day is increased by one, average wait time falls by:								
-using before-experiment averages				-22%				-12%
-using after-experiment averages				-32%				-21%
If the total number of booth-hours open over the day is increased by three shifts (24 hours), average wait time falls by:								
-using before-experiment averages			-19%				-14%	
-using after-experiment averages			-30%				-27%	
If the total number of booth-hours open over the day is increased by three shifts (24 hours), passenger vehicle trips rise by:								
-using before-experiment averages			9%				6%	
-using after-experiment averages			13%				8%	

TABLE 2A-3. BASELINE AND EXPERIMENTAL VALUES FOR SAN YSIDRO, JULY 21-22, 2012: NEXUS LANES

	SENTRI LANES							
	Saturday				Sunday			
	Vehicles	Wait Time	Total booth-hours	Average booths open	Vehicles	Wait Time	Total booth-hours	Average booths open
Average daily values:								
-entire post-mid-March period	10255	8	121	6	9434	8	128	6
-before experiment	9972	8	107	5	9149	7	112	6
-after experiment	10620	9	136	7	9818	8	147	7
Experiment value	10225	5	148	8	9547	6	157	8
Experiment as % of:								
-before-experiment average	3%	-42%	38%	39%	4%	-11%	40%	41%
-after-experiment average	-4%	-46%	9%	11%	-3%	-19%	7%	8%
Implied vehicle trips-wait time elasticity value:								
-using before-experiment averages	-0.1				-0.4			
-using after-experiment averages	0.1				0.1			
Implied wait time-booths elasticity value:								
-using before-experiment averages			-1.1	-1.1			-0.3	-0.3
-using after-experiment averages			-5.3	-4.1			-2.9	-2.3
If the average number of booths open over the day is increased by one, average wait time falls by:								
-using before-experiment averages				-20%				-5%
-using after-experiment averages				-61%				-31%
If the total number of booth-hours open over the day is increased by three shifts (24 hours), average wait time falls by:								
-using before-experiment averages			-25%				-6%	
-using after-experiment averages			-94%				-48%	
If the total number of booth-hours open over the day is increased by three shifts (24 hours), passenger vehicle trips rise by:								
-using before-experiment averages			1%				2%	
-using after-experiment averages			-8%				-7%	

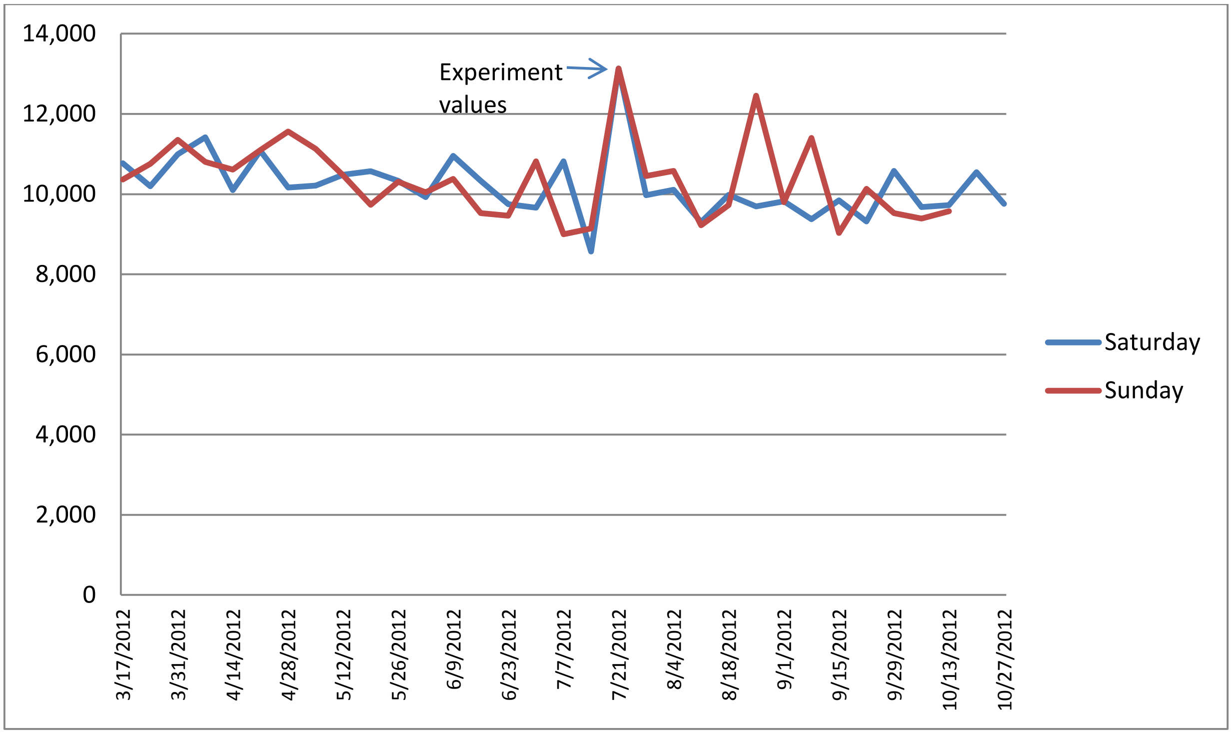

FIGURE 2A-5. NUMBER OF VEHICLES PROCESSED IN REGULAR LANES AT SAN YSIDRO CROSSING

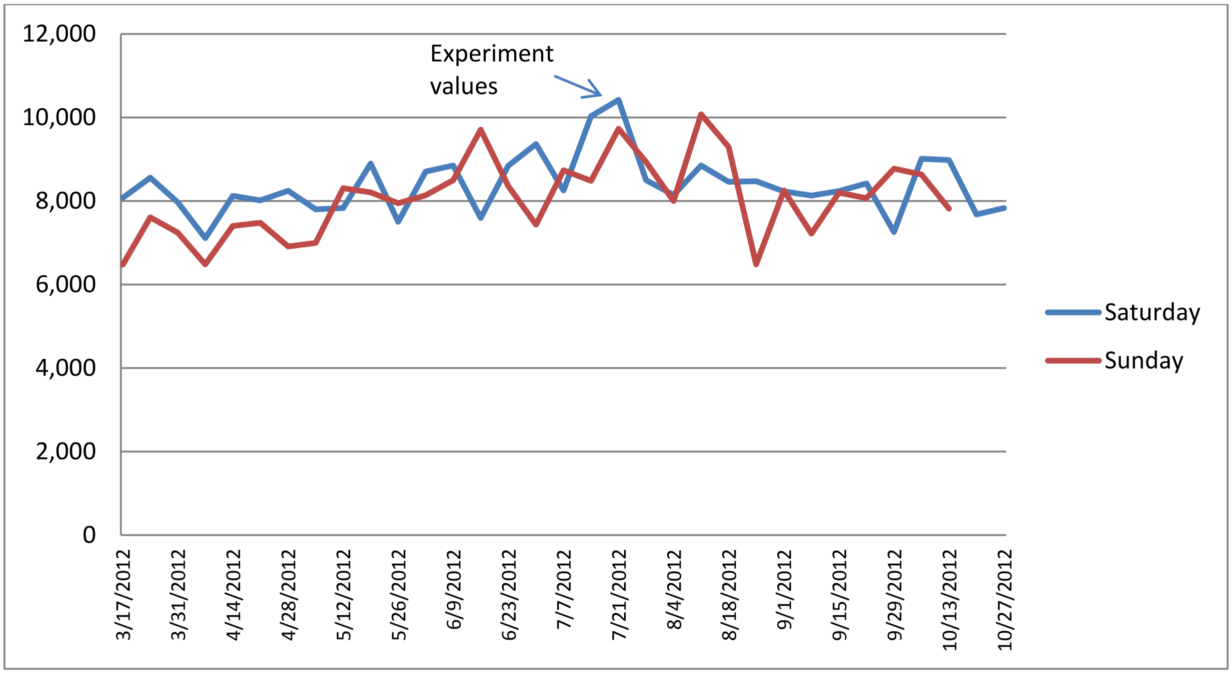

FIGURE 2A-6. NUMBER OF VEHICLES PROCESSED IN READY LANES AT SAN YSIDRO CROSSING

C. A Simple Algebraic Approach to the Wait Time-Booths Open Relationship for a Saturated Border Crossing

Although no formal results from queuing theory are available for saturated queuing systems (e.g. rush hours), it is possible to develop a simple algebraic approach to quantifying how wait time changes if processing capacity is added to or subtracted from a saturated system. This requires that all variables be made deterministic, so that random fluctuations are stripped from the analysis. For a given hour, define the following variables as:

V = total number of vehicles processed;
B = average number of booths open;
W = average wait time in seconds spent in the queue;
Q = average queue length expressed as number of vehicles waiting in the queue at any given time in the hour;
v = V/B = number of vehicles processed by the average both;
s = 3600/v = seconds required to process a vehicle at an average booth;
n = Q/B = the number of time periods that are s seconds long that are required to eliminate a queue of size Q;
Note also that n = W/s.

For all land border crossings, CBP has collected data on V, B, and W, and therefore v, s, and n, since November 2009. Q is not measured by CBP. However, because n = Q/B and n = W/s, Q can be estimated using this equation:

$$Q = \left(\frac{W}{s}\right) B$$

Now consider a queue system that is in equilibrium, so that arrivals to the queue equal departures from the queue, and Q is not changing over time. Denote arrivals by A, and departures by D. If the system is in equilibrium, then every s seconds, it must be the case that arrivals equal departures. Because departures equal B, arrivals must equal B, so that the change in queue length Q is:

$$\Delta Q = (A - D) = (B - B) = 0.$$

Now consider adding one extra booth at the beginning of the hour, and keeping arrivals fixed at B every s seconds. Departures every s seconds become B+1, and it must be the case that every s seconds, the change in Q is:

$$\Delta Q = (A - D) = (B - \{B + 1\}) = -1.$$

Over the course of an entire hour, Q falls by v vehicles:

$$\Delta Q = -v,$$

and at the mid-point of the hour,

$$\Delta Q = -\left(\frac{v}{2}\right).$$

Denote the queue length at the start of the hour as Q_0. Then adding an extra booth leads to a new queue length at the mid-point of the hour equal to:

$$Q_{M=}Q_0 - \left(\frac{v}{2}\right).$$

Using the equation Q = (W/s)*B, wait time at the mid-point of the hour is:

$$W_M = \frac{sQ_M}{(B+1)} = \frac{s\left(Q_0 - \frac{v}{2}\right)}{(B+1)}$$

The ratio of the new wait time to the old wait time is therefore:

$$\frac{W_M}{W} = \frac{\frac{s\left(Q_0 - \frac{v}{2}\right)}{(B+1)}}{\frac{sQ_0}{B}}$$

or

$$\frac{W_M}{W} = \left(\frac{B}{B+1}\right)\left(\frac{Q_0 - \frac{v}{2}}{Q_0}\right).$$

For a given hour at a given border crossing for a given lane type (regular, READY, SENTRI/NEXUS), actual data can be used to calculate values for n and Q_0, and then the above equation can be used to estimate how much wait time would change if one booth was added. This is the approach taken to calculating the percentage change in wait time in an hour resulting from adding one booth. If a booth is subtracted, the equation becomes:

$$\frac{W_M}{W} = \left(\frac{B}{B-1}\right)\left(\frac{Q_0 + \frac{v}{2}}{Q_0}\right).$$

This approach gives a result that is an approximation, because the approach assumes that the queue is initially in equilibrium. There are two important limitations to this approach:

- *Q is not stationary.* In most hours of the day, Q is not stationary but is rising or falling;
- *Cross-hour spillover impact not captured.* When a booth is added in one hour, it reduces the queue in that hour, but it also reduces the queue length and wait time in subsequent hours. This spillover impact is not captured by the simple approach outlined here. This approach thus gives a lower bound to the impact of adding one booth for a whole day.

Validation of Algebraic Approach

If controlled experiments are performed, results from these experiments can be used to validate the algebraic approach by comparing experiment outcomes with change in wait time that would be predicted by the approach. The July 2012 experiment provides one set of outcomes that can be used for validation purposes. There are two validation exercises that can be done using data from the July 2012 experiment. First, if the algebraic approach is used to predict change in wait time during the experiment days, how do those predictions compare with what actually happened during the experiment? Second, if the wait time-booth elasticity value resulting from the experiment is used to predict change in wait time at other crossings, how do those predictions compare to predictions of the algebraic approach?

Validation Exercise #1

Data for the typical San Ysidro weekly profiles that are depicted in Figures 2A-2 and 2A-3 above can be used to determine how much wait time falls in a given hour of a given day if an extra booth is opened in that hour based on the algebraic approach developed above. Table 2A-4 compares these projections with outcomes from the July 2012 experiment. Projected outcomes are quite close to experiment outcomes, which is reassuring.

TABLE 2A-4. COMPARISON OF CHANGES IN WAIT TIME FOR THE SAN YSIDRO JULY EXPERIMENT AND PROJECTED VALUES FROM ALGEBRAIC APPROACH

	Regular lanes	READY lanes
Saturday		
July experiment[A]	-12%	-27%
Algebraic approach	-12%	-25%
Sunday		
July experiment[A]	-11.5%	-16.5%
Algebraic approach	-10%	-19%

A : average of two values for “average booths open” column in Table 2A-1 or Table 2A-2.

Validation Exercise #2

If the wait time-booth elasticity value that resulted from the July 2012 experiment plausibly describes how wait time would change at other crossings, it can be used to make predictions of how adding one booth would change wait time in percentage terms at those crossings. If booths at a crossing change by a percentage amount and wait time changes in response by a percentage amount, then the wait time booth elasticity is:

$$\epsilon_{W,B} = \frac{\frac{\Delta W}{W}}{\frac{\Delta B}{B}},$$

or the ratio of the relevant percentage changes. Table 2A-1 and 2A-2 show that values for this elasticity emerging from the July 2012 experiment for regular and READY lanes range from -1.5 to -1.9 and -1.2 to -3.2 respectively, and that an overall average is close to -2. We use the equation

$$\frac{\Delta W}{W} = \epsilon_{W,B}^{SYE} * \frac{\Delta B}{B},$$

to predict wait time change at other crossings, where ϵ^{SYE} is the elasticity value from the experiment equal to San Ysidro, which is set at -2, and ΔB/B is the percentage change in number of booths for the eight most congested hours of the day if one booth is added.

Table 2A-5 gives values under the two prediction approaches for crossings other than San Ysidro, and Figure 2A-7 gives a scatter plot of predicted values. There is a significant correlation between the prediction values, and most of the points in the scatter plot are close to the 45-degree line. Two noticeable outliers are the Windsor Tunnel and Ambassador Bridge crossings in the Detroit port of entry: predictions of percentage change in wait time using the San Ysidro experiment elasticity are much smaller that predictions using the algebraic approach. If these outliers are excluded, the average difference between the two sets of predictions is equal to 3%, a small difference.

This validation exercise is based on assuming that the wait time-booth elasticity value that was associated with the San Ysidro experiment is applicable to other crossings. It is straightforward to show that when one booth is added to a crossing, the wait time-booth elasticity is a function of change in the size of the queue Q:

$$\epsilon_{W,B} = \left(\frac{B^2}{B+1}\right)\left(\frac{Q_0 - \frac{v}{2}}{Q_0}\right)$$

It is not obvious that the elasticity value at one crossing would necessarily equal the elasticity value at another crossing, as values for B, Q^0, and v will differ across crossings.

Given the fundamental importance of the wait time-booth relationship for analyzing primary inspection at border crossings, it would be highly desirable to carry out more controlled experiments to gain better understanding of this relationship. A carefully designed set of controlled experiments at a representative set of border crossings could conceivably provide quantitative results on the wait time-booth relationship that would obviate the need to use a prediction methodology based on mathematical analysis.

TABLE 2A-5. COMPARISON OF PREDICTIONS FOR CROSSINGS OTHER THAN SAN YSIDRO

Port	Crossing	Average Number of Booths for Most Congested 8 Hour Period	Percentage Change in Booths if One Booth is Added	Prediction on Change in Wait Time Based on Elasticity = -2	Prediction on Change in Wait Time Based on Algebraic Approach	Difference Between Predictions
Calexico	Calexico/East	4	24%	-49%	-35%	-14%
	Calexico/West	9	12%	-23%	-16%	-7%
El Paso	Ysleta	5	20%	-40%	-37%	-2%
	Paso Del Norte	6	18%	-35%	-37%	1%
	Bridge of the Americas	9	11%	-21%	-31%	10%
Laredo	Lincoln-Juarez	8	13%	-26%	-28%	2%
	Convent St.	4	25%	-51%	-48%	-3%
Nogales	Mariposa	4	24%	-49%	-55%	7%
	Deconcini	4	25%	-49%	-46%	-4%
Buffalo-Niagara Falls	Rainbow Bridge	9	11%	-23%	-33%	10%
	Lewiston Bridge	6	16%	-33%	-38%	6%
	Peace Bridge	8	13%	-25%	-39%	14%
Blaine	Peace Arch	6	17%	-33%	-49%	16%
	Pacific Highway	4	24%	-48%	-62%	14%
Detroit	Windsor Tunnel	8	13%	-26%	-73%	46%
	Ambassador Bridge	9	11%	-22%	-63%	41%

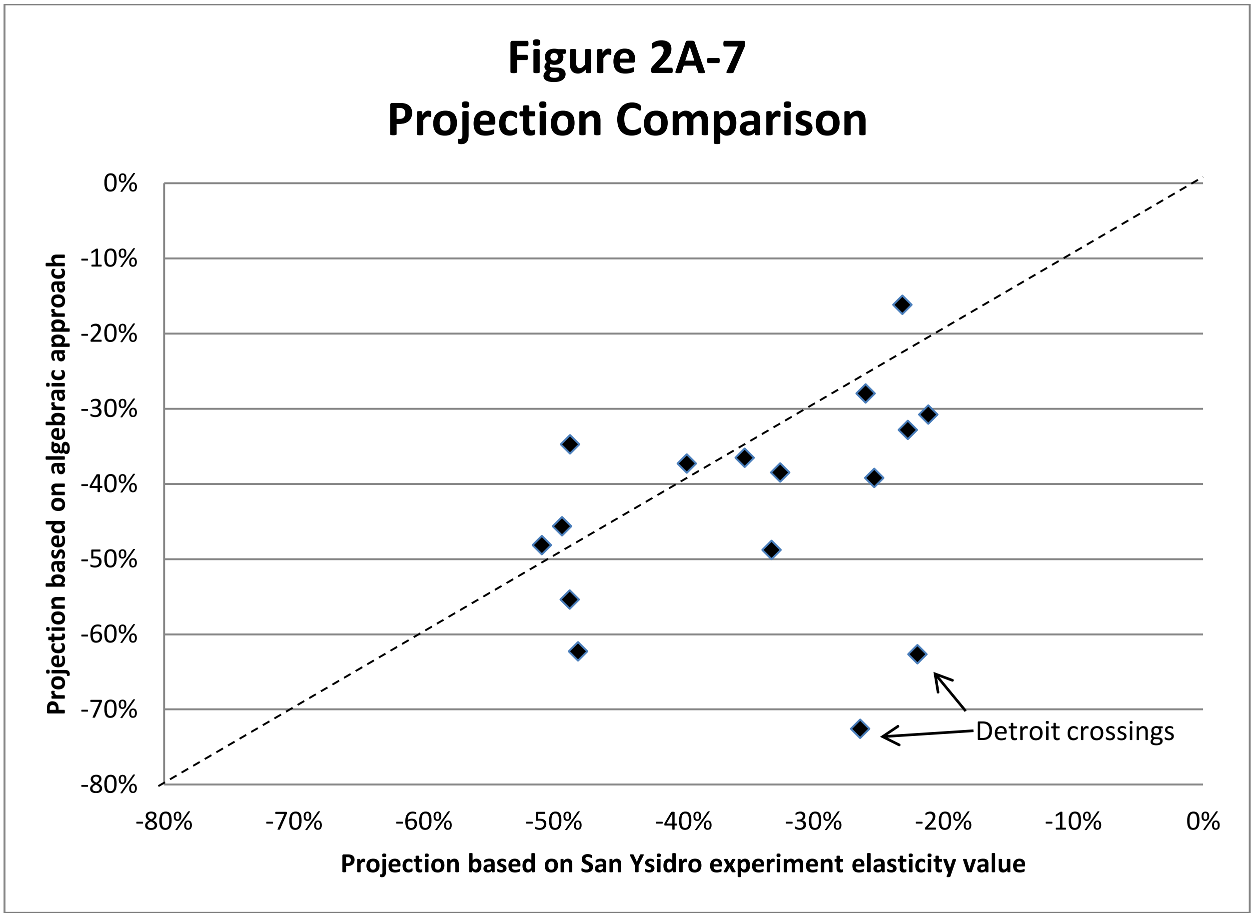

FIGURE 2A-7. NUMBER OF VEHICLES PROCESSED IN READY LANES AT SAN YSIDRO CROSSING

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CHAPTER 3. IMPACTS OF CBP CHANGES IN STAFFING ON WAIT TIMES FOR PASSENGERS AT U.S. AIRPORTS

by

Bryan Roberts

I. International Flight Passenger Processing at US Airports

This project also analyzes the impacts of adding or subtracting one primary inspection officer at passport control sites at airports at U.S. Ports of Entry (POEs). Table 3-1 summarizes the four airports and their passport control processing sites that we analyze.

TABLE 3-1. AIRPORTS AND SITES COVERED BY THE STUDY

Airport	**Passport Control Site**
Chicago O'Hare	Terminal 5
John F Kennedy International Airport	American
	British
	Delta
	Terminal 1
	Terminal 4
Los Angeles International Airport	Satellite 2
	Satellite 5
	Satellite 7
	Terminal 4
	Tom Bradley
Miami International Airport	Central Terminal
	General Aviation
	South Terminal
	North Terminal

Passengers who arrive on an international flight landing at a US airport are subjected to primary inspection at a passport control site operated by CBP. Passengers debark from their plane and walk to the passport control site. They then enter either a queue for US citizens (USCs) and legal permanent residents (LPRs), or a queue for non-immigrant foreign nationals (NIMs). After reaching the end of the queue, they are allocated to an open primary inspection booth where they are inspected by a CBP officer. This inspection is similar in key aspects to primary inspection of passengers in vehicles at land border crossings: identity documents are examined, and a determination is made to admit the passenger into the U.S. or subject them to further examination in secondary inspection.

For every international flight arriving at a US airport, CBP collects data on how many USC, LPR, and NIM passengers were processed at passport control from that flight, what the total amount of time waited by

USC, LPR and NIM passengers separately was, and what the maximum time waited for a passenger on this flight was. Wait time for an individual passenger is measured as the time interval from the "block time" of the aircraft (the time at which the aircraft parks at the gate and ceases to operate under its own power) to the time when the passenger completes primary inspection processing. An estimate of the time required to walk from the aircraft to the inspection site (a "walk time") is subtracted from this time interval.[36] CBP also reports the maximum number of inspection booths that were open in the time period when this flight's passengers were processed. Only the total number of inspection booths open at the site is recorded by CBP, not the number of booths processing USC and LPR passengers and the number of booths processing NIM passengers separately.[37]

II. Change in Air Traveler Wait Time Resulting From the Addition of a CBP Officer

No previous research has established an analytical framework that can be used to quantify how wait time changes with processing capacity at passport control sites. Appendix 3A reviews key issues and challenges involved with developing such a framework, and describes the methodology that we use to quantify this relationship. Data on passport inspection is specific to flights rather than hours of the day, and passengers from flights tend to arrive in clusters, which creates special challenges for analysis. No controlled experiments have been performed at US airports that are analogous to the July 2012 experiment at the San Ysidro crossing. We develop a simple algebraic approach for analysis of passport control that is based on the assumptions that all passengers from a given flight arrive at the queuing area at the same time, processing is on a first-in, first-out basis, and the last passenger from a flight to be processed experiences the greatest wait time. Clustering of flights creates methodological challenges that are not yet fully addressed, and we have based analysis of how wait time changes with an extra processing booth on evaluation of non-clustered flights and the first flight in a cluster (see Appendix 3B for further details.) It is important to note that we cannot analyze wait times for the two queues of USC and LPR passengers and NIM passengers separately, as the number of processing booths is only given in the aggregate.

As in the case of land border crossings, we must make an assumption on how an additional officer at a passport control site is deployed. We assume that an additional officer works for 153 days in the year, and on each day worked, the officer is deployed to the eight busiest hours of the day in terms of the number of passengers on arriving flights.[38] We average over all of the hourly estimates for FY 2012 to get an average percentage change in wait time resulting from the addition of one officer.[39]

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[36] The system that records passenger wait times is known as the Airport Wait Time system. This system excludes the last 3% of passengers processed on each flight. It is assumed that these passengers are stragglers who took longer time to get to the processing site for individual reasons.
[37] It is not possible to cleanly break down the number of booths processing USC and LPR passengers versus NIM passengers, because an individual booth can process all types of passenger, and over the course of processing a flight, some booths might be shifted from USC and LPR passengers to NIM passengers or vice versa in response to changes in the relative volumes of these two groups.
[38] Our analysis assumes that necessary equipment and infrastructure is available to permit opening an extra booth at a given site.
[39] We do not determine which days are most optimal for deployment of an additional officer, but average over all days of the year. This approach recognizes that there are staffing constraints such that it might not be possible to deploy an extra officer only to the most optimal days.

Table 3-2 presents average wait time values for USC, LPR, and NIM passengers at studied passport control sites in FY 2012, and how average wait time in the 8 most congested hours at these sites changes if one additional processing booth is added, and passenger processing volume is kept constant. As in the case of passenger vehicles, it is very important to note that these results are based on analyzing marginal change from FY 2012 passenger volumes. Rises or falls in demand for international air trips due to factors such as a strengthening or weakening economy, change in exchange rates, or change in airline ticket prices are not taken into account. At almost all sites, the average wait time is lowest for an USC passenger, higher for an LPR passenger, and highest for an NIM passenger.[40] Results on change in wait time show that an extra officer does reduce average wait time at passport control sites, but generally by less in percentage terms than at land border crossings.

Table 3-3 presents change in the value of time waited in millions of dollars after one officer/processing booth is added to a passport control site. The number of passengers that are processed is fixed at the FY 2012 level, so that we do not assume any increase or decrease in passenger volumes from that level. Development of values of time for air travelers waiting in passport control queues is described in detail in Appendix 3B.[41] Results are given for USC, LPR, and NIM passengers separately. For each airport, the passport control site that produces the greatest value of time savings after the additional of one officer is marked in yellow highlight. If only one additional officer is deployed to an airport, and that officer works only at one passport control site, it would be optimal to deploy that office to the marked site. The greatest value of time savings is achieved by deploying an officer to Chicago-O'Hare, followed by JFK International Airport (Terminal 4), Miami International Airport (Central Terminal), and Los Angeles International Airport (Satellite 2).

TABLE 3-2. BASELINE WAIT TIMES AND AVERAGE CHANGE IN WAIT TIMES FROM ONE ADDITIONAL PROCESSING BOOTH AT INDIVIDUAL PROCESSING SITES

	Average Wait Time in Minutes in FY 2012			Change in Average Wait Time in 8 Most Congested Hours
Airport Site	**USC**	**LPR**	**NIM**	**+1 Officer**
ORD	17.3	21.7	33.8	-4.7%
JFK				
American	16.4	24.5	39.6	-5.7%
British	14.3	24.8	34.0	-7.6%
Delta	21.9	27.1	38.6	-6.4%

40 The higher wait time for NIM passengers can be explained by a higher average processing time for individual NIM passengers, which will directly increase the wait time for an individual passenger and also increase the time waited by individuals in the queue. The higher wait time for LPR passengers may be due to a higher average processing time for individual LPR passengers as opposed to USC passengers.

41 Values of time for passengers traveling on business and personal purposes are developed separately. The number of passengers arriving at each airport traveling for business or personal purposes in 2011 are developed using data from Office of Travel and Tourism Industries (2012a) and (2012b.)

Terminal 1	18.2	23.9	43.6	-4.9%
Terminal 4	22.3	28.9	38.8	-3.5%
LAX				
Satellite 2	15.3	18.5	28.1	-6.6%
Satellite 5	14.9	22.4	31.2	-9.4%
Satellite 7	12.7	16.5	28.1	-9.2%
Terminal 4	13.8	17.7	27.2	-13.7%
Tom Bradley	13.0	18.8	24.2	-3.1%
MIA				
Central Terminal	16.0	21.9	32.7	-2.7%
General Aviation	5.5	4.0	5.7	-100.0%
South Terminal	15.9	17.9	33.5	-5.7%
North Terminal	17.1	24.4	33.5	-2.4%

TABLE 3-3. CHANGE IN VALUE OF TIME WAITED AT PASSPORT CONTROL SITES

	+1 Officer Deployed to 8 Most Congested Hours of the Day				
	Change in Value of Total Wait Time (million US dollars)				
	USC Passengers	LPR Passengers	**USC and LPR Passengers**	**NIM Passengers**	***All Passengers***
ORD	$1.4	$0.2	**$1.7**	**$1.6**	***$3.3***
JFK					
American	$0.6	$0.2	**$0.8**	**$1.1**	***$1.9***
British	$0.3	$0.1	**$0.4**	**$0.9**	***$1.3***
Delta	$0.8	$0.1	**$0.9**	**$0.7**	***$1.6***
Terminal 1	$0.4	$0.2	**$0.6**	**$1.6**	***$2.2***
Terminal 4	$0.9	$0.3	**$1.2**	**$1.1**	***$2.3***
LAX					
Satellite 2	$0.4	$0.1	**$0.5**	**$0.9**	***$1.3***
Satellite 5	$0.2	$0.1	**$0.3**	**$0.5**	***$0.8***
Satellite 7	$0.4	$0.1	**$0.5**	**$0.4**	***$0.9***
Terminal 4	$0.2	$0.0	**$0.2**	**$0.1**	***$0.3***
Tom Bradley	$0.4	$0.1	**$0.5**	**$0.8**	***$1.3***
MIA					
Central Terminal	$0.7	$0.2	**$0.9**	**$1.1**	***$1.9***
General Aviation	$0.0	$0.0	**$0.0**	**$0.0**	***$0.0***
South Terminal	$0.3	$0.1	**$0.4**	**$1.2**	***$1.6***
North Terminal	$0.1	$0.0	**$0.1**	**$0.2**	***$0.3***

We do not quantify change in air passenger trips resulting from a decrease in passport control wait time at airports. As in the case of land border crossings, the costs associated with having to go through primary inspection at airports may deter some international travelers from coming to the U.S., as well as some US residents from traveling abroad (as they would undergo inspection upon return). Estimating how international air trips to and from the U.S. might increase as a result of change in wait time at airports is a task for future research.[42] As in the case of land border trips, change in wait time will affect both those coming to the U.S. and those leaving the U.S. Analysis of the impact on the U.S. economy must take into account changes in both flows, as increased arrivals of international travelers will increase domestic spending, but increased departures of U.S. residents will lower domestic spending.

We also do not quantify any increase in airport capacity to process flights that might result from increased primary inspection capacity, and related increase in the number of flights and passengers arriving at the airport. Conducting such analysis properly would be complex and would require addressing a range of issues. Determining the degree to which primary inspection capacity is a constraint requires understanding all of the constraints at play in the determination of an airport's flight processing capacity, including, for example, runways, air traffic control, and baggage handling. It is not obvious that increasing primary inspection capacity would increase an airport's processing capacity if other constraints are not also relaxed. Estimating the economic impacts of an additional flight would require determining how many new passenger trips are created as opposed to substitution of existing passengers into the new flight and away from existing flights. New flights would also create new trips of both international passengers coming to the U.S. and US residents going abroad.

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[42] There are two approaches that could be taken to quantifying change in trips in response to change in wait time. First, an approach based on the price elasticity of demand for international air trips could be taken. The monetary value of wait time for an average USC, LPR, and NIM passenger can be added to the total monetary expenditures on an international air trip from or to the U.S. to get the total price of a trip. The percentage change in the total price of a trip resulting from the fall in wait time can then be determined, and change in the volume of international air trips estimated by multiplying this percentage change in total trip price by a price elasticity of demand for international air travel. The second approach would be to obtain survey data on the wait experience of international air travelers, and either to use econometric analysis to determine if change in wait time affects travel volume, or to ask potential travelers directly if they have been deterred from coming to or leaving the U.S. because of the primary inspection process.

Appendix 3A: Wait Time Analysis for Airport Passport Control Stations

Passport inspection for passenger arrivals on international flights at US airports is similar to inspection at land border crossings. Passengers on international flights arriving at a US airport disembark from their plane and walk to a primary booth. They enter either a queue for US citizens (USCs) and legal permanent residents (LPRs), or a queue for non-immigrant foreign nationals (NIMs). After reaching the end of the queue, they are allocated to an open primary inspection booth where they are inspected by a CBP officer.

For every international flight arriving at a US airport, CBP collects data on how many USC, LPR, and NIM passengers were processed at passport control from that flight, what the total amount of time waited by USC, LPR and NIM passengers separately was, what the maximum time waited for a passenger on this flight was, and how many inspection booths were open on average to process this flight's passengers. Only the total number of inspection booths open at the site is given, not the number of booths processing USC and LPR passengers and the number of booths processing NIM passengers separately.

Passenger traffic arriving at a passport control site tends to arrive in discrete clusters that are associated with clusters of arriving flights. We define clusters in the following manner. Consider flight #1 that arrives first, whose passengers start to be processed at time A. The passenger on this flight who experiences the longest wait time finishes being processed at time B. Flight #2 arrives next, and its passengers start to be processed at time C. If time B is later than time C, then passengers from the second flight find some passengers from the first flight who are still standing in the queue, and the latter must be processed before any passengers from the second flight can be processed. In this case, we treat these two flights as forming a cluster. If a third flight arrives and its passengers find passengers from the second flight still standing in the queue, then that flight is treated as being part of the same cluster. If a flight subsequently arrives whose passengers find an empty queue, then this flight is the first flight of a new cluster.

Figure 3A-1 shows the number of total passengers in the queue at the passport control site Terminal 2 at Los Angeles International Airport at various times during the day of October 1 2011.[43] The clustered nature of flight arrivals and passenger processing is revealed in this graph. A first flight arrived at 12:03 am and a second flight arrived at 12:29 am to form the first cluster: passengers from the second flight arrived at the passport control site to find some passengers from the first flight standing in front of them in the queue. The next cluster did not appear until 11 am, but this cluster included 11 consecutive flights and was processed over 4.5 hours. A third cluster of two flights processed over one hour appeared at 4:30 pm, followed by a cluster of eight flights starting at 6:45 pm processed over 3 hours. This cluster was followed by a single flight that was processed in 15 minutes and whose passengers did not encounter passengers from any other flight either in front of them or behind them in the queue. Finally, a cluster of three flights began at 11 pm that was processed over 1 hour.

Figure 3A-1 also shows the average number of booths open over each flight. As in the case of land border crossings, there is significant endogenous adaptation by the passport control site manager to smooth wait times for passenger arrivals. The number of booths open rises with the length and volume of a cluster, and is smallest for single flights or small clusters. Simple approaches to quantifying this relationship such as

[43] Because data are not kept on the number of booths processing USCs plus LPRs versus NIMs separately, we must treat the two groups of passengers as one larger group for analytical purposes.

regressing wait time on the number of booths open gives a positive coefficient on booths open, suggesting that opening a booth increases wait time. As in the case of passenger vehicles at land border crossings, this result is due to the fact that site managers increase the number of booths as the number of passengers arriving to be processed increases.

No controlled experiments have been performed at US airports that are analogous to the July 2012 experiment at the San Ysidro crossing. We must therefore develop a simple algebraic approach that is analogous to the one developed for land border crossings. In order to develop an approach, we make the following assumptions:

- All passengers from a given flight arrive at the queuing area at the same time;
- Processing is on a first-in, first-out basis;
- The last passenger from a flight to be processed experiences the greatest wait time.

A. Single Flight Not In a Cluster

For a single flight not in a cluster, the analytics of adding an extra processing booth is straightforward. CBP provides actual values for each flight for the following variables:

P = total number of passengers that are processed (sum of USC, LPR, and NIM passengers);
B = average number of booths open for processing this flight;
WT = total time waited by passengers from this flight in seconds;
WM = maximum recorded wait time for a passenger from this flight in seconds.

We can easily calculate the following variables from these variables:

n = P/B: number of passengers processed by average booth;
WA = WT/P: average wait time for passengers from this flight in seconds.

Consider the value for s = average number of seconds required to process an average passenger at an average booth. It is straightforward to show that the value of s can be calculated as:

$$s = \frac{WT}{\left[B * \sum_{i=1}^{rnddn(n-1)} i\right] + [(P - \{rnddn(n) * B\})rnddn(n)]} \ ,$$

where the "rnddn(a)" function rounds the number a down to an integer value.

Now consider adding one booth, processing the same number of passengers P, and assume that processing time s does not change. The value of n changes:

$$n^* = \frac{P}{B+1}$$

The new value for total time waited by passengers is:

$$WT^* = \left[(B+1) * s * \sum_{i=1}^{rnddn(n^*-1)} i\right] + \{[P - (rnddn(n^*) * (B+1))] * rnddn(n^*) * s\}$$

and the new average time waited is:

$$WA^* = \frac{WT^*}{P}$$

The ratio of the average wait time after adding a booth to before adding a booth is:

$$\frac{WA^*}{WA} = \frac{WT^*}{WT}$$

B. Flights in a Cluster

For a cluster, analysis is more complicated. For the first flight in a cluster, the impact of an extra booth can be analyzed using the methodology for a single flight. This is because of the assumption that all passengers from a given flight arrive at the queuing area at the same time. Unless passengers from two flights enter the queuing area at roughly the same time, they will not intermingle, and passengers from the first flight in a cluster will not have any passengers from another flight ahead of them in the queue.

For subsequent flights in a cluster, analysis must take into account that some passengers from previous flights are still in the queue, and these residual previous-flight passengers add time to the wait of passengers on subsequent flights. It is tempting to think that one could analytically treat a cluster of flights as one large flight to be processed, and apply the technique for a single flight to aggregated cluster data. However, it is not clear that this approach is correct. Until it can be demonstrated mathematically what the appropriate approach is for flights in a cluster after the first flight, we will not make this assumption.

We therefore analyze the impact of adding a booth to a passport control site only for single flights that are not in a cluster, and for the first flights in clusters. The assumption that flight A's passengers all arrive for processing before flight B's passengers even when the flights arrive at almost the same time is clearly too extreme. We therefore also aggregate together the first flight and subsequent flights in a cluster whose passengers arrive at the passport control site within 3 minutes of each other.[44]

[44] A 3-minute assumption is arbitrary, but it is not obvious what cutoff value is optimal. A more satisfactory treatment of flight arrival clustering would build in randomness to the arrival process of the passengers, so that passengers from flights that arrive close to each other tend to be intermingled in the queue, but as the time separation between flight arrival times increases, the degree of intermingling decreases. At some degree of time separation, even though processing of the flights' passengers would overlap, it would also be the case that all of the later flight's passengers enter the queue behind the earlier flight's passengers. Developing this analytical approach is beyond the scope of the current project and is a subject for future research.

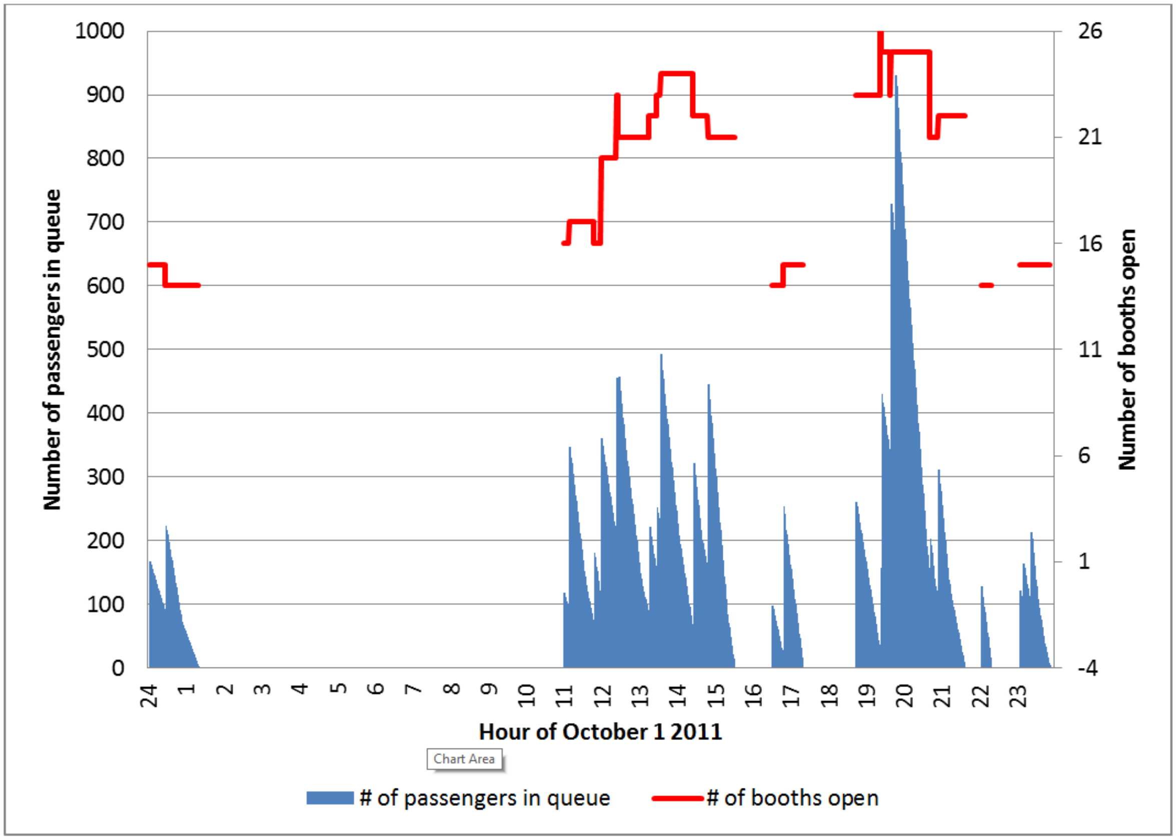

FIGURE 3A-1. FLIGHT CLUSTERING AT LAX-SATELLITE 2 ON OCTOBER 1 2011

Source: developed from CBP data for individual flights and assuming that passengers in a given flight are processed at a uniform rate over time.

Appendix 3B. Value of Time for Automobile and Air Travelers

The values of an hour of time spent in travel by people on business and personal trips are developed based on a methodology established by the US Department of Transportation. For US citizens and legal permanent residents, the value of time for business travelers is based on the May 2011 median pre-tax wage plus benefits, and the value of time for personal travel is based on the May 2011 median pre-tax wage without benefits multiplied by 0.6. [45] These values are further modified to reflect the disutility of waiting in queues using a methodology developed for the Department of Homeland Security in which the values are multiplied by a factor equal to 1.47.[46] Values for business and personal travel time are then aggregated into a composite value of time based on the breakdown of cross-border travelers by purpose of trip.[47]

For land border crossings, we develop value-of-time estimates using both the nationwide US median wage, and median wage rates for the local region in which a border crossing is situated. As results generally do not differ much under these two approaches, we present results using the nationwide wage in this report. For non-immigrant Canadian nationals, the value of time for both business and personal travelers is based on the May 2011 median nationwide wage rate converted into US dollars using the 2011 commercial exchange rate. For non-immigrant Mexican nationals, the value of time for both business and personal travelers is based on multiplying the US nationwide median wage by the ratio of Mexican to US per capita income in 2011, with Mexican per capita income valued in nominal US dollars using the commercial exchange rate.

For air travelers, the US Department of Transportation methodology sets much higher values of time in travel than for travelers in ground vehicles.[48] We follow this methodology. For US citizens and LPRs, we use an appropriately adjusted value of the May 2011 nationwide median wage. For non-immigrant foreign nationals (NIMs), we first construct a weighted average of the ratios of per capita income in various countries valued in US dollars at the commercial exchange rate to US per capita income, with weights being the fraction of overseas visitors arriving by air to the US from a particular country in 2011.[49] This ratio is then multiplied by the value for a US citizen/LPR air traveler's time.

Table 3B-1 gives values of time spent waiting in queues at land border crossings or at airports that are used in this study.[50]

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[45] See US Department of Transportation (2011).
[46] See Robinson (2007), who developed this methodology to support economic impact analysis related to the Western Hemisphere Travel Initiative rule.
[47] For passengers crossing the northern border, data from Statistics Canada (2011) on Canadian and American nationals crossing the border by automobile by purpose of trip is used to create the breakdown. Unlike the northern border, very little data is available for travel across the southern border broken down by purpose of trip. The only available evidence available is from a survey of several thousand travelers crossing in the San Diego region in 2004 and 2005 that was carried out to support the SANDAG (2006) study, which is used here.
[48] See US Department of Transportation (2011).
[49] These weights are constructed from data obtained from Office of Travel and Tourism Industries (2012b).
[50] These values are derived using a value of the hourly median pre-tax nationwide US wage in May 2011 of $16.57, and an estimated hourly median pre-tax nationwide US wage plus benefits of $23.94.

TABLE 3B-1
Value of Hour of Time Spent Waiting in Primary Inspection Queues

	Value of wait time: Personal			Value of wait time: Business			Value of wait time: Composite, northern border			Value of wait time: Composite, southern border		
	Low	"Best"	High	Low	"Best"	High	Low	"Best"	High	Low	"Best"	High
PASSENGER VEHICLES												
U.S. Citizens and LPRs												
Nationwide	$8.53	$14.61	$21.92	$28.15	$35.19	$42.23	$9.65	$15.80	$23.09	$10.33	$16.51	$23.79
California	$9.53	$16.33	$24.50	$31.46	$39.33	$47.20	NA	NA	NA	$11.55	$18.45	$26.59
San Diego-Carlsbad-San Marcos	$9.41	$16.12	$24.18	$31.06	$38.82	$46.58	NA	NA	NA	$11.40	$18.21	$26.25
El Centro (Calexico crossings)	$7.47	$12.81	$19.21	$24.67	$30.84	$37.00	NA	NA	NA	$9.05	$14.47	$20.85
Arizona	$8.44	$14.46	$21.70	$27.86	$34.83	$41.79	NA	NA	NA	$10.22	$16.34	$23.55
Texas	$7.94	$13.62	$20.43	$26.23	$32.79	$39.35	NA	NA	NA	$9.63	$15.38	$22.17
El Paso	$6.30	$10.80	$16.21	$20.81	$26.01	$31.22	NA	NA	NA	$7.64	$12.20	$17.59
Laredo	$5.85	$10.03	$15.04	$19.32	$24.15	$28.97	NA	NA	NA	$7.09	$11.33	$16.32
Washington	$9.93	$17.02	$25.53	$32.79	$40.99	$49.18	$11.24	$18.40	$26.89	NA	NA	NA
Bellingham (Blaine crossings)	$8.59	$14.72	$22.08	$28.35	$35.44	$42.53	$9.72	$15.91	$23.26	NA	NA	NA
Michigan	$8.47	$14.53	$21.79	$27.98	$34.98	$41.97	$9.60	$15.70	$22.95	NA	NA	NA
Detroit-Livonia-Dearborn	$9.46	$16.22	$24.33	$31.24	$39.05	$46.86	$10.71	$17.53	$25.63	NA	NA	NA
New York	$9.79	$16.78	$25.16	$32.31	$40.39	$48.47	$11.08	$18.13	$26.50	NA	NA	NA
Buffalo-Niagara Falls	$8.33	$14.29	$21.43	$27.52	$34.40	$41.28	$9.44	$15.44	$22.57	NA	NA	NA
Mexican Nationals	$1.78	$3.05	$4.58	$5.88	$7.35	$8.82	NA	NA	NA	$2.16	$3.45	$4.97
Canadian Nationals	$10.00	$17.14	$25.71	$22.86	$28.57	$34.29	$10.74	$17.80	$26.21	NA	NA	NA
AIR TRAVELERS												
U.S. Citizens and LPRs	$41.84	$52.23	$62.61	$76.51	$95.60	$114.69						
Non-Immigrant Foreign Nationals	$29.62	$36.97	$44.32	$54.16	$67.67	$81.19						

REFERENCES FOR APPENDIX 3B

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CHAPTER 4. IMPACTS OF WAIT TIMES ON TRUCK TRANSPORTATION COSTS

by

Nathaniel Heatwole

I. INTRODUCTION

A. Purpose of this Chapter

This chapter summarizes the methodology for estimating the total transportation costs (from origin to destination) for freight moving across the northern and southern U.S. land Ports of Entry (POEs) by truck. This framework is to be used to evaluate changes in wait times in relation to total freight transportation cost, wherein the percentage change in transportation cost will be the primary input into a computable general equilibrium (CGE) model, which will then be used to evaluate the macroeconomic impacts of changes in wait times for freight transportation at major POEs (Chapter 5). We also develop a method for monetizing the opportunity cost of time for truck traffic at the border, and present these opportunity cost results alongside the changes in the "out-of-pocket" transportation costs.

It is important to note that we do not quantify in this study the impact of changes in wait time on the number of businesses established in the border region. A lowering of wait time for commercial vehicles may encourage the establishment of new businesses in the region, and an increase in wait time may cause some businesses to shut down. Quantifying such impacts is outside the scope of this study. We also do not evaluate the impact of wait time on supply chain productivity. Lower wait time might permit cross-border supply chains to reduce inventory holdings and achieve other kinds of productivities that reduce cost of production.

B. Basic Modeling Approach

In this chapter, in general, transport costs are quantified on a *per-hour* basis, so that they can be directly linked to the time that the truck spends crossing the border. The costs are also specified on a *per-truck* (rather than aggregate) basis. Unless noted otherwise, all values are in 2011 US$, with inflation adjustments made using the Producer Price Index (across all commodities). A general flow diagram of how truck traffic moves through a POE (on the U.S.-Mexico border) is given in Figure 4-1.

The cost of transportation is composed of three components in relation to the movement of the freight:

1. Within the country of origin (Mexico or Canada) to the U.S. border;
2. Across the U.S. border itself; *and*
3. From the U.S. border to the destination point within the U.S. interior.

In each of these cases, the transportation cost consists of the truck operating cost, which includes driver wages, fuel consumption, and sundry other vehicle-related things such as vehicle maintenance and depreciation. Additionally, Component #2 (cross-border) includes the customs broker fees and, on the southern border, the drayage costs (unloading/loading associated with the freight movement across the border). In addition to out-of-pocket costs, the border crossing also has an opportunity cost of time (or of delay or congestion). Modeling all of these transport costs is challenging, as it involves assessing the operating environment for trucks in three different countries (i.e., the U.S., Mexico, and Canada).

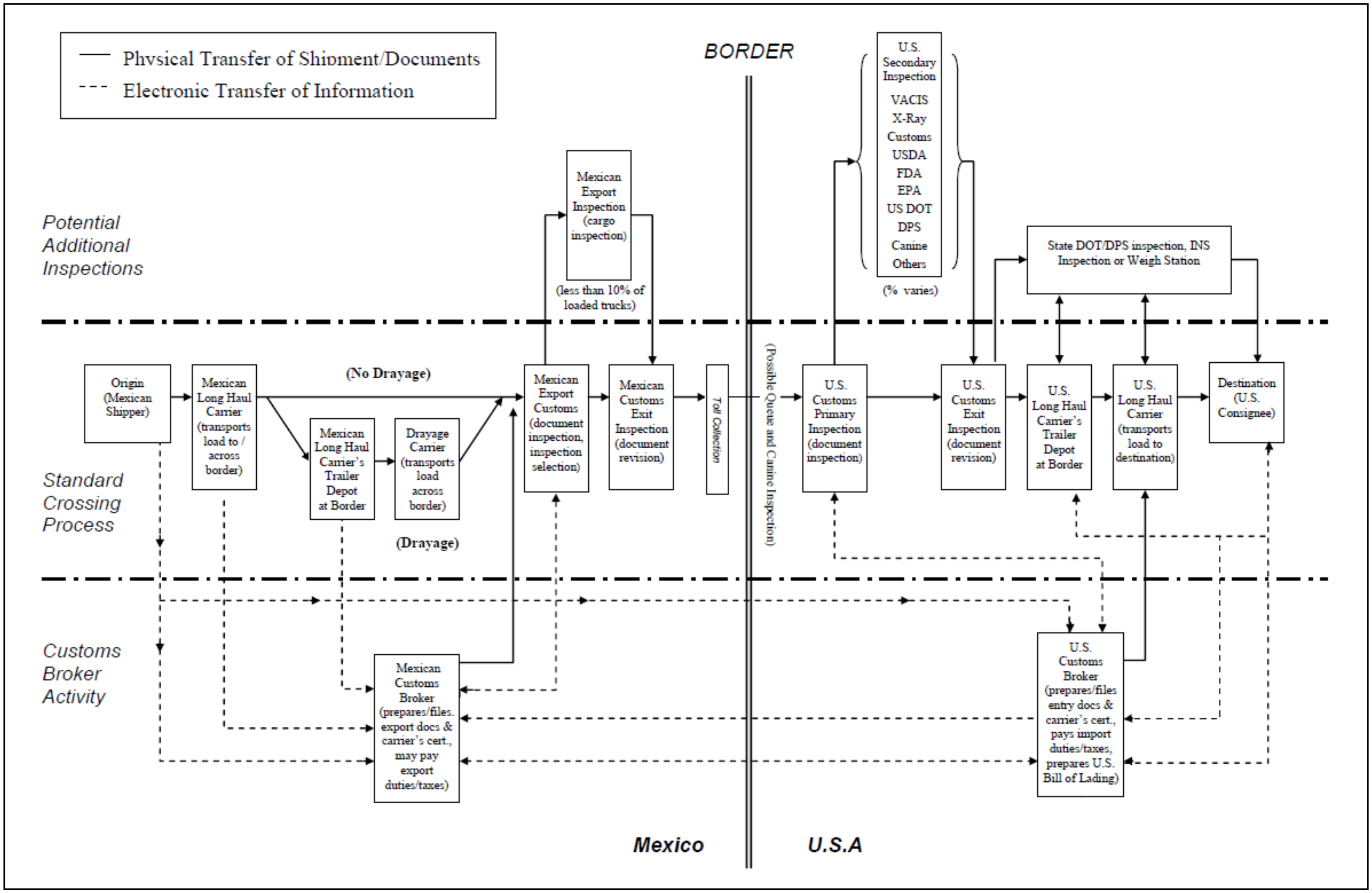

FIGURE 4-1. FLOW DIAGRAM OF HOW TRUCK TRAFFIC MOVES THROUGH THE BORDER (SOURCE: OJAH *ET AL.*, 2002)

In our model, the "nationality" of all trucks crossing the border must be known, as the truck operating costs can be quite different for U.S. trucks versus Canadian and Mexican trucks (see Table 4-4). So in Component #2 of the analysis (i.e., the cross-border segment of the trip), we make the simplifying assumption that all trucks crossing the border are registered in the country from which they originate. And while the assumption of no U.S. trucks traveling into Canada or Mexico may not always be the case, we do not have any data on which to base this specification, so we simply assume that only Mexican trucks cross the southern border and that only Canadian trucks cross the northern border.

C. Variables Used

In the CBP vernacular, *waiting time* refers to the time spent waiting for an inspection to begin (from entering the queue until the initiation of the inspection), and *processing time* is the amount of time needed to undergo the inspection itself. This wording convention is also adopted in this chapter. A summary of these and all other variables used in this chapter – along with their units, data sources, and whether or not we assume that the quantity is affected by (i.e., changes with) wait times at the border – is given in Table 4-1. In Table 4-1, note that 'not applicable' (n.a.) is listed for the wait times variable (WT) under the column indicating if the quantity is affected by wait times because these two concepts are synonymous in this case.

In the sections that follow, we discuss how the various quantities in Table 4-1 are used to model the transport costs for freight traveling through the border.

TABLE 4-1. SUMMARY OF ALL PARAMETERS USED IN ESTIMATING CHANGES IN TRANSPORTATION COSTS

	Notation	Description	Units	Depends on Wait Time?	Data Source
Time-Related	**WT**	Wait time for primary inspection (from entering queue until start of inspection)	hours	n.a.	CBP
	PT_1	Primary inspection processing time; time needed for primary inspection itself		No	
	PT_2	Secondary inspection processing time; time needed for secondary inspection itself			
	TT	Total time needed for the border crossing (primary and secondary inspections)		Yes	calc
	P_2	Portion of all trucks which are referred to secondary screening	n.a.	No	CBP
	BOOTHS	No. of inspection booths (lanes) open			
	E	Elasticity of wait time with respect to number of booths open			Table 4-3
Unit Costs	**UC_{time}**	Unit cost of time for commercial vehicles	$/hour	No	LIT
	$UC_{vehicle}$	Unit vehicle-related commercial vehicle operating cost (excluding fuel)			
	UC_{wage}	Hourly truck driver wage			
	UC_{fuel}	Unit cost of diesel fuel	$/gallon		
Total Costs	**TC_{broker}**	Total customs broker fees	$	No	INT
	$TC_{drayage}$	Total drayage-related cost (unloading/loading)			LIT
	TC_{fuel}	Total fuel cost		Yes	calc
	$TC_{vehicle}$	Total vehicle-related costs (excluding fuel)			
	TC_{border}	Total transportation cost of the border crossing itself			
	TTC	Total transportation-related cost (from origin to destination)			
	OC_{time}	Total opportunity cost of time			
	DX	Distance traveled	miles	No	BE, LIT
Others	**F**	Fuel used	gallons	Yes	calc
	S_{queue}	Average truck speed while crossing border	mi/hr	No	BE
	S_{hwy}	Average truck speed while on the open highway			LIT
	TFE	Truck fuel economy (fuel efficiency)	mi/gal		LIT, BE

BE=analyst's best estimate; **CBP**=U.S. Customs and Border Protection; **LIT**=literature; **INT**=customs broker interview; **calc**=calculated (using other values in table); **n.a.**=not applicable

II. TIME NEEDED FOR BORDER CROSSING

The total time (TT) needed for the border crossing is

$$TT = (WT + PT_1) + P_2 \cdot (PT_2) \tag{4-1}$$

where WT is the wait time for the primary inspection (in the queue), P_2 is the portion of all trucks which are referred to secondary screening, and PT_1 and PT_2 are the processing times for the primary and secondary inspections themselves, respectively. The second term in Equation 4-1 can be thought of as the "expected value" of the time needed for the secondary inspection (across all trucks – even those which are not referred to secondary screening). And because all of the parameters in Equation 4-1 except for WT are assumed invariant (see Table 4-1), the change in the total time needed for the border crossing is simply

$$\Delta TT = \Delta WT \tag{4-2}$$

While CBP has extensive data on waiting and processing times for the primary inspections, only general ranges for the time associated with secondary inspections are available. Accordingly, we do not include the wait time for the secondary inspection in Equation 4-1 (i.e., waiting for the secondary inspection to begin after the primary inspection has ended) – in essence, assuming that a secondary inspection booth is always available when needed.

The wait times and processing times for the primary inspection (or WT and PT_1, respectively), as well as the number of booths open during the eight most congested hours of each day, are summarized by POE in Table 4-2. Note that although our model uses hours as the calculational unit for time, the values in Table 4-2 are given in minutes, as the magnitudes are such that this is a more intuitive unit for display. The wait time values in Table 4-2 (WT) are the average of the (hourly) wait times: 1) across all hours in FY2012 that the port was open; and 2) across only the most congested eight hours of each day. On the one hand, the additional CBP officer is presumed to be added to the eight most congested hours each day, which suggests that only the wait time data for these eight hours should be used. On the other hand, the benefits (i.e., wait time reductions) induced by the additional customs officer can extend beyond the eight hours when that person is actually on duty (because their presence helps thin out the queue), suggesting that the wait times in other hours should also be considered. So we simply average the two wait times together (across all hours and in only the eight most congested hours each day).

Information related to secondary screening was obtained from CBP personnel, who informed us that about one third of all trucks are referred to secondary inspection (P_2=0.333). Of those trucks sent to secondary, roughly three quarters receive a non-intrusive inspection (duration: 10 minutes), with the remaining one quarter undergoing an intrusive inspection (duration: 40 minutes). This equates to an expected secondary inspection processing time of

$$PT_2 = 0.75 \cdot (10\,\text{min}) + 0.25 \cdot (40\,\text{min}) = 17.5\,\text{min} \tag{4-3}$$

which applies to one third of the trucks moving through the border.

Table 4-3 gives the estimated elasticities of the wait times with respect to the number of inspection booths open for the +1 officer scenario (optimally allocated, to the eight busiest hours of the day), which we denote $E_{(+1)}$. And for the -1 officer scenario (or $E_{(-1)}$), the elasticity is specified simply as minus 50% of the elasticity in the +1 officer scenario, or mathematically as

$$E_{(-1)} = -0.5 \cdot \left[E_{(+1)} \right] \tag{4-4}$$

In the +1 officer scenario, the number of booths increases by one, and the change in the wait time (relative to the 'default' situation) is given by

$$\Delta WT = E \cdot \left(\frac{WT_0}{BOOTHS_0} \right) \tag{4-5}$$

where E is the wait time-booth elasticity, and WT_0 and $BOOTHS_0$ are the (average) hourly wait time and (average) number of booths open during the eight most congested hours of the day, respectively, both in the 'default' scenario (values given in Table 4-2).

And finally, Table 4-4 summarizes the information from the literature that is applied in the transport cost model. In cases where more than one value was located for a particular cell in Table 4-4, the average of the values was taken and used in the model.

TABLE 4-2. TRUCK VOLUME, PROCESSING TIME, AND WAIT TIME IN THE BASE-CASE SCENARIO FOR EACH PORT OF ENTRY

Port of Entry	Crossing	Invariant (all scenarios)		Base-Case (Current/Default) Scenario			
		Annual Truck Volume	Processing Time (minutes)[a]	Wait Time (minutes)[a]	Standard Deviation of Wait Time (minutes)[a]	No. of Booths Open[b]	Standard Deviation of No. of Booths Open[b]
Calexico	**Calexico/East**	320,482	1.24	26.4	17.9	2.6	0.44
El Paso	**Ysleta**	360,470	1.27	11.0	10.0	3.5	0.94
	Bridge of the Americas	290,220	1.41	14.8	14.5	4.1	1.04
Laredo	**Columbia Solidarity**	215,701	0.64	7.5	6.5	2.9	0.25
	World Trade Bridge	1,356,418	0.56	24.3	20.1	6.9	2.23
Nogales	**Mariposa**	644,925	1.76	33.5	32.7	2.9	0.98
Otay Mesa	**Otay Mesa**	309,365	1.15	31.2	7.9	8.0	1.30
Blaine	**Pacific Highway**	625,651	1.18	13.5	14.6	2.3	2.23
Buffalo-Niagara Falls	**Lewiston Bridge**	298,730	0.94	3.8	20.4	2.6	2.25
	Peace Bridge	343,396	1.18	6.2	11.7	4.7	0.87
Detroit	**Windsor Tunnel**	39,056	1.02	3.9	3.5	1.0	0.03
	Ambassador Bridge	1,425,757	1.03	6.7	4.6	7.2	3.00

[a]Average of the values: across all hours in FY2012, and for only the eight most congested hours of each day.
[b]During only the eight most congested hours of each day.
Note that all data are for FY 2012.

TABLE 4-3. EXPECTED CHANGES IN WAIT TIMES FOR ADDING AND SUBTRACTING ONE CBP OFFICER TO EACH PORT OF ENTRY

Port of Entry	Crossing	Wait Time in Default Case (minutes)	+1 CBP Officer Scenario[a]			-1 CBP Officer Scenario		
			Wait Time-Booth Elasticity	Change in Wait Time[b] (minutes)	New Wait Time (minutes)	Wait Time-Booth Elasticity[c]	Change in Wait Time[b] (minutes)	New Wait Time (minutes)
Calexico	**Calexico/East**	26.4	-0.70	-7.2	19.2	+0.35	+3.6	30.0
El Paso	**Ysleta**	11.0	-0.73	-2.3	8.7	+0.36	+1.2	12.2
	Bridge of the Americas	14.8	-0.58	-2.1	12.6	+0.29	+1.1	15.8
Laredo	**Columbia Solidarity**	7.5	-0.95	-2.4	5.0	+0.48	+1.2	8.7
	World Trade Bridge	24.3	-0.69	-2.4	21.9	+0.35	+1.2	25.5
Nogales	**Mariposa**	33.5	-0.55	-6.3	27.2	+0.27	+3.2	36.6
Otay Mesa	**Otay Mesa**	31.2	-0.38	-1.5	29.7	+0.19	+0.7	31.9
Blaine	**Pacific Highway**	13.5	-0.83	-4.9	8.6	+0.42	+2.5	16.0
Buffalo-Niagara Falls	**Lewiston Bridge**	3.8	-0.71	-1.1	2.8	+0.35	+0.5	4.4
	Peace Bridge	6.2	-0.47	-0.6	5.6	+0.24	+0.3	6.5
Detroit	**Windsor Tunnel**	3.9	-1.00	-3.9	0.0	+0.50	+2.0	5.9
	Ambassador Bridge	6.7	-0.61	-0.6	6.2	+0.31	+0.3	7.0

[a]Optimally allocated, to the eight most congested hours of each day.
[b]Relative to the default values.
[c]Equal to negative one half of the wait time elasticity in the +1 officer scenario (Equation 4-4).

III. Travel Distances

A key parameter in the transport cost model is the distance the freight must travel – both overall and within each of the three countries (the U.S., Mexico, and Canada). The overall (origin to destination) distances are estimated by assuming that the freight starts at the population centroid of the country of origin (either Canada or Mexico) and then ends at the U.S. population centroid. In this way, we are assuming that the location of people is a good proxy for the origin and destination of freight, although this may not be the case in actuality. For example, because of their traditionally heavy volumes of trade with the U.S., manufacturing within Mexico and Canada may be more clustered around the U.S. border, more so that would be suggested by the layout of the populations of the two countries.

The locations of the three population centroids were assessed using data downloaded from NASA's Socioeconomic Data and Applications Center (SEDAC, 2005). The SEDAC data does not give the location of literally all persons in each country, but rather the locations (latitude/longitude) and populations of various sub-national administrative units, using UN population data from the year 2000. Using the SEDAC data, the mean centroids of population were determined as approximately

- *Mexico*: (21.16°N, 100.18°W)
- *U.S.*: (37.63°N, 91.95°W) (state of Missouri)
- *Canada*: (46.82°N, 87.53°W)

The U.S. centroid above corresponds very closely to that given by the U.S. Census Bureau (2012), which is at about (37.52°N, 92.17°W) – also in the state of Missouri – and which uses data that has *not* been aggregated to the level of administrative units. Note also that the Canadian population center, interestingly, is actually *in the U.S.*![51]

The overall travel distances (from origin to destination) were then defined as the straight line distances between the centroids, determined using the calculator from the U.S. National Hurricane Center (NHC, 2010). While the freight would in fact be transported by road – and therefore would likely take a route that may correspond only weakly with the straight line route – the use of the population centers to determine the travel distances is only an approximation to begin with (see first paragraph of this section). These straight line distances work out to about 674 miles for goods shipped to the U.S. from Canada, and about 1,240 miles for goods incoming from Mexico.

These overall distances are next broken down by the country in which they are incurred. This is necessary because the operating costs for trucks are quite different in each of the three countries (see Table 4-4). We make this division using data on domestic freight activity in each of the three countries, using the North American Transportation Statistics Database (NATSB, 2012). By taking the ratio of the freight movement in ton-kilometers to the freight movement in tons (for truck traffic in 2010 – the most recent year for which these data are available for all three countries), the average distance per domestic shipment was estimated to be about 279km for Canada, 469km for Mexico, and 251km for the U.S. We assume that these distances are proportional to the distance that the goods travel within each country (even though the data apply to domestic shipments, rather than to imports). So for example, the ratio

[51] This is a consequence of the fact that such a large portion of Canada's population is clustered so far south, combined with the particular shape of the country (most notably the "dip" to the south in the province of Ontario).

of the distance for domestic shipments for Mexico to that for the U.S. are (469km/251km)=1.87, so we assign 87% more of the total Mexico-U.S. transport distance (1,240 miles – see above) to Mexico than to the U.S., resulting in 808 miles shipped in Mexico and 432 miles shipped in the U.S. And applying this process to Canadian shipments gives 355 miles traveled in Canada and 319 miles in the U.S.

An additional estimate for the distance traveled in Canada is available from Statistics Canada (2010). In 2009, the total number of vehicle-kilometers driven by Canadian trucks on "trips across Canada and United States border" was around 3,168.6 million vehicle-km (total for all Canadian trucks weighing 4.5+ metric tons), or about 1,969 million vehicle-miles. And according to the U.S. Bureau of Transportation Statistics (BTS, 2012), the number of trucks entering the U.S. through its northern border in 2009 was 5,020,633 (sum over all northern POEs). Assuming that all of these trucks are registered in Canada (see Section IB), this equates to a per-trip mileage of about 392 miles per truck, which corresponds closely to the value determined above (355 miles).

IV. Fuel Costs

The fuel used (F; gallons) is

$$F = \frac{DX}{TFE} \qquad (4\text{-}6)$$

or the distance traveled (DX) divided by the truck fuel efficiency (TFE; miles/gallon). When the truck is at the border (in the queue and during the inspections), the distance traveled (DX) is equal to the product of the truck's (average) speed while at the border (S_{queue}), and the total time needed for the border crossing (TT).

For the truck fuel efficiency, we use the regression equation presented by Schrank *et al*. (2011), or

$$TFE = 1.4898 \cdot \ln(S) - 0.2554 \qquad (4\text{-}7)$$

where 'S' is the truck's (average) speed (miles/hour). Equation 4-7 is based on fuel efficiency data from the Environmental Protection Agency (EPA) and the Federal Highway Administration (FHWA). These data, however, apply to U.S. trucks, so to account for the possible relative fuel efficiencies of vehicles in Canada and Mexico, we use data from the North American Transportation Statistics Database (NATSB, 2012). Although the database does not include fuel efficiency data specifically for 18-wheel trucks, it does contain these data for "new light-duty trucks," which we use as a proxy for semi-tractor trailers. For 2002-2007 (the only years for which these data are available for all three countries), the fleet average fuel efficiency (in kilometers per liter) in Canada is about 1% greater than in the U.S., and is about 9% greater in Mexico than in the U.S.[52] So for Canadian trucks, we simply use the results from Equation 4-7 unmodified and for Mexican trucks, we inflate the results from Equation 4-7 by 9%.

[52] The higher fuel efficiency for Mexican trucks may be due to less stringent health and safety regulations related to vehicle manufacturing and operation in Mexico, thereby allowing a greater travel distance per unit of fuel consumed to be achieved. Another possible explanation is that Mexican trucks are lighter (i.e., less well-equipped) than their counterparts in the U.S. and Canada, thereby allowing a greater level of fuel efficiency.

During the border crossing (in the queue and during the inspections), the truck speed will likely be rather low, so we use S_{queue}=5 mi/hr. When on the open highway (away from the border station), however, the speed should be considerably higher, so we use S_{hwy}=40 mi/hr, which is a somewhat standard value used for overall truck speed in the trucking industry (ATRI, 2011).

The unit cost of diesel fuel (UC_{fuel}) is determined using MyTravelCost.com, which gives current fuel prices for all countries worldwide. These cost data comes from a variety of sources, including official government figures and self-reported data by travelers. Table 4-4 indicates that the price of diesel fuel is currently the highest in Canada, followed by the U.S., with the cheapest fuel found in Mexico. The total fuel cost is then

$$TC_{fuel} = UC_{fuel} \cdot (F) \tag{4-8}$$

or the product of the per gallon fuel cost (UC_{fuel}) and the number of gallons used (F).

V. All Vehicle-Related Costs Other Than Fuel

Per-mile truck operating costs for Canada are available from Transport Canada (2005). This includes the costs of repairs, cleaning, tires, depreciation, licenses, operator profit margin, interest, insurance, and administration.

For U.S. trucks, a variety of sources of operating cost information are available. One is a Minnesota Department of Transportation report (MDOT, 2003), which presents costs for repairs/maintenance, tires, and depreciation, based on a review of a variety of sources of cost data. Another estimate is given by the American Trucking Research Institute (ATRI, 2011). Boyer (1997) also suggests that as a very general rule of thumb, it costs one dollar (1997$) to drive a standard 18-wheel, 80,000-pound truck a distance of one mile – equating to about $1.58/mile in 2011$ – of which he suggests approximately 40% is for driver wages, 20% for fuel, and the remaining 40% for vehicle depreciation, licensing, interest, tires, maintenance, and other miscellaneous items. Yet another source is Schrank *et al*. (2011), who suggest a value of about $96/hour, including driver wages, vehicle depreciation, interest, insurance, general maintenance, tires, repairs, and other similar costs. Excluding driver wages, this equates to a vehicle-related operating cost of $76.85/hr (by subtracting out the average hourly trucker wage from BLS, 2012 – see Table 4-4).

And finally, the vehicle-related costs for trucks in Mexico are specified by adjusting the operating cost data for the U.S. and Canada, based on the relative GDPs per capita of the two countries (using GDP data from the World Bank, 2013).

The total vehicle-related cost is then

$$TC_{vehicle} = UC_{vehicle} \cdot (TT) \tag{4-9}$$

where $UC_{vehicle}$ is the appropriate hourly truck operating cost.

VI. Truck Driver Wages

Hourly wage data for workers in Canada's "transportation and warehousing" industry is available from Statistics Canada (2012). Transport Canada (2005) also provides numerous wage estimates (depending on the type of truck and the province in Canada). For the U.S., the distribution of hourly wage data for "heavy and tractor-trailer truck drivers" is available from the U.S. Bureau of Labor Statistics (BLS, 2012), and also from the American Transportation Research Institute (ATRI, 2011). And because data on truck driver wages in Mexico could not be found in the literature, this was inferred by adjusting the wage rates for the U.S. and Canada, based on the relative GDPs per capita of the two countries (again using GDP data from the World Bank, 2013).

The total wage cost is then

$$TC_{wage} = UC_{wage} \cdot (TT) \qquad (4\text{-}10)$$

where UC_{wage} is the hourly wage rate, and TT is the total crossing time.

VII. Customs Broker and Drayage Costs

To assess the customs broker fees, we contacted a customs broker in Los Angeles (Gould, 2012). This subject matter expert claims that the customs broker fees are generally \$20-\$30/truck on the southern border (where the process is more repetitive and organized than on the northern border), with some fees (in the case of extremely organized broker customs broker firms) being as low as \$5/truck. And for the northern border, they suggested a range of \$50-\$150/truck for customs broker fees. So we use TC_{broker}=\$25 for the southern border and TC_{broker}=\$100 for the northern border. We also assume that the broker fees do not depend on the wait time encountered at the border.

In an analysis of the costs of transporting a (hypothetical) truck load from Chicago, Illinois, to Monterrey, Mexico (through the Nuevo Laredo POE), Haralambides & Londono-Kent (2004) suggest a total loading and unloading cost \$75-\$150/truck (2004\$) associated with the drayage operation at the U.S.-Mexico border, which is based on interviews conducted with trucking carriers. We use the middle of the range, which corresponds to about $TC_{drayage}$=\$154 in 2011\$.

TABLE 4-4. SUMMARY OF THE COST ESTIMATES FROM THE LITERATURE USED TO BUILD THE TRANSPORT COST MODEL

	Canada	U.S.	Mexico
Driver Wages (UC_{wage})	1. **$22.99/hr** (Statistics Canada, 2012) 2. **$23.10/hr** (range: $19.28-$29.59/hr) (Transport Canada, 2005)	1. **$18.74/hr**, or **$24.68/hr** including benefits (ATRI, 2011) 2. **$19.15/hr** (middle 50% range: $14.67-$22.66/hr) (BLS, 2012)	**$4.48/hr** (adjusted from values for U.S. and Canada using per capita GDP data from World Bank, 2013)
Diesel Fuel (UC_{fuel})	**$5.01/gal** (2013$) (MyTravelCost.com)	**$4.09/gal** (2013$) (MyTravelCost.com)	**$3.47/gal** (2013$) (MyTravelCost.com)
All Vehicle-Related Costs Other Than Fuel ($UC_{vehicle}$)	**$77.60/hr** (range: $46.80-$128/hr) (Transport Canada, 2005)[a]	1. **$12.80/hr** (range: $10.00-$16.00/hr) (MDOT, 2003)[a] 2. **$25.28/hr** (Boyer, 1997)[a] 3. **$23.95/hr** (ATRI, 2011) 4. **$96/hr** including driver wages (Schrank *et al*., 2011), **$76.85/hr** excluding wages (using average hourly wage from BLS, 2012)	**$11.37/hour** (adjusted from values for U.S. and Canada using per capita GDP data from World Bank, 2013)
Drayage Cost ($TC_{drayage}$)	n.a.	n.a.	**$154** (Haralambides & Londono-Kent, 2004)
Distance Traveled (DX)	1. **392 miles** (using data from Statistics Canada, 2010; BTS, 2012) 2. **355 miles** (using data from NATSD, 2012; SEDAC, 2005)	**432 miles** for freight from Mexico, **319 miles** for freight from Canada (using data from NATSD, 2012; SEDAC, 2005)	**808 miles** (using data from NATSD, 2012; SEDAC, 2005)

[a]Adjusted from the per mile cost, assuming an overall average truck speed of 40 miles per hour (ATRI, 2011).
Note that all values are on a *per-truck* basis. All costs are in 2011 US$ (other than the fuel costs), with inflation adjustments made using the Producer Price Index (PPI), across all commodities. Conversions from Canadian dollars were made using the currency converter available from the Bank of Canada (http://www.bankofcanada.ca/rates/exchange/).

VIII. Changes in Transportation Costs

The total cost associated with the border crossing itself is the sum of the driver wages, fuel and other vehicle-related costs, drayage costs (southern border only), and the customs broker fees, or

$$TC_{border} = (TC_{wage} + TC_{vehicle} + TC_{fuel} + TC_{drayage} + TC_{broker}) \tag{4-11}$$

Note that TC_{border} is not to be confused with TC_{broker}, the latter being a component of the former. The highway transportation costs – or those transportation costs incurred away from the border crossing station – are the same as in Equation 4-11, with the exception that the broker and drayage costs in this case are zero. The percentage change in the total transportation costs is then

$$\%\Delta TC = 100\% \cdot \left(\frac{\Delta TC_{border}}{TTC} \right) \tag{4-12}$$

where TTC is the total transportation cost (from origin to destination), which is the sum of the border-related costs (Equation 4-11) in the default scenario, and the non-border (or highway) costs. Note that the numerator of Equation 4-12 includes only the border-related costs, as these are the only costs which are affected by changes in wait times at the border. And because the drayage and broker costs are assumed unaffected by the wait time at the border (Table 4-1), the change in the border-related transportation costs is given by

$$\Delta TC_{border} = (\Delta TC_{wage} + \Delta TC_{vehicle} + \Delta TC_{fuel}) \tag{4-13}$$

which can also be expressed as

$$\Delta TC_{border} = \left[UC_{wage} + UC_{vehicle} + UC_{fuel} \cdot \left(\frac{S}{TFE} \right) \right] \cdot (\Delta TT) \tag{4-14}$$

And using Equation 4-2, Equation 4-14 can be expressed in terms of the change in the wait time (rather than the change in the total crossing time, TT) as

$$\Delta TC_{border} = \left[UC_{wage} + UC_{vehicle} + UC_{fuel} \cdot \left(\frac{S}{TFE} \right) \right] \cdot (\Delta WT) \tag{4-15}$$

Equation 4-15 shows that the change in the border-related transportation costs (and therefore, the change in the total transportation costs – see Equation 4-12) is linear in the change in the wait time. The final changes in transportation costs are summarized in Table 4-5. For the plus one officer scenario, the changes in transportation costs range from -0.435% to -0.030%, with the change in the total transportation costs (sum over all trucks) ranging from -$5.79M to -$0.18M.

TABLE 4-5. CHANGES IN FREIGHT TRANSPORT COSTS FOR ADDING OR SUBTRACTING ONE CUSTOMS OFFICER TO EACH PORT OF ENTRY

	Port of Entry	Crossing	Annual Truck Volume (FY2012)	Change in Total Freight Transport Costs			
				+1 CBP Officer[a]		-1 CBP Officer[b]	
				Percent	Total (all trucks)	Percent	Total (all trucks)
Southern Border	**Calexico**	Calexico/East	320,482	-0.144%	-$0.90 M	+0.072%	$0.45 M
	El Paso	Ysleta	360,470	-0.046%	-$0.32 M	+0.023%	$0.16 M
		Bridge of the Americas	290,220	-0.042%	-$0.24 M	+0.021%	$0.12 M
	Laredo	Columbia Solidarity	215,701	-0.049%	-$0.20 M	+0.024%	$0.10 M
		World Trade Bridge	1,356,418	-0.049%	-$1.28 M	+0.024%	$0.64 M
	Nogales	Mariposa	644,925	-0.126%	-$1.58 M	+0.063%	$0.79 M
	Otay Mesa	Otay Mesa	309,365	-0.030%	-$0.18 M	+0.015%	$0.09 M
Northern Border	**Blaine**	Pacific Highway	343,396	-0.435%	-$5.79 M	+0.217%	$2.89 M
	Buffalo-Niagara Falls	Lewiston Bridge	309,365	-0.094%	-$0.60 M	+0.047%	$0.30 M
		Peace Bridge	625,651	-0.054%	-$0.39 M	+0.027%	$0.20 M
	Detroit	Windsor Tunnel	39,056	-0.343%	-$0.28 M	+0.172%	$0.15 M
		Ambassador Bridge	1,425,757	-0.050%	-$1.52 M	+0.025%	$0.76 M

[a]Optimally allocated, to the eight most congested hours of the day.
[b]Equal to negative one half of the wait time elasticity in the +1 officer scenario (Equation 4-4).

IX. Comparison of Results to GTAP Transport Costs

Using a FOB-CIF analysis and the GTAP model, the total transportation cost of goods shipped into the U.S. by land from Mexico and from Canada were estimated and these results compared to the "bottom-up" transport cost method presented in the preceding sections. To split out the truck transportation cost from the total land transportation cost obtained from the GTAP model, we first computed the truck transportation cost share with respect to total land transportation cost for all imports to the U.S. based on the 2010 IMPLAN data. The truck transportation cost share is then applied to the land transportation cost of goods shipped from Canada and from Mexico to obtain the total truck transportation cost of goods imported from each of these two countries.

Using this method, the total transports cost for goods imported from Canada by truck is about $5,511 M in 2007$, or about $6,418 M in 2011$. For Mexico, the total truck transport costs are about $2,639 M in 2007$, or about $3,073 M in 2011$. According to the U.S. Bureau of Transportation Statistics (BTS, 2012), annually during 2010 (the year of the IMPLAN data) the total number of trucks crossing the U.S.-Canada border (sum over all northern ports of entry) was 5,444,405, and the total number of trucks crossing the U.S.-Mexico border (sum over all southern ports of entry) was 4,742,925. On a unit basis, then, these total transportation costs are about TTC=$1,179/truck for the northern border, and about TTC=$648/truck for the southern border.

When using the "bottom-up" method for estimating the total transportation costs (Sections I-VIII), the total transportation costs are about TTC=$1,939/truck for the southern border, and TTC=$2,117/truck for the northern border (weighted average by number of trucks across all ports of entry in the 'default' scenario). These transport cost results are considerably higher than those from the GTAP model (previous paragraph) and, unlike those from the GTAP model, there is not a large difference in the values for the northern versus the southern border.

Superficially, using the GTAP transport costs would seem the most conservative approach, as they are lower than the "bottom-up" cost estimate. As was found, however, when the change in transport costs is ultimately inputted into the CGE model (next chapter), the most conservative results occur when using the (larger) costs from the "bottom-up" transport cost model. This counterintuitive result is a consequence of the nature of international trade. As wait times for truck traffic entering the U.S. from Canada and Mexico decrease, while all three of the countries benefit, Canada and Mexico benefit more than the U.S. does (because they are the exporting countries, which tend to benefit more in a trade relationships than the importing countries).

X. Value of Time Waited by Trucks

A. Background and Framework

The border crossing is associated with various out-of-pocket costs (Table 4-5). In addition to these more tangible (or "hard") costs, there are also opportunity costs, most notably the opportunity cost of time (or equivalently, foregone trucking activity) associated with delays at the border. This opportunity cost of time (OC_{time}) is specified as

$$OC_{time} = UC_{time} \cdot (TT) \qquad (4\text{-}16)$$

or the product of the hourly time cost for commercial vehicles (UC_{time}), and the time needed for the border crossing (TT). The change in the opportunity cost of time for trucks is then

$$\Delta OC_{time} = UC_{time} \cdot (\Delta TT) \tag{4-17}$$

or equivalently (using Equation 4-2) as

$$\Delta OC_{time} = UC_{time} \cdot (\Delta WT) \tag{4-18}$$

B. Valuing Shipping Carriers' Time

A frequently cited source on the cost of time to carriers is a 1999 National Cooperative Highway Research Program (NCHRP) report, prepared for the American Association of State Highway Transportation Officials (AASHTO), and the Federal Highway Administration (FHWA).

The report estimates the value of time for shipping carriers using stated preference experiments, conducted by telephone with representatives from 20 trucking firms in California. The firms were chosen from four industry groups (five firms from each group), which collectively were believed to represent a range of sensitivities to transit times. These four industry groups were:

1. *High time sensitivity* (e.g., agriculture/fresh produce);
2. *Moderate-to-high time sensitivity* (e.g., building materials/cement/construction materials/aggregate);
3. *Moderate-to-low time sensitivity* (e.g., bulk liquids/liquid petroleum/water); *and*
4. *Low time sensitivity* (e.g., household goods)

The stated preference experiments (120 in total) were designed to evaluate how carriers would trade off freight costs and improvements in transit time reliability in congested/delay settings in selecting how much extra planned delivery time to allow. The cost estimates were then assessed by performing regression analysis on the survey results. The average transit time estimates range from about $144-$193/hour (experiments conducted in 1995) for the value of time for commercial vehicles (which we denote UC_{time}), and around $371/hour for non-scheduled delay, or that which carriers do *not* build into their delivery schedules.

In 2011$, the midpoint of the range of costs above corresponds to about UC_{time}=$272/hour. The values for Mexico and Canada were then determined by adjusting the value for the U.S., based on the relative per capita GDPs of the two countries (using data from World Bank, 2013). This results in UC_{time}=$285/hr for trucks in Canada, and UC_{time}=$56.80/hr for trucks in Mexico.

For the purposes of our transportation cost analysis, however, the NCHRP study has several shortcomings, including the facts that:

1. The sample size (i.e., number of carriers) is rather small (n=20);

2. The transit time estimates pertain to shipments in general transit, rather than those transitioning through the border;[53]
3. It is unclear exactly which transportation-related costs (e.g., fuel) might be included (implicitly or explicitly) as part of these cost estimates; *and*
4. The study is now more than a decade old, and it is unknown how the value of time to carriers might have changed in that interval (owing to, for example, changes in shipping logistics and supply chain management).

C. Value of Time Results

The changes in the opportunity cost of time for trucks are summarized in Table 4-6. In the +1 officer scenario, the total value of the change in the opportunity cost of time for Canadian trucks (sum over all northern ports in Table 4-6) is about -$93.5M. For Mexican trucks, the total change in the opportunity cost of time (sum over all southern ports in Table 4-6) is considerably less, at about -$23.85M. Note that table 4-6 does not include opportunity cost values for U.S. trucks, as we assume that all trucks entering the U.S. are foreign-registered (see Section IB). In other words, reductions in wait times at the border do not decrease the opportunity cost of time for U.S. trucks because in our model, none of the trucks transitioning through the border are U.S.-registered.

[53] In other words, carriers may not value an hour spent waiting and being inspected at the border the same as an hour spent traveling on the interstate.

TABLE 4-6. CHANGES IN VALUE OF TIME WAITED BY TRUCK TRAFFIC

	Port of Entry	Crossing	Annual Truck Volume (FY2012)	Change in Value of Time Waited by Truck Traffic (sum over all trucks)			
				+1 CBP Officer[a]		-1 CBP Officer[b]	
				Canada	Mexico	Canada	Mexico
Southern Border	**Calexico**	Calexico/East	320,482	n.a.	-$2.19 M	n.a.	$1.09 M
	El Paso	Ysleta	360,470		-$2.46 M		$1.23 M
		Bridge of the Americas	290,220		-$1.98 M		$0.99 M
	Laredo	Columbia Solidarity	215,701		-$1.47 M		$0.74 M
		World Trade Bridge	1,356,418		-$9.25 M		$4.62 M
	Nogales	Mariposa	644,925		-$4.40 M		$2.20 M
	Otay Mesa	Otay Mesa	309,365		-$2.11 M		$1.05 M
Northern Border	**Blaine**	Pacific Highway	343,396	-$21.41 M	n.a.	$10.70 M	n.a.
	Buffalo-Niagara Falls	Lewiston Bridge	309,365	-$10.22 M		$5.11 M	
		Peace Bridge	625,651	-$11.75 M		$5.87 M	
	Detroit	Windsor Tunnel	39,056	-$1.34 M		$0.67 M	
		Ambassador Bridge	1,425,757	-$48.78 M		$24.39 M	
		Total	5,920,324	-$93.50 M	-$23.85	$46.74 M	$11.92 M

[a]Optimally allocated, to the eight most congested hours of the day.

Note that opportunity cost data are not presented for U.S. truckers, as all entering trucks are assumed to be foreign-registered (see Section IB).

XI. Sensitivity Analysis

Rather than examining the sensitivity of the results at all of the various POEs, we limit our focus to only the Nogales (Mariposa) POE (southern border). The ranges of variation for all model parameters for the sensitivity analysis are given in Table 4-7. Note that 'low' and 'high' scenarios in the table refer to the final cost values, and not to the values of the input parameters. This is why, for example, the highest (i.e., fastest) queue speed examined (S_{queue}=15 miles/hour) is listed under the '*low*' scenario, and not the 'high' scenario. The 'middle' results in Table 4-7 are identical to those presented in Tables 4-5 and 4-6.

To specify the wait time in the 'low' and 'high' scenarios, we assume the wait time (across trucks, rather than across hours) is log-normally distributed, with mean and standard deviation equal to the values given in Table 4-2. The log-normal distribution is seemingly a good modeling fit here: non-negative, with many values clustered around the mode, and also a few (but very influential) points far out to the right of the median. At the same time, the log-normal distribution is also limited in this circumstance, as it does not allow for a wait time of zero, which a truck might actually encounter at the border. With this, the 'low' and 'high' wait time values in the sensitivity analysis are set to the 25th and 75th percentile points of this (log-normal) distribution.

For the other model parameters, in general, we use variations of -/+30% in the 'low' and 'high' scenarios, respectively. We do this because 30% represents a good analytical compromise between too much and too little variation, given than all of the parameters in the model are being varied (up or down) simultaneously in the sensitivity analysis, and also because this range of variation seems to cover most of the parameter values listed in Table 4-4.

The sensitivity analysis results for both the transport costs and the opportunity cost of time are presented in Table 4-8. Note that the percentage change in the transport costs is non-monotonic, in that the value in the 'high' scenario is generally the same as the value in the 'low' scenario. This is a consequence of the fact that this is a *percentage change*, and because various input quantities in both the numerator and the denominator are being varied all at once (and these changes work to offset one another somewhat). The remaining two quantities, however, both refer to absolute (aggregate) changes and, consequently, they are monotonic in the changes in the input parameters. The changes in the opportunity cost of time are also linear, as this cost is linear in the change in wait time (Equation 4-18).

The results in Table 4-8 indicate that changes in the values of the various input parameters can have a significant influence on the bottom line numbers. For example, the percentage change in transport costs has a range of around +/-20% about the 'middle' value, while the aggregate change (sum across all trucks) swings nearly +/-65%. The change in the opportunity cost of time is in between these two cases, with a range of about +/-30%. So in other words, a change of +/-30% in many of the values of the input parameters (Table 4-7) leads to a change in total transportation costs (sum over all trucks) of more than double this.

Table 4-7. Summary of All Parameter Values Used in the Model Sensitivity Analysis (for the Nogales Mariposa Port of Entry)

	Low Scenario	Middle Scenario	High Scenario
WT_0	41.6 min	33.5 min	13.8 min
PT_1	1.76 min	1.76 min	1.76 min
PT_2	10 min	17.5 min	2 hours
P_2	0.25	0.333	0.45
$BOOTHS_0$	2.9	2.9	2.9
$E_{(+1)}$	-0.55	-0.55	-0.55
DX	-30%	U.S.: 432 miles Canada: 0 miles Mexico: 808 miles	+30%
UC_{time}	-30%	U.S.: $272/hr Canada: $285/hr Mexico: $56.80/hr	+30%
$UC_{vehicle}$	-30%	U.S.: $34.72/hr Canada: $77.60/hr Mexico: $11.37/hr	+30%
UC_{wage}	-30%	U.S.: $20.86/hr Canada: $23.05/hr Mexico: $4.48/hr	+30%
UC_{fuel}	-30%	U.S.: $4.09/gal Canada: $5.01/gal Mexico: $3.47/gal	+30%
$TC_{drayage}$	-30%	$154	+30%
TC_{broker}	$5	$25	$150
S_{queue}	15 mi/hr	5 mi/hr	2 mi/hr
S_{hwy}	50 mi/hr	40 mi/hr	30 mi/hr

Values in parenthesis represent the change relative to the value in the 'middle' scenario.

TABLE 4-8. SUMMARY OF THE SENSITIVITY ANALYSIS RESULTS FOR ADDING ONE ADDITIONAL OFFICER TO THE NOGALES MARIPOSA PORT OF ENTRY

		+1 CBP Officer[a]		
		Low Scenario	**Middle Scenario**	**High Scenario**
Total Freight Transport Costs	Percent change	-0.101% (+20%)	-0.126%	-0.103% (-18%)
	Aggregate change (sum over all trucks)	-$0.56 M (+65%)	-$1.58 M	-$2.65 M (-68%)
Opportunity Cost of Truck Time – Mexican Trucks	Aggregate change (sum over all trucks)	-$3.08 M (+30%)	-$4.40 M	-$5.72 M (-30%)

[a]Optimally allocated, to the eight most congested hours of the day.
Values in parenthesis represent the change relative to the value in the 'middle' scenario.

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CHAPTER 5. NATIONAL COMPETITIVENESS AND MACROECONOMIC IMPACTS OF CHANGES IN TRANSPORTATION COSTS

by

Misak Avetisyan

I. INTRODUCTION

In this chapter, we estimate the macroeconomic impacts of a reduction in freight transportation costs stemming from changes in wait times at U.S. land ports of entry (POEs). We utilize the Global Trade Analysis Project (GTAP) Model, a state of the art economic model used widely in the analysis of international trade issues (Hertel et al., 2001; GTAP, 2012).

Note the following caveats and limitations regarding the national and international macroeconomic results:

- Our macroeconomic impact analysis of passenger vehicle and freight activity is undertaken using a non-linear model. However, we have evaluated macro impacts only at the level of unit changes in staffing and cannot draw any inferences about the shape of the non-linarites of larger staffing changes. Moreover, the overall impacts at these levels are also the product of these macroeconomic effects and the microeconomic impacts of staffing changes.

II. BACKGROUND

The majority of U.S. trade with its largest trading partners, Canada and Mexico, is conducted via land transport through its northern and southern borders. In 1994, the United States, Canada, and Mexico signed the North American Free Trade Agreement (NAFTA) to eliminate various trade duties and restrictions, and created the largest free trade zone in the world. The remaining restrictions were removed in 2008. According to the Office of the United States Trade Representative (2012), NAFTA has better connected 450 million people that produce goods and services worth $17 trillion. In 2009, the total value of the U.S. trade with its NAFTA partners was $1.6 trillion, with exports and imports worth $397 billion and $438 billion, respectively.

Exports: In 2010, a significant share of U.S. exports (32.2% of the total) was shipped to Canada and Mexico, consisting of $248.2 billion and $163.3 billion, respectively. The growth in total U.S. exports to NAFTA was 23.4% ($78 billion) compared to 2009, and about 150% relative to 1994. As reported by the Office of the United States Trade Representative (2012), the main commodities exported by the U.S. at the 2-digit Harmonized System (HS) level represent:

1. Machinery ($63.3 billion)
2. Vehicles Parts ($56.7 billion)
3. Electrical Machinery ($56.2 billion)
4. Mineral Fuel and Oil ($26.7 billion)
5. Plastic ($22.6 billion).

The U.S. exports of agricultural products to Canada and Mexico were $31.4 billion in 2010, and the top categories included:

1. Red meats, fresh/chilled/frozen ($2.7 billion)
2. Coarse grains ($2.2 million)
3. Fresh fruit ($1.9 billion)
4. Snack foods (excluding nuts) ($1.8 billion)
5. Fresh vegetables ($1.7 billion).

The U.S. exports of private commercial services to NAFTA countries were $63.8 billion in 2009 (not including military and government services).

Imports: In 2010, Canada and Mexico were the second and third main importers of goods (26.5% of total U.S. imports in 2010) to the U.S., consisting of $276.5 billion and $229.7 billion, respectively). Total U.S. imports from NAFTA countries were up by 25.6% ($103 billion) from 2009, about 185% higher than in 1994. According to the Office of The United States Trade Representative (2012), the main imported categories at the 2-digit HS level were:

1. Mineral Fuel and Oil (crude oil) ($116.2 billion)
2. Vehicles ($86.3 billion)
3. Electrical Machinery ($61.8 billion)
4. Machinery ($51.2 billion)
5. Precious Minerals (gold) ($13.9 billion).

In 2010, the agricultural commodities imported from NAFTA countries were $29.8 billion, and the main categories included:

1. Fresh vegetables ($4.6 billion)
2. Snack foods, (including chocolate) ($4.0 billion)
3. Fresh fruit (excluding bananas) ($2.4 billion)
4. Live animals ($2.0 billion)
5. Red meats, fresh/chilled/frozen ($2.0 billion).

Lastly, the imports of private commercial services from Canada and Mexico, not including military and government services, were $35.5 billion in 2009.

Although the ratification of the free trade agreement eliminated the trade restrictions and tariffs, it only moderately improved border crossing procedures (e.g., inspections/processing). Regarding U.S.-Canada border, Taylor et al. (2003) argue that, despite being the longest unfortified border in the world, the trade, border, and immigration policies across the U.S.-Canada border have been influenced by pre-NAFTA concepts of collecting import and export duties and controlling the flows of people and investment. Moreover, the economies of both countries have incurred significant cost impacts due to such policies, and these cost impacts became even more significant after tightened border security following the 9/11 terrorist attacks.

III. BACKGROUND

Time is one of the most important factors affecting trade between various countries. It is therefore intuitive to assume that the longer a product travels from the origin to the destination country, the higher its shipping or transport cost. The shipping time may also vary due to other factors, such as wait times at border crossings and other checkpoints, quality of logistics infrastructure, etc. The relationship between time and trade has been addressed in a number of studies.

Hertel et al. (2001) estimate both the short- and long-run effects of the Free Trade Agreement (FTA) between Japan and Singapore on the output, consumption, investment, exports and imports, GDP and welfare of both trading partners. The authors argue that with the decline in global manufacturing tariffs, the concentration of free trade agreements moved to other issues, such as regulations of e-commerce, foreign investment, customs procedures, etc.

The authors consider potential gains from the introduction of uniform e-commerce standards in Singapore and Japan. They also study the effects of automating Japanese customs procedures to make them compatible with the computer systems used by customs in Singapore. This initiative assumed reduction in administrative costs and lag times in Japan’s exports and imports enabling faster delivery of commodities. Using the dynamic GTAP model, Hertel et al. (2001) find that bilateral trade and investment are significantly affected by the FTA between Singapore and Japan. They also conclude that the increase in trade volumes between two trading partners is mainly due to customs automation. Moreover, the increasing rates of return in Japan and Singapore positively affect their GDP and investment. They find that in the short or medium run the trade balance in both countries declines, but it improves in the long run due to increased foreign income payments. Finally, the authors find that Japan, which implements most of the customs procedure reforms, gains more from the FTA.

Minor et al. (2008) note that over the last four decades the reduction in average import taxes significantly facilitated international trade. Moreover, changes in transportation technology also contributed to the growth in trade, resulting in an average annual increase of air transport services by 10%. The authors suggest that reduced tariffs and trade times enable countries to trade a wider variety of commodities that involve low-value bulk products, advanced high value goods and food products requiring faster delivery. Minor et al. (2008) state that “trade facilitation” is one of the important topics addressing the growth in trade across borders of developing countries.

Furthermore, a number of studies show a strong relationship between transport costs and time required to ship goods from an origin to a destination (Djankov et al., 2006 and OECD, 2003). The study by OECD shows that indirect costs associated with delayed times have more significant impact on trade levels than the direct costs. Additionally, Djankov et al. (2006) find that the delay in trade by one day decreases trade levels by 1%.

Minor et al. (2008) use a database of tariff equivalents for time in trade by product and country pairs. They use a computable general equilibrium framework to simulate reduction in trade times for four different country groups defined by income brackets. Minor et al. (2008) show that countries that reduce trade time gain significant benefits when other countries make no improvements in trade. The authors state that their finding is consistent with the theory of supply chain management, which suggests that the benefits from the reduction in shipping times for the fastest deliverer grow with the increase of the gap between that deliverer and the next fastest deliverer. Finally, Minor et al. (2008)

find that in Sub-Saharan Africa the reduction in delivery times increases the export share of high value products.

A study by Hummels et al. (2012) analyzes firms' choice between fast but expensive air transport and slow but inexpensive maritime transport. They state that the choice depends on the value placed by consumers on the fast shipping and the price elasticity of demand. The authors find that each day of shipping is equal to an ad-valorem tariff of 0.6 to 2.3 percent. They also suggest that parts and components represent the most time-sensitive trade flows. Hummels et al. (2012) state that these results show a strong relationship between the reduction of air transport costs and fast growth in trade. Finally, they urge that their findings can be helpful in estimating the economic effect of policies associated with the reduction of time in trade.

IV. TRADE AND TRANSPORT IN GTAP

International trade and transport in the Global Trade Analysis Project (GTAP) model are represented by margins services (shipping services, or transport costs) and merchandise goods (other transport and retail trade). These data are contained in a "trade matrix", which includes bilateral flows of only non-margin components, while the margins preserve the balance between global imports (CIF[54] values) and exports (FOB[55] values). The difference between imports and exports of global merchandise represents global exports of transport services (margins) (see Figure 5-1). In GTAP, global imports are defined by the sum of merchandise trade valued at CIF prices. Similarly, the sum of merchandise trade valued at FOB prices represents global exports. The share of exports of traded goods (non-margins) for each country in the global exports of non-margins is used to allocate ("share out") the global margins exports across countries.

In the GTAP model, the origins and destinations of traded goods are specified. However, this is not the case for transport services, which are grouped into a single Global Transport Services Industry, and then allocated to the various importing countries using the share of exports of traded merchandise (non-margins) for each country in the global exports of traded goods.

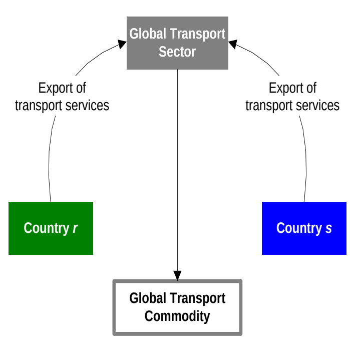

FIGURE 5-1. GLOBAL TRANSPORT INDUSTRY IN GTAP
Source: Davies and Hertel (1997)

[54] Cost, insurance, freight (CIF) value includes the cost of goods, insurance, and freight up to the destination.
[55] Free on Board (FOB) value does not include the cost of shipping and insurance. The seller is required to deliver merchandise on board of a vessel specified by the buyer.

More specifically, when the source country, *r*, exports a commodity to the country of destination, *s*, the export commodity (at FOB price) is combined with the composite international transport good (a mix of air, water, and other transport modes), thereby generating the CIF price of the commodity in the destination country (see Figure 5-2).

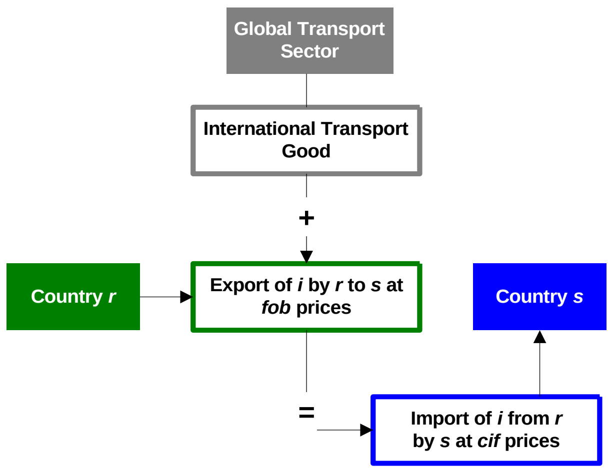

FIGURE 5-2. FORMATION OF THE CIF PRICE IN THE IMPORTING COUNTRY
Source: Davies and Hertel (1997)

While the transport input is a fixed composite good, the model allows for substitution among modes within the composite transport good. In the GTAP model, the modal substitution is determined by a Constant Elasticity of Substitution (CES) production function. The CES elasticity of substitution governs modal choice changes in response to variations in the relative cost of the different transport options.

V. MODELING A TRANSPORT COST REDUCTION SCENARIO IN GTAP

In the GTAP model, transportation costs per unit are endogenously determined. A transport cost reduction scenario can be implemented by exogenizing and perturbing the corresponding transportation price variables (*ptrans(i,r,s)* and *pt(m)*). Specifically, *ptrans(i,r,s)* is the price of composite transport services in Global Transport Industry for shipping good *i* from source *r* to destination *s*, and *pt(m)* is the price of global transport services by mode *m*. The latter is a price index for each mode that applies globally, and is not differentiated by industry, source or destination.

There are two options for this simulation. If transportation cost decreases due to technological factors not factored in the model, the transport cost variable *ptrans(i,r,s)* needs to be swapped with the variable representing the change in technology of shipping good *i* from source *r* to destination *s*. Ideally, the value of this now endogenous variable would remain zero or very close to it. Otherwise, if the transport cost changes due to non-tariff policy measures, *ptrans(i,r,s)* can be swapped with the variable *tms(i,r,s)*, representing a source-specific change in tax on imports of good *i* from source *r* to destination *s*. Since the reduction of wait times at the U.S.-Canada border assumes an increase in U.S. security staff on the Canadian side, we conclude that it is best to model the corresponding reduction in transport costs as a technological change in the form of an increase in the labor input.

The other transport cost variable *pt(m)*, representing the price index for transport commodity *m* in margin services usage, can become exogenous only by swapping it with the variable *atm(m)*, representing the change in technology of transport mode *m* worldwide. This is the only candidate for the swap, since the transport cost variable *pt(m)* is a source, industry and destination generic variable.

The design of the transport cost reduction scenario becomes more complex due to a need to separate the truck transport from the Other Transport industry in the model. The GTAP model has three transport industries: Other Transport, Water Transport, and Air Transport. In our analysis we are interested in air and truck transport. While working with the GTAP air transport industry is straightforward, there are some issues related to the truck transport. The latter represents part of the Other Transport industry in GTAP, which also includes rail transport, pipelines, auxiliary transport activities, and travel agencies. This makes it more difficult to identify the linkage between the truck transport from the U.S. Input-Output table and the GTAP model. Therefore, we draw on external data sources to find a bridging scheme between the U.S. Input-Output table and GTAP. We then use this mapping scheme to find the share of truck transport in the aggregate Other Transport industry, and implement the truck transport cost reduction scenario in the GTAP model.

Recall that transport costs in the GTAP data base are available by mode, commodity, source and destination countries. On the other hand, the U.S. Input-Output Table provides the use of imported transport services by each industry in the U.S. economy. Therefore, we use the following procedure to establish a bridging scheme between the transport industries of the U.S. Input-Output table and the GTAP model:

a. Find the total use of imported transport services by mode from the U.S. Input-Output table.
b. Use the GTAP international trade margins by commodity and source for shipments to the U.S. by Other Transport to create shares for allocating the total imports of truck transport services across industries and source countries in the GTAP model.
c. Apply these weights/shares (from step 2) to the total use of imported truck transport services (from step 1) to find the U.S. truck transport costs by commodity and source country (see Table 5-1).

TABLE 5-1. TRUCK TRANSPORT COSTS FOR U.S. IMPORTS (MILLION 2011 DOLLARS)

Commodities	Canada	Mexico	Rest of World	Total
Paddy rice	0.007	0.000	0.791	0.799
Wheat	4.344	0.143	0.000	4.487
Cereal grains nec	1.851	0.257	0.001	2.108
Vegetables, fruit, nuts	127.342	920.035	1.119	1048.496
Oil seeds	42.630	0.673	0.503	43.806
Sugar cane, sugar beet	0.000	0.000	0.005	0.005
Plant-based fibers	0.006	0.257	0.034	0.297

Crops nec	31.472	0.970	0.098	32.541
Cattle, sheep, goats, horses	72.199	25.062	0.179	97.440
Animal products nec	41.435	0.322	0.062	41.819
Raw milk	0.000	0.000	0.000	0.000
Wool, silk-worm cocoons	0.017	0.001	0.074	0.092
Forestry	1.876	1.408	0.002	3.287
Fishing	75.261	0.459	0.059	75.779
Coal	0.656	0.000	0.015	0.671
Oil	217.634	0.256	0.120	218.010
Gas	1065.611	8.335	7.565	1081.512
Minerals nec	2.354	1.227	0.004	3.585
Meat: cattle, sheep, goats, horse	35.597	2.973	2.870	41.440
Meat products nec	24.108	1.610	0.038	25.756
Vegetable oils and fats	67.207	3.803	0.324	71.334
Dairy products	2.532	0.511	0.035	3.077
Processed rice	0.100	0.309	0.256	0.664
Sugar	1.484	0.083	0.002	1.569
Food products nec	269.580	72.559	1.156	343.294
Beverages and tobacco products	63.388	68.777	0.666	132.831
Textiles	65.671	34.727	0.901	101.300
Wearing apparel	12.925	36.142	0.824	49.890
Leather products	2.600	1.990	0.247	4.838
Wood products	673.124	190.452	2.802	866.377
Paper products, publishing	268.819	32.227	0.243	301.289
Petroleum, coal products	3.978	0.294	0.018	4.289
Chemical, rubber, plastic prods	514.001	40.576	1.270	555.847
Mineral products nec	51.000	135.521	0.503	187.023
Ferrous metals	90.949	3.622	0.138	94.708
Metals nec	63.009	14.717	0.102	77.829
Metal products	126.614	102.503	1.057	230.174
Motor vehicles and parts	1711.585	189.307	1.187	1902.078
Transport equipment nec	7.240	60.025	0.068	67.333
Electronic equipment	4.534	124.307	0.356	129.196
Machinery and equipment nec	123.697	729.353	2.175	855.225
Manufactures nec	6.853	7.814	0.307	14.974
Total	**5875.291**	**2813.605**	**28.177**	**8717.074**

Note that in Table 5-1 there are small non-zero entries for truck transport costs from Rest of World region to the U.S. This is because the weights derived from the Other Transport industry in the GTAP model also include auxiliary transport activities and travel agencies.[56]

[56] It might be the case that cargo shipped to the U.S. from the Rest of World regions is then carried by a truck.

VI. RESULTS AND COMPARISONS

We modify the standard GTAP model to analyze the economic impacts of a reduction in transport costs, due to changes in CBP staffing, for all goods shipped from Canada (northern border) and Mexico (southern border) to the United States. We focus on five northern and seven southern ports of entry (POE). For each of these POEs, we use the reduction in total truck freight costs from Chapter 4 as an input to the GTAP model.[57]

Since in the GTAP model the unit transportation costs (*ptrans(i,r,s)* -- the price of composite transport services in the Global Transport Industry differentiated by industry, source or destination) are endogenous, we need to make the corresponding transportation price variables exogenous to simulate the reduction in transport costs and determine the impact of these cost changes on the U.S. economy. Since the transportation cost decreases due to production inputs not factored into the model, we have to make the transport cost variable *ptrans(i,r,s)* exogenous and do so by swapping it with the variable representing the change in production structure (often referred to as "technology", broadly defined) of shipping good *i* from source *r* to destination *s*.

Scenario 1 – Blaine POE (Reduction in Truck Transport Costs by 0.44%): In this scenario we adjust the 0.44% reduction of truck transport costs to 0.31% using the share (0.7) of Truck Transport in the Other Transport industry of the GTAP model. The results of the GTAP simulation show that the reduced transport costs affect total exports, imports and GDP in each region (see Table 5-2). Overall, the results indicate that a +1 change in staffing at the Blaine POE will result in a very small positive increase in the U.S. GDP of $1.36 million in 2011 dollars.

As expected, the reduction in transport costs for shipping goods from Canada to the U.S. results in the increase of total imports to the U.S. (0.0028%). It is interesting that the total imports to Canada from the U.S. and the Rest of the World also increase (0.0196%), which can be explained by Canada's increased import demand for intermediate goods due to the lower cost of U.S. produced commodities, which also ripples through the global economy lowering production costs elsewhere. Our findings demonstrate a link between reduced transport costs and growth in trade, which is consistent with Djankov et al. (2006) and Hummels et al. (2012).

The change in the trade balance is negative in the U.S. and Canada, because in both countries imports grow more than exports. In contrast, the trade balance increases in Mexico and the Rest of the World, as a result of an increase in exports and decline in imports. Also, the GDP of Canada increases by $6.89 million in 2011 dollars, 0.00045% due to increased exports. Note that, while the U.S. implements and pays for the reduction in crossing time, its gains from transport cost reduction policies are not as high as those of Canada. Overall, the GDP increases in the U.S. and Canada, while it declines in Mexico and Rest of the World. This is consistent with the results of Minor et al. (2008) illustrating that countries that reduce trade time gain significant benefits when other regions make no improvements in trade.

[57] Note that in all GTAP simulations these truck transport cost reductions are adjusted by the share (0.7) of Truck Transport in the Other Transport industry of the GTAP model.

TABLE 5-2. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER)

Regions	Exports (percent)	Imports (percent)	Trade balance[58] ($US million)	GDP ($US million)	GDP (percent)
United States	0.0019	0.0028	-7.756	1.364	0.000009
Canada	0.0045	0.0196	-18.633	6.887	0.000446
Mexico	0.0003	-0.0007	0.944	-0.052	-0.000004
Rest of World	0.0000	-0.0003	30.035	-8.184	-0.000016

As shown in Tables 5A-1 and 5A-217, the trade balance becomes negative in most cases when the production of commodities declines (while the consumption increases), and imports exceed exports. As expected, the imports from Canada to the U.S. increase, while the U.S. imports from Mexico and the Rest of World decline (see Table 5A-3 and Figure 5-3). The results in Figure 5-3 are consistent with the findings of Minor et al. (2008), suggesting that reduced trade times allow countries to trade a wider variety of products, involving low value bulk goods, advanced high value commodities and food products requiring faster delivery.

The most significant increase can be observed in the imports of Canadian paddy rice and vegetables and fruits, 0.288% and 0.260%, respectively. The reduction of transport costs for shipping goods from Canada to the U.S. results also in a relatively moderate increase of Canadian imports from the U.S., Mexico, and Rest of World (see Table 5A-4 and Figure 5-4).

As shown in Table 5A-5 and Figure 5-5, there are also changes in the U.S. exports to all regions of the world. The U.S. increases almost all its exports to Canada, except minerals, coal, metals, and transport equipment. Both imports and exports within the U.S. (trade between U.S. states) decline for the majority of U.S. industries due to the increased imports of relatively cheaper intermediate products from Canada and growing exports of final consumption goods to all regions of the world.

We summarize the aggregate macroeconomic results for the remaining 4 northern (U.S. – Canada Border) and 7 southern (U.S. – Mexico Border) POEs in Tables 5-5 through 5-15. The macroeconomic impacts for the remaining northern POEs (see Tables 5-5 through 5-8) are similar to the results of Scenario 1 with some variation in scale. Finally, the reduction in truck transport costs for all U.S. imports from Mexico through southern POEs increases the GDP of the U.S. and Mexico, while having a negative impact on Canada and the Rest of World regions. Under all these scenarios, the U.S. increases both the imports of intermediate goods and exports of commodities for final consumption.

We also report the GDP and employment impacts of +1 and -1 changes in staffing at all POEs. Tables 5-3 and 5-4 illustrate the changes in the U.S. GDP and employment by southern and northern POE crossings.

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[58] Note that the world trade balance should be zero, but it is a slight non-zero number because of the use of different GDP deflators for different countries in the model. This also refers to Tables 5-5 to 5-15.

Note that the GDP impacts in 2007 dollars were deflated to 2011 dollars using the appropriate GDP deflators for the U.S., Canada, and Mexico.

TABLE 5-3. CHANGES IN UNITED STATES GDP AND EMPLOYMENT (+1 CBP OFFICER)

	Port of Entry	Crossing	Change in transport cost (-1CBP Officer) (percent)	Change in U.S. GDP (2011 $US million)	Change in U.S. Employment (jobs)	Change in Canada GDP (2011 $US million)	Change in Mexico GDP (2011 $US million)
Southern Border	**Calexico**	Calexico/East	-0.14%	0.270	2.8	-0.065	1.062
	El Paso	Ysleta	-0.05%	0.090	0.9	-0.020	0.339
		Bridge of the Americas	-0.04%	0.075	0.8	-0.019	0.309
	Laredo	Columbia Solidarity	-0.05%	0.090	0.9	-0.022	0.361
		World Trade Bridge	-0.05%	0.090	0.9	-0.022	0.361
	Nogales	Mariposa	-0.13%	0.240	2.4	-0.057	0.928
	Otay Mesa	Otay Mesa	-0.03%	0.060	0.6	-0.014	0.220
Northern Border	**Blaine**	Pacific Highway	-0.44%	1.364	13.9	6.887	-0.052
	Buffalo-Niagara Falls	Lewiston Bridge	-0.09%	0.300	3.1	1.488	-0.011
		Peace Bridge	-0.05%	0.165	1.7	0.855	-0.006
	Detroit	Windsor Tunnel	-0.34%	1.079	11.0	5.446	-0.041
		Ambassador Bridge	-0.05%	0.150	1.5	0.791	-0.006
		Totals	-	3.973	40.5	15.248	3.464

TABLE 5-4. CHANGES IN UNITED STATES GDP AND EMPLOYMENT (-1 CBP OFFICER)

	Port of Entry	Crossing	Change in transport cost (-1CBP Officer) (percent)	Change in U.S. GDP (2011 $US million)	Change in U.S. Employment (jobs)	Change in Canada GDP (2011 $US million)	Change in Mexico GDP (2011 $US million)
Southern Border	**Calexico**	Calexico/East	0.07%	-0.135	-1.4	0.032	-0.531
	El Paso	Ysleta	0.02%	-0.045	-0.5	0.010	-0.169
		Bridge of the Americas	0.02%	-0.037	-0.4	0.009	-0.154
	Laredo	Columbia Solidarity	0.02%	-0.045	-0.5	0.011	-0.181
		World Trade Bridge	0.02%	-0.045	-0.5	0.011	-0.181
	Nogales	Mariposa	0.06%	-0.120	-1.2	0.029	-0.464
	Otay Mesa	Otay Mesa	0.02%	-0.030	-0.3	0.007	-0.110
Northern Border	**Blaine**	Pacific Highway	0.22%	-0.682	-7.0	-3.443	0.026
	Buffalo-Niagara Falls	Lewiston Bridge	0.05%	-0.150	-1.5	-0.744	0.006
		Peace Bridge	0.03%	-0.082	-0.8	-0.427	0.003
	Detroit	Windsor Tunnel	0.17%	-0.540	-5.5	-2.723	0.021
		Ambassador Bridge	0.03%	-0.075	-0.8	-0.396	0.003
		Total	-	-1.986	-20.4	-7.624	-1.731

TABLE 5-5. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Buffalo-Niagara Falls (Lewiston Bridge) POE (Reduction in Truck Transport Costs by 0.09%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0004	0.0006	-1.676	0.300	0.000002
Canada	0.0010	0.0042	-4.026	1.488	0.000096
Mexico	0.0001	-0.0002	0.204	-0.011	-0.000001
Rest of World	0.0000	-0.0001	6.490	-1.746	-0.000004

TABLE 5-6. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Buffalo-Niagara Falls (Peace Bridge) POE (Reduction in Truck Transport Costs by 0.05%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0002	0.0004	-0.963	0.165	0.000001
Canada	0.0006	0.0024	-2.313	0.855	0.000055
Mexico	0.0000	-0.0001	0.117	-0.006	-0.000001
Rest of World	0.0000	0.0000	3.728	-0.998	-0.000002

TABLE 5-7. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Detroit (Windsor) POE (Reduction in Truck Transport Costs by 0.34%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0015	0.0022	-6.134	1.079	0.000007
Canada	0.0036	0.0155	-14.735	5.446	0.000352
Mexico	0.0002	-0.0006	0.746	-0.041	-0.000003
Rest of World	0.0000	-0.0003	23.751	-6.487	-0.000013

TABLE 5-8. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Detroit (Ambassador Bridge) POE (Reduction in Truck Transport Costs by 0.05%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0002	0.0003	-0.892	0.150	0.000001
Canada	0.0005	0.0022	-2.141	0.791	0.000051

Mexico	0.0000	-0.0001	0.108	-0.006	-0.000001
Rest of World	0.0000	0.0000	3.452	-0.948	-0.000002

TABLE 5-9. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Calexico POE (Reduction in Truck Transport Costs by 0.14%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0003	0.0005	-1.107	0.270	0.000002
Canada	0.0000	-0.0003	0.472	-0.065	-0.000004
Mexico	0.0000	0.0050	-2.519	1.062	0.000085
Rest of World	0.0000	0.0000	3.398	-0.798	-0.000002

TABLE 5-10. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): El Paso (Ysleta) POE (Reduction in Truck Transport Costs by 0.05%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0001	0.0002	-0.353	0.090	0.000001
Canada	0.0000	-0.0001	0.151	-0.020	-0.000001
Mexico	0.0000	0.0016	-0.803	0.339	0.000027
Rest of World	0.0000	0.0000	1.083	-0.249	-0.000001

TABLE 5-11. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): El Paso (Bridge of the Americas) POE (Reduction in Truck Transport Costs by 0.04%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0001	0.0001	-0.322	0.075	0.000001
Canada	0.0000	-0.0001	0.138	-0.019	-0.000001
Mexico	0.0000	0.0015	-0.733	0.309	0.000025
Rest of World	0.0000	0.0000	0.989	-0.249	-0.000001

TABLE 5-12. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Laredo (Columbia Solidarity) POE (Reduction in Truck Transport Costs by 0.05%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0001	0.0002	-0.376	0.090	0.000001
Canada	0.0000	-0.0001	0.160	-0.022	-0.000001

Mexico	0.0000	0.0017	-0.855	0.361	0.000029
Rest of World	0.0000	0.0000	1.154	-0.249	-0.000001

TABLE 5-13. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Laredo (WT Bridge) POE (Reduction in Truck Transport Costs by 0.05%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0001	0.0002	-0.376	0.090	0.000001
Canada	0.0000	-0.0001	0.160	-0.022	-0.000001
Mexico	0.0000	0.0017	-0.855	0.361	0.000029
Rest of World	0.0000	0.0000	1.154	-0.249	-0.000001

TABLE 5-14. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Nogales POE (Reduction in Truck Transport Costs by 0.13%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0003	0.0004	-0.967	0.240	0.000002
Canada	0.0000	-0.0003	0.413	-0.057	-0.000004
Mexico	0.0000	0.0044	-2.200	0.928	0.000075
Rest of World	0.0000	0.0000	2.968	-0.699	-0.000001

TABLE 5-15. CHANGES IN UNITED STATES TRADE AND GDP (+1 CBP OFFICER): Otay Mesa POE (Reduction in Truck Transport Costs by 0.03%)

Regions	Exports (percent)	Imports (percent)	Trade balance ($US million)	GDP ($US million)	GDP (percent)
United States	0.0001	0.0001	-0.230	0.060	0.000000
Canada	0.0000	-0.0001	0.098	-0.014	- 0.000001
Mexico	0.0000	0.0010	-0.524	0.220	0.000018
Rest of World	0.0000	0.0000	0.707	-0.150	0.000000

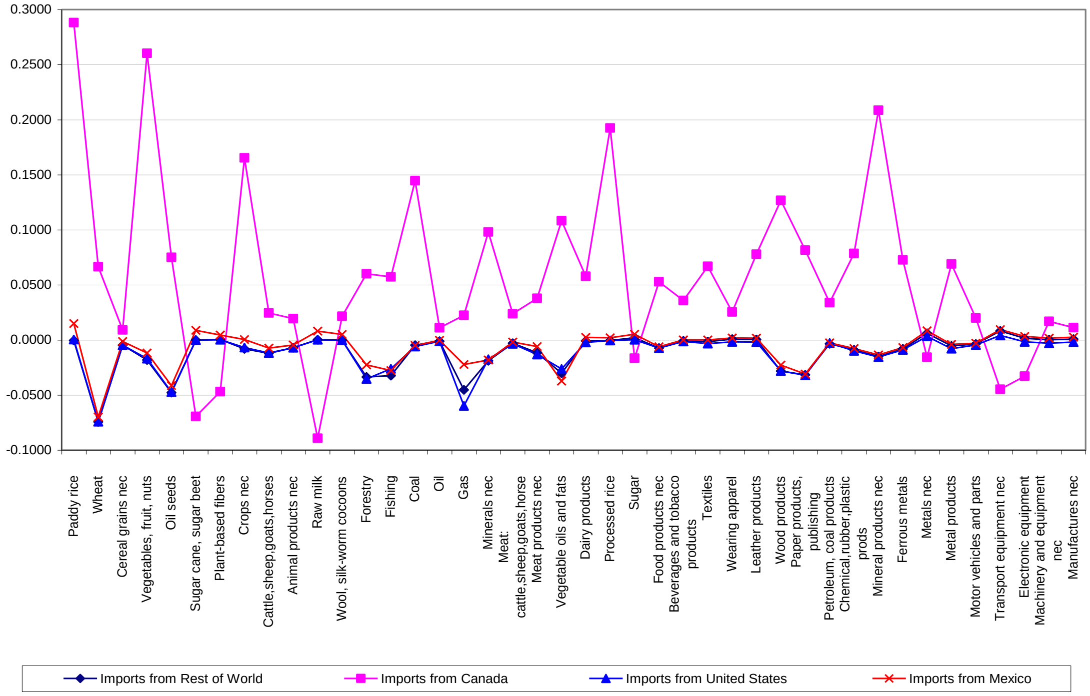

FIGURE 5-3. CHANGES IN IMPORTS TO UNITED STATES (+1 CBP OFFICER), PERCENT

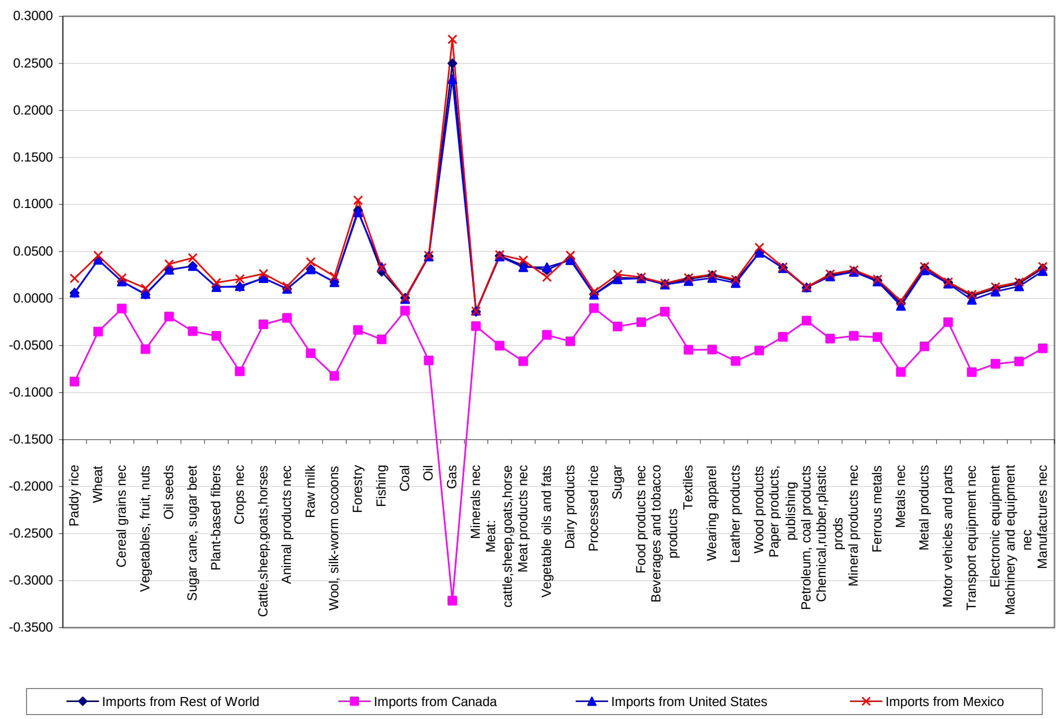

FIGURE 5-4. CHANGES IN IMPORTS TO CANADA (+1 CBP OFFICER), PERCENT

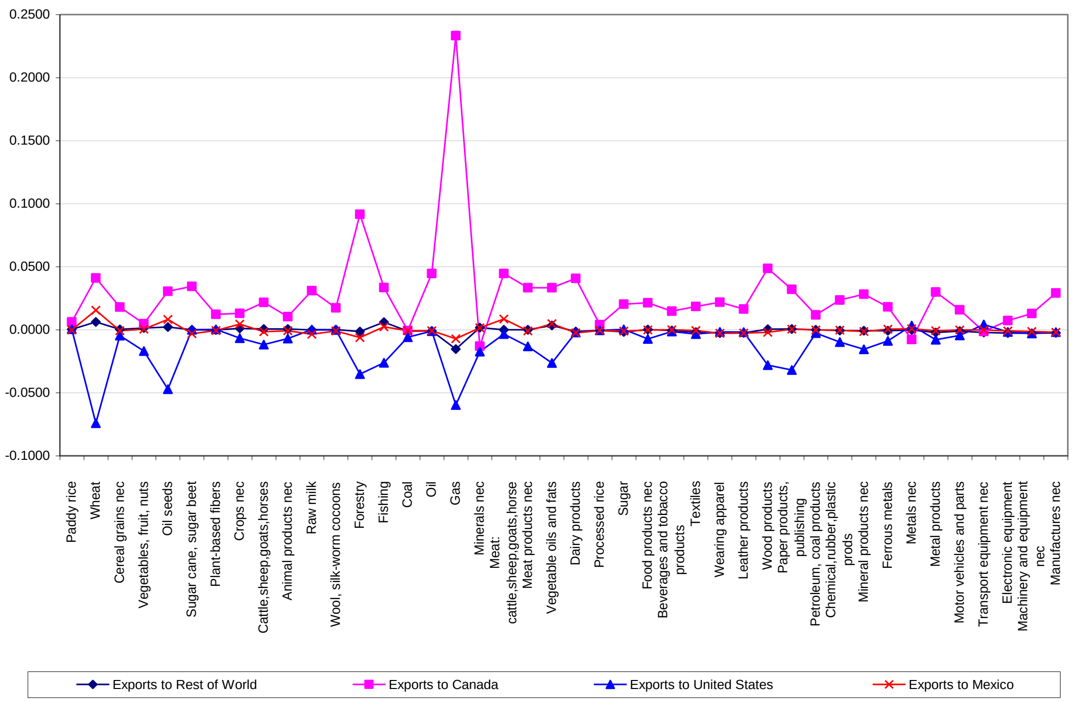

FIGURE 5-5. CHANGES IN EXPORTS FROM UNITED STATES (+1 CBP OFFICER), PERCENT

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APPENDIX 5A

TABLE 5A-1. CHANGES IN OUTPUT, CONSUMPTION AND TRADE IN UNITED STATES (+1 CBP OFFICER)

Commodities	Production, percent	Consumption, percent	Exports, percent	Imports, percent	Trade balance, $US million
Paddy rice	0.00026	0.00002	0.00035	0.00010	-0.0005
Wheat	0.00208	0.00002	0.00690	0.05696	0.3187
Cereal grains nec	0.00017	0.00002	0.00074	0.00446	0.0301
Vegetables, fruit, nuts	-0.00221	0.00002	0.00239	0.01075	-0.2670
Oil seeds	0.00018	0.00002	0.00347	0.04064	0.1449
Sugar cane, sugar beet	0.00024	0.00001	0.00282	-0.00013	0.0001
Plant-based fibers	-0.00016	0.00047	-0.00009	-0.00040	-0.0244
Crops nec	-0.00088	0.00002	0.00238	0.00333	-0.0418
Cattle, sheep, goats, horses	-0.00016	0.00066	0.00266	0.01148	-0.1283
Animal products nec	0.00023	0.00082	0.00101	0.00583	0.0100
Raw milk	0.00024	0.00046	0.00344	0.00028	0.0001
Wool, silk-worm cocoons	0.00018	0.00054	0.00014	0.00003	0.0001
Forestry	-0.00068	0.00044	0.01838	0.00689	0.3365
Fishing	-0.00155	0.00526	0.01958	0.01318	0.2740
Coal	-0.00005	0.00030	-0.00098	0.00319	-0.0788
Oil	-0.00038	0.00082	0.04231	0.00022	1.8329
Gas	-0.00030	0.00197	0.10549	0.01072	0.8337
Minerals nec	-0.00216	0.01084	-0.00203	0.00934	0.2197
Meat: cattle, sheep, goats, horses	0.00059	0.00046	0.01071	0.00407	0.2416
Meat products nec	0.00040	0.00041	0.00488	0.01286	0.1120
Vegetable oils and fats	-0.00016	0.00313	0.00885	0.01193	0.1290
Dairy products	0.00024	0.00037	0.00097	0.00261	-0.0230
Processed rice	0.00001	0.00001	0.00000	0.00037	-0.0023
Sugar	0.00026	0.00025	0.00170	-0.00018	0.0069
Food products nec	0.00022	0.00078	0.00620	0.00677	0.1869
Beverages and tobacco products	0.00026	0.00038	0.00257	0.00160	0.1170
Textiles	-0.00049	0.00049	0.00220	0.00196	-0.2018
Wearing apparel	-0.00024	0.00042	0.00139	0.00124	-0.4120
Leather products	-0.00069	0.00051	-0.00073	0.00082	-0.1091
Wood products	-0.00298	0.00229	0.02086	0.01809	-4.3042
Paper products, publishing	-0.00127	0.00090	0.00931	0.02588	-2.4731
Petroleum, coal products	-0.00002	0.00096	0.00161	0.00201	0.4216
Chemical, rubber, plastic prods	-0.00067	0.00104	0.00322	0.00647	-1.7879
Mineral products nec	-0.00115	0.00202	0.00747	0.01124	-0.8144
Ferrous metals	-0.00097	0.00128	0.00479	0.00534	-0.1178
Metals nec	0.00021	0.00016	-0.00150	-0.00175	0.1253
Metal products	-0.00022	0.00070	0.00695	0.00610	-0.1608
Motor vehicles and parts	0.00078	0.00083	0.00754	0.00323	4.1392

Transport equipment nec	-0.00025	0.00004	-0.00208	-0.00243	-1.2978
Electronic equipment	-0.00075	0.00040	-0.00174	0.00077	-2.8040
Machinery and equipment nec	-0.00037	0.00038	-0.00004	0.00189	-4.1753
Manufactures nec	0.00001	0.00045	0.00139	0.00107	-0.1964
Electricity	0.00022	0.00015	0.01995	-0.02752	0.8569
Gas manufacture, distribution	-0.00002	0.00019	-0.00205	0.00109	-0.0401
Water	0.00005	0.00018	0.00111	0.00129	0.0026
Construction	0.00030	0.00029	-0.00132	0.00066	-0.1013
Trade	0.00008	0.00013	0.00103	-0.00052	0.2187
Transport nec	-0.00014	0.00037	-0.00195	0.00001	-0.7169
Sea transport	-0.00099	0.00024	-0.00577	-0.00069	-0.5734
Air transport	-0.00020	0.00049	-0.00179	-0.00003	-0.9011
Communication	0.00015	0.00009	0.00168	-0.00124	0.2477
Financial services nec	0.00009	0.00007	0.00093	0.00024	0.4055
Insurance	0.00028	0.00005	0.00449	-0.00060	0.8846
Business services nec	0.00010	0.00011	0.00054	-0.00109	0.9541
Recreation and other services	0.00023	0.00021	0.00153	-0.00138	0.5215
PubAdmin/Defense/Health/Educat	0.00011	0.00012	0.00057	-0.00033	0.4254
Dwellings	0.00008	0.00008	0.00008	0.00008	0.0000
Total			0.00193	0.00284	-7.7562

TABLE 5A-2. CHANGES IN OUTPUT, CONSUMPTION AND TRADE IN CANADA (+1 CBP OFFICER)

Commodities	Production, percent	Consumption, percent	Exports, percent	Imports, percent	Trade balance, $US million
Paddy rice	-0.0129	0.0002	0.1430	0.0061	-0.0019
Wheat	-0.0441	0.0002	-0.0499	0.0411	-1.9635
Cereal grains nec	-0.0017	0.0002	-0.0094	0.0180	-0.0807
Vegetables, fruit, nuts	0.0567	0.0002	0.0810	0.0049	2.3138
Oil seeds	-0.0199	0.0002	-0.0257	0.0305	-0.6420
Sugar cane, sugar beet	0.0036	0.0001	-0.0691	0.0347	-0.0007
Plant-based fibers	0.0022	0.0050	-0.0498	0.0122	-0.0097
Crops nec	0.0185	0.0002	0.0565	0.0126	0.4802
Cattle, sheep, goats, horses	0.0047	0.0035	0.0203	0.0217	0.5270
Animal products nec	-0.0075	0.0049	0.0011	0.0103	0.1681
Raw milk	-0.0020	0.0038	-0.0895	0.0312	-0.0022
Wool, silk-worm cocoons	0.0005	0.0070	-0.0572	0.0175	-0.0025
Forestry	0.0283	-0.0067	-0.0299	0.0918	-0.4626
Fishing	0.0090	-0.0040	0.0309	0.0329	0.6157
Coal	-0.0055	0.0121	-0.0034	-0.0004	-0.0227
Oil	-0.0016	0.0062	0.0089	0.0449	-0.3565
Gas	0.0009	0.0010	0.0159	0.2334	4.2550
Minerals nec	-0.0099	0.0079	0.0071	-0.0135	1.8843
Meat: cattle, sheep, goats, horses	-0.0039	0.0034	-0.0174	0.0449	-0.5143
Meat products nec	-0.0241	0.0054	-0.0399	0.0335	-1.2533
Vegetable oils and fats	0.0173	0.0063	0.0535	0.0326	0.7287
Dairy products	-0.0019	0.0039	-0.0255	0.0418	-0.2823
Processed rice	0.0041	0.0002	0.1658	0.0042	-0.0038
Sugar	-0.0062	0.0063	-0.0270	0.0219	-0.1358
Food products nec	0.0060	0.0059	0.0315	0.0213	2.1614
Beverages and tobacco products	0.0024	0.0048	0.0200	0.0152	-0.1358
Textiles	0.0041	0.0097	0.0481	0.0197	0.0837
Wearing apparel	-0.0099	0.0098	0.0077	0.0242	-1.2270
Leather products	-0.0120	0.0113	0.0387	0.0186	-0.3248
Wood products	0.0449	0.0085	0.0954	0.0488	15.8360
Paper products, publishing	0.0088	0.0069	0.0353	0.0322	6.8333
Petroleum, coal products	0.0049	0.0073	0.0312	0.0117	3.5047
Chemical, rubber, plastic prods	0.0143	0.0097	0.0449	0.0239	11.6596
Mineral products nec	0.0241	0.0089	0.1780	0.0284	3.6104
Ferrous metals	0.0059	0.0077	0.0488	0.0185	2.3751
Metals nec	-0.0389	0.0112	-0.0384	-0.0065	-9.9356
Metal products	0.0013	0.0083	0.0354	0.0308	0.3094
Motor vehicles and parts	0.0095	0.0118	0.0176	0.0161	5.7950
Transport equipment nec	-0.0496	0.0103	-0.0568	0.0000	-7.4446
Electronic equipment	-0.0407	0.0122	-0.0485	0.0096	-6.8426

Machinery and equipment nec	-0.0168	0.0114	-0.0097	0.0141	-9.5686
Manufactures nec	-0.0076	0.0089	-0.0174	0.0310	-2.4497
Electricity	-0.0062	0.0032	-0.0466	0.0329	-1.4535
Gas manufacture, distribution	-0.0047	0.0018	-0.0811	0.0265	-0.1198
Water	-0.0017	0.0056	-0.0616	0.0293	-0.0357
Construction	0.0075	0.0081	-0.0464	0.0238	-0.2504
Trade	0.0014	0.0025	-0.0513	0.0251	-2.9736
Transport nec	-0.0030	0.0047	-0.0305	0.0221	-2.5037
Sea transport	-0.0211	0.0101	-0.0265	0.0047	-0.9401
Air transport	-0.0108	0.0092	-0.0292	0.0127	-2.2424
Communication	-0.0028	0.0029	-0.0490	0.0235	-1.6609
Financial services nec	-0.0030	0.0028	-0.0514	0.0224	-3.0062
Insurance	-0.0102	0.0041	-0.0510	0.0242	-3.3772
Business services nec	-0.0043	0.0026	-0.0507	0.0244	-12.9324
Recreation and other services	-0.0052	0.0035	-0.0482	0.0192	-3.2074
PubAdmin/Defense/Health/Educat	0.0010	0.0029	-0.0504	0.0228	-3.4085
Dwellings	0.0016	0.0016	0.0016	0.0016	0.0000
Total			0.0045	0.0196	-18.6334

TABLE 5A-3. CHANGES IN IMPORTS TO UNITED STATES (+1 CBP OFFICER), PERCENT

Commodities	Imports from Rest of World	Imports from Canada	Imports from United States	Imports from Mexico	Total U.S. Imports
Paddy rice	-0.0005	0.2882	0.0005	0.0150	0.0001
Wheat	-0.0742	0.0664	-0.0741	-0.0700	0.0570
Cereal grains nec	-0.0047	0.0091	-0.0047	-0.0013	0.0045
Vegetables, fruit, nuts	-0.0182	0.2602	-0.0170	-0.0119	0.0107
Oil seeds	-0.0477	0.0751	-0.0472	-0.0413	0.0406
Sugar cane, sugar beet	-0.0001	-0.0693	-0.0001	0.0087	-0.0001
Plant-based fibers	0.0005	-0.0469	0.0004	0.0045	-0.0004
Crops nec	-0.0081	0.1654	-0.0068	0.0005	0.0033
Cattle, sheep, goats, horses	-0.0121	0.0246	-0.0118	-0.0074	0.0115
Animal products nec	-0.0071	0.0195	-0.0070	-0.0046	0.0058
Raw milk	0.0003	-0.0892	0.0002	0.0081	0.0003
Wool, silk-worm cocoons	-0.0003	0.0216	-0.0002	0.0050	0.0000
Forestry	-0.0336	0.0601	-0.0353	-0.0226	0.0069
Fishing	-0.0323	0.0574	-0.0262	-0.0277	0.0132
Coal	-0.0048	0.1447	-0.0059	-0.0048	0.0032
Oil	-0.0011	0.0111	-0.0012	-0.0003	0.0002
Gas	-0.0453	0.0223	-0.0598	-0.0222	0.0107
Minerals nec	-0.0188	0.0980	-0.0174	-0.0182	0.0093
Meat: cattle, sheep, goats, horses	-0.0030	0.0239	-0.0034	-0.0019	0.0041
Meat products nec	-0.0116	0.0379	-0.0133	-0.0060	0.0129
Vegetable oils and fats	-0.0302	0.1083	-0.0263	-0.0373	0.0119
Dairy products	-0.0009	0.0578	-0.0022	0.0024	0.0026
Processed rice	-0.0004	0.1925	-0.0004	0.0021	0.0004
Sugar	0.0020	-0.0166	0.0003	0.0052	-0.0002
Food products nec	-0.0074	0.0530	-0.0073	-0.0061	0.0068
Beverages and tobacco products	-0.0008	0.0359	-0.0014	0.0000	0.0016
Textiles	-0.0014	0.0669	-0.0034	0.0001	0.0020
Wearing apparel	0.0008	0.0254	-0.0018	0.0019	0.0012
Leather products	0.0004	0.0778	-0.0019	0.0017	0.0008
Wood products	-0.0283	0.1267	-0.0280	-0.0228	0.0181
Paper products, publishing	-0.0316	0.0815	-0.0319	-0.0309	0.0259
Petroleum, coal products	-0.0034	0.0340	-0.0027	-0.0026	0.0020
Chemical, rubber, plastic prods	-0.0090	0.0786	-0.0098	-0.0077	0.0065
Mineral products nec	-0.0150	0.2086	-0.0155	-0.0136	0.0112
Ferrous metals	-0.0081	0.0727	-0.0089	-0.0068	0.0053
Metals nec	0.0061	-0.0157	0.0033	0.0084	-0.0017
Metal products	-0.0054	0.0690	-0.0079	-0.0039	0.0061
Motor vehicles and parts	-0.0037	0.0199	-0.0046	-0.0030	0.0032
Transport equipment nec	0.0082	-0.0447	0.0042	0.0095	-0.0024

Electronic equipment	0.0015	-0.0328	-0.0017	0.0032	0.0008
Machinery and equipment nec	0.0003	0.0169	-0.0029	0.0018	0.0019
Manufactures nec	0.0008	0.0112	-0.0019	0.0026	0.0011
Electricity	0.0307	-0.0432	0.0280	0.0319	-0.0275
Gas manufacture, distribution	0.0022	-0.0795	-0.0008	0.0035	0.0011
Water	0.0019	-0.0607	-0.0010	0.0019	0.0013
Construction	0.0011	-0.0453	-0.0004	0.0021	0.0007
Trade	0.0030	-0.0497	0.0008	0.0041	-0.0005
Transport nec	0.0012	-0.0442	0.0000	0.0020	0.0000
Sea transport	0.0002	-0.0347	-0.0014	0.0009	-0.0007
Air transport	0.0012	-0.0287	0.0006	0.0014	0.0000
Communication	0.0042	-0.0470	0.0019	0.0052	-0.0012
Financial services nec	0.0024	-0.0504	0.0000	0.0036	0.0002
Insurance	0.0033	-0.0500	0.0009	0.0039	-0.0006
Business services nec	0.0035	-0.0489	0.0013	0.0047	-0.0011
Recreation and other services	0.0034	-0.0463	0.0017	0.0046	-0.0014
PubAdmin/Defense/Health/Educat	0.0030	-0.0493	0.0008	0.0042	-0.0003
Dwellings	0.0005	0.0005	0.0001	0.0005	0.0001

TABLE 5A-4. CHANGES IN IMPORTS TO CANADA (+1 CBP OFFICER), PERCENT

Commodities	Imports from Rest of World	Imports from Canada	Imports from United States	Imports from Mexico	Total Canada Imports
Paddy rice	0.0058	-0.0884	0.0062	0.0213	0.0061
Wheat	0.0411	-0.0353	0.0410	0.0456	0.0411
Cereal grains nec	0.0180	-0.0107	0.0180	0.0218	0.0180
Vegetables, fruit, nuts	0.0042	-0.0539	0.0048	0.0108	0.0049
Oil seeds	0.0303	-0.0193	0.0305	0.0365	0.0305
Sugar cane, sugar beet	0.0344	-0.0348	0.0344	0.0432	0.0347
Plant-based fibers	0.0123	-0.0398	0.0122	0.0168	0.0122
Crops nec	0.0123	-0.0777	0.0131	0.0207	0.0126
Cattle, sheep, goats, horses	0.0216	-0.0276	0.0217	0.0264	0.0217
Animal products nec	0.0103	-0.0208	0.0103	0.0130	0.0103
Raw milk	0.0312	-0.0584	0.0310	0.0389	0.0312
Wool, silk-worm cocoons	0.0175	-0.0825	0.0173	0.0235	0.0175
Forestry	0.0936	-0.0335	0.0917	0.1045	0.0918
Fishing	0.0285	-0.0435	0.0335	0.0326	0.0329
Coal	0.0007	-0.0130	-0.0006	0.0007	-0.0004
Oil	0.0449	-0.0660	0.0445	0.0457	0.0449
Gas	0.2499	-0.3213	0.2332	0.2755	0.2334
Minerals nec	-0.0141	-0.0295	-0.0130	-0.0135	-0.0135
Meat: cattle, sheep, goats, horses	0.0453	-0.0502	0.0447	0.0465	0.0449
Meat products nec	0.0350	-0.0668	0.0333	0.0407	0.0335
Vegetable oils and fats	0.0300	-0.0388	0.0333	0.0226	0.0326
Dairy products	0.0423	-0.0457	0.0408	0.0459	0.0418
Processed rice	0.0043	-0.0103	0.0040	0.0073	0.0042
Sugar	0.0221	-0.0298	0.0203	0.0255	0.0219
Food products nec	0.0214	-0.0253	0.0213	0.0227	0.0213
Beverages and tobacco products	0.0153	-0.0140	0.0147	0.0162	0.0152
Textiles	0.0205	-0.0546	0.0184	0.0220	0.0197
Wearing apparel	0.0245	-0.0543	0.0219	0.0256	0.0242
Leather products	0.0188	-0.0666	0.0164	0.0201	0.0186
Wood products	0.0487	-0.0555	0.0486	0.0541	0.0488
Paper products, publishing	0.0327	-0.0409	0.0321	0.0334	0.0322
Petroleum, coal products	0.0113	-0.0236	0.0118	0.0121	0.0117
Chemical, rubber, plastic prods	0.0245	-0.0428	0.0235	0.0259	0.0239
Mineral products nec	0.0289	-0.0399	0.0282	0.0304	0.0284
Ferrous metals	0.0191	-0.0411	0.0181	0.0205	0.0185
Metals nec	-0.0051	-0.0782	-0.0078	-0.0028	-0.0065
Metal products	0.0324	-0.0511	0.0298	0.0339	0.0308
Motor vehicles and parts	0.0168	-0.0253	0.0158	0.0175	0.0161
Transport equipment nec	0.0026	-0.0785	-0.0015	0.0042	0.0000

Electronic equipment	0.0104	-0.0695	0.0072	0.0122	0.0096
Machinery and equipment nec	0.0161	-0.0670	0.0128	0.0175	0.0141
Manufactures nec	0.0319	-0.0531	0.0292	0.0338	0.0310
Electricity	0.0347	-0.0393	0.0320	0.0358	0.0329
Gas manufacture, distribution	0.0276	-0.0540	0.0246	0.0289	0.0265
Water	0.0309	-0.0317	0.0280	0.0309	0.0293
Construction	0.0240	-0.0224	0.0225	0.0250	0.0238
Trade	0.0258	-0.0268	0.0237	0.0270	0.0251
Transport nec	0.0224	-0.0230	0.0212	0.0232	0.0221
Sea transport	0.0048	-0.0301	0.0032	0.0055	0.0047
Air transport	0.0130	-0.0169	0.0124	0.0132	0.0127
Communication	0.0249	-0.0263	0.0226	0.0259	0.0235
Financial services nec	0.0241	-0.0287	0.0217	0.0253	0.0224
Insurance	0.0261	-0.0271	0.0238	0.0268	0.0242
Business services nec	0.0254	-0.0270	0.0232	0.0266	0.0244
Recreation and other services	0.0200	-0.0297	0.0183	0.0212	0.0192
PubAdmin/Defense/Health/Educat	0.0245	-0.0278	0.0223	0.0258	0.0228
Dwellings	0.0558	0.0016	0.0558	0.0558	0.0016

TABLE 5A-5. CHANGES IN EXPORTS FROM UNITED STATES (+1 CBP OFFICER), PERCENT

Commodities	Exports to Rest of World	Exports to Canada	Exports to United States	Exports to Mexico	Total U.S. Exports
Paddy rice	0.0003	0.0062	0.0005	-0.0002	0.0004
Wheat	0.0062	0.041	-0.0741	0.0155	0.0069
Cereal grains nec	0.0002	0.018	-0.0047	-0.0008	0.0007
Vegetables, fruit, nuts	0.0014	0.0048	-0.017	0.0004	0.0024
Oil seeds	0.0021	0.0305	-0.0472	0.0082	0.0035
Sugar cane, sugar beet	0.0001	0.0344	-0.0001	-0.0031	0.0028
Plant-based fibers	-0.0001	0.0122	0.0004	-0.0006	-0.0001
Crops nec	0.001	0.0131	-0.0068	0.0045	0.0024
Cattle, sheep, goats, horses	0.0005	0.0217	-0.0118	-0.0015	0.0027
Animal products nec	0.0006	0.0103	-0.007	-0.0007	0.001
Raw milk	-0.0002	0.031	0.0002	-0.0036	0.0034
Wool, silk-worm cocoons	0.0001	0.0173	-0.0002	-0.0009	0.0001
Forestry	-0.0014	0.0917	-0.0353	-0.0063	0.0184
Fishing	0.006	0.0335	-0.0262	0.0023	0.0196
Coal	-0.0011	-0.0006	-0.0059	-0.0008	-0.001
Oil	-0.001	0.0445	-0.0012	-0.0007	0.0423
Gas	-0.0153	0.2332	-0.0598	-0.0072	0.1055
Minerals nec	0.0017	-0.013	-0.0174	0.0015	-0.002
Meat: cattle, sheep, goats, horses	-0.0001	0.0447	-0.0034	0.0085	0.0107
Meat products nec	0	0.0333	-0.0133	-0.0009	0.0049
Vegetable oils and fats	0.0034	0.0333	-0.0263	0.0047	0.0088
Dairy products	-0.0014	0.0408	-0.0022	-0.0024	0.001
Processed rice	-0.0004	0.004	-0.0004	-0.0006	0
Sugar	-0.0017	0.0203	0.0003	-0.0011	0.0017
Food products nec	0.0001	0.0213	-0.0073	-0.0002	0.0062
Beverages and tobacco products	-0.0007	0.0147	-0.0014	0	0.0026
Textiles	-0.0019	0.0184	-0.0034	-0.0006	0.0022
Wearing apparel	-0.0026	0.0219	-0.0018	-0.0029	0.0014
Leather products	-0.0024	0.0164	-0.0019	-0.0026	-0.0007
Wood products	0.0004	0.0486	-0.028	-0.002	0.0209
Paper products, publishing	0.0006	0.0321	-0.0319	0.0004	0.0093
Petroleum, coal products	-0.0001	0.0118	-0.0027	-0.0002	0.0016
Chemical, rubber, plastic prods	-0.0006	0.0235	-0.0098	-0.0004	0.0032
Mineral products nec	-0.0008	0.0282	-0.0155	-0.0014	0.0075

Ferrous metals	-0.0008	0.0181	-0.0089	0.0005	0.0048
Metals nec	-0.0002	-0.0078	0.0033	0.0007	-0.0015
Metal products	-0.0023	0.0298	-0.0079	-0.0008	0.007
Motor vehicles and parts	-0.0011	0.0158	-0.0046	-0.0003	0.0075
Transport equipment nec	-0.0022	-0.0015	0.0042	-0.0002	-0.0021
Electronic equipment	-0.0027	0.0072	-0.0017	-0.001	-0.0017
Machinery and equipment nec	-0.0028	0.0128	-0.0029	-0.0014	0
Manufactures nec	-0.0025	0.0292	-0.0019	-0.002	0.0014
Electricity	-0.0024	0.032	0.028	-0.0009	0.0199
Gas manufacture, distribution	-0.0027	0.0246	-0.0008	-0.0029	-0.002
Water	-0.0027	0.028	-0.001	-0.002	0.0011
Construction	-0.0016	0.0225	-0.0004	-0.0024	-0.0013
Trade	-0.0019	0.0237	0.0008	-0.002	0.001
Transport nec	-0.0017	0.0212	0	-0.0007	-0.0019
Sea transport	-0.0028	0.0032	-0.0014	-0.0025	-0.0058
Air transport	-0.0002	0.0124	0.0006	-0.0002	-0.0018
Communication	-0.0018	0.0226	0.0019	-0.0017	0.0017
Financial services nec	-0.0018	0.0217	0	-0.0017	0.0009
Insurance	-0.0012	0.0238	0.0009	0.0005	0.0045
Business services nec	-0.0016	0.0232	0.0013	-0.0021	0.0005
Recreation and other services	-0.0008	0.0183	0.0017	-0.0003	0.0015
PubAdmin/Defense/Health/Educat	-0.0014	0.0223	0.0008	-0.0018	0.0006
Dwellings	-0.0021	0.0558	0.0001	-0.0031	0.0001

CHAPTER 6. REGIONAL AND NATIONAL MACROECONOMIC IMPACTS OF CHANGES IN TOURISM AND BUSINESS TRAVEL

by

Dan Wei

I. INTRODUCTION

In this chapter, we estimate the macroeconomic impacts of changes in tourist and business travel resulting from CBP inspection staffing changes at the passenger land Ports of Entry (POEs). The macroeconomic level analysis is based on the micro level analysis results on land passenger travel presented in Chapter 2. Wait time changes resulting from adding or reducing one CBP officer are estimated for each selected POE. The increased or decreased numbers of tourist and business travelers were then estimated using the elasticity of vehicle trips to wait time. The increased or decreased numbers of Canadian and Mexican travelers were then translated into changes in direct spending on goods and services of these travelers. This chapter analyzes the total, or "multiplier" effect, of the changes in direct tourism and business travel spending.

We used an input-output (I-O) analysis approach to evaluating the regional and national impacts of changes in tourist and business spending associated with wait time changes at the land POEs. The impact analysis is performed for the regional economy of each POE, the rest of the U.S., and the U.S. as whole. Input-Output (I-O) analysis, developed by Nobel laureate Wassily Leontief, is the most widely used tool of regional impact analysis in the U.S. and throughout the world (Rose and Miernyk, 1989; Miller and Blair, 2009). Many studies have successfully utilized I-O models to estimate tourism impacts on local and national economies (Horvath and Frechtling, 1999; SDAG, 2006; Pavlakovich-Kochi and Charney, 2008; Madsen and Zhang, 2010).

This chapter is divided into six sections. In the next section, we present an overview of the input-output analysis approach. Section III summarizes the selected POEs for this study and how the POE regions are defined. The methodology, analytical steps, and major assumptions of this study are summarized in Section IV. In Section V, we calculated the average spending per traveler for both the Canadian and Mexican visitors and the American travelers who visit Canada or Mexico. Section VI presents the simulation results.

Note the following caveats and limitations regarding the regional macroeconomic results:

- Our macroeconomic impact analysis of passenger vehicle activity is undertaken by a linear model. The macroeconomic impacts of expenditures on business and personal travel is reasonably linear over the broad range of increases or decreases in economic activity likely to arise from changes in POE staffing. However, the direct change in the number of passengers is non-linear. Hence, the product of the two numbers is non-linear as well.

II. INPUT-OUTPUT ANALYSIS

An input-output (I-O) table consists of a set of accounts of all transactions between sectors in a given year. An I-O model can be constructed from these accounts by assuming a proportional relationship between inputs and outputs. In its basic form, the I-O model can be defined as a static, linear model of all purchases and sales between sectors of an economy, based on the technological relationships of production. It is especially adept at estimating ripple, or multiplier, effects. In an I-O analysis, it is important to distinguish two types of second-order effects. The first is "indirect" effects, which represent the interaction between producing sectors. The second is "induced" effects, which represent the interaction between households and producing sectors; production generates income paid to households, who in turn spend a major portion of this income on produced goods and services, thereby generating additional multiplier effects.

For this study, we employ the most widely used source of regional and national I-O tables, the Impact Analysis for Planning (IMPLAN) System (MIG, 2012). This source consists of three components: 1) a study region (can be state, county, sub-county) data base, 2) a set of algorithms capable of generating I-O tables for any state, county or sub-county group, and 3) a computational capability for calculating multipliers and performing impact analyses. The IMPLAN sectoring scheme is currently based on the North American Industrial Classification System (NAICS), which disaggregates the economy into 440 sectors. In the I-O models constructed for this study, we aggregate the 440 IMPLAN sectors into 86 3-digit NAICS sectors.

In the analysis, we use the standard demand-side version of the I-O model, which evaluates how a change in final demand in a sector (or many sectors) would generate changes in "upstream" demands for successive rounds of production inputs. This leads to economic impacts rippling through the economy, thereby resulting in multiplier effects. Outputs from the I-O analysis include impacts on employment, gross output, personal income, and gross domestic product (GDP) at both the regional and national levels.[59]

III. SELECTED POEs FOR THE STUDY

A total of eight POEs, three on the U.S.-Canada border and five on the U.S.-Mexico border, have been selected for the economic impact analysis of CBP staffing changes:

Northern Border POEs: Buffalo-Niagara Falls, Blaine, and Detroit
Southern Border POEs: Calexico, El Paso, Laredo, Nogales, and San Ysidro

These are among the major POEs in terms of personal vehicles processed annually. Based on Bureau of Transportation Statistics 2011 data, the three northern border POEs selected ranked in the top three in terms of the total number of personal vehicles coming through the U.S.-Canada border. The five

[59] Gross output measures the total revenue received from the sale of a good from a given sector. It includes all costs of production--both returns to primary factors of production (including a normal rate of return on investment) and payments for intermediate goods. Value-added pertains to the returns to primary factors of production (labor, capital, and natural resources), which provide the basis for a net measure of economic activity. Essentially, value-added is equivalent to Gross Domestic Product (GDP) or Gross Regional Product (GRP).

southern border POEs selected ranked within top 9 in terms of the total number of personal vehicles entering the U.S. through the U.S.-Mexico border.

To designate the POE regions, we adopted the following decision rules: 1) for a POE that is located in/near big cities, the regional impact analysis covers the entire metropolitan statistical areas (MSAs); 2) for those POEs that are not near any MSAs, the POE region only includes the county within which the POE is located. Table 6-1 presents the MSAs and counties corresponding to each of the eight POE regions we established.

TABLE 6-1. MSAs AND COUNTIES IN THE POE REGIONS

POE	Metropolitan or Micropolitan Statistical Area	County
Calexico	N/A	Imperial County
El Paso	El Paso, TX Metropolitan Statistical Area	El Paso County
Laredo	Laredo, TX Metropolitan Statistical Area	Webb County
Nogales	Nogales, AZ Micropolitan Statistical Area	Santa Cruz County
San Ysidro	San Diego-Carlsbad-San Marcos, CA Metropolitan Statistical Area	San Diego County
Buffalo-Niagara Falls	Buffalo-Niagara Falls, NY Metropolitan Statistical Area	Erie County, Niagara County
Blaine	N/A	Whatcom County
Detroit	Detroit-Warren-Livonia, MI Metropolitan Statistical Area	Wayne County, Lapeer County, Livingston County, Macomb County, Oakland County, St. Clair County

IV. METHODOLOGY, ANALYTICAL STEPS, AND MAJOR ASSUMPTIONS

A. Offsetting Impacts Resulting from Changes in U.S. Resident Travels

When we calculate the economic impact of increased tourist spending resulting from wait time reductions at, we should not only focus on the stimulating impacts from the spending of the increased Canadian and Mexican visitors traveling to the U.S.

Reduced wait time for returning Americans to re-enter the U.S. from their travels to Canada and Mexico can also result in more trips to these two countries made by the American residents. When the American residents make more foreign trips, they tend to reduce their domestic travel plans or reduce some other expenditure domestically to offset their increased spending abroad. Therefore, to calculate the net economic impacts (net of the stimulating impacts and the offsetting impacts) of wait time reduction at the land POEs, we also quantify the economic impacts of the changes domestic spending by the American residents who decide to alter their amount of travel to Canada and Mexico in light of the reduced wait time at the border.

B. Regional Impacts vs. Impacts to Rest of the U.S.

In order to estimate the economic impacts of CBP staffing changes to both the POE region and to rest of the U.S., we first calculate the proportion of direct spending taking place in the POE regions, and the proportion taking place in other places (e.g., the destination of a Mexican traveler who enters the U.S. through San Ysidro POE might be Los Angeles, rather than San Diego).

For Canadian/Mexican travelers by car, there are only limited data identifying their destinations outside of the POE region. According to the SANDAG study (SANDAG, 2006), survey shows that only 5.6% of the Mexican travelers entered the U.S. through the San Diego region POEs have their primary destination outside of the San Diego County. According to a 2008 report by Arizona Office of Tourism, "4.39 percent of parties crossing at Nogales continue to metro Phoenix" and "more than 13 percent of parties coming through Nogales visit metro Tucson". No similar data have been found for the other POEs. We decided to use the average of the data we obtained from the SANDAG study (5.6%) and the Arizona Office of Tourism study (17.39%), which is 11.5%, for all the other land POEs, to represent the proportion of the direct tourist spending that takes place outside of the POE region.

For the American travelers, when they increase trips to Mexico and Canada, they tend to reduce the numbers of domestic travels to offset the increased spending in foreign trips. We make assumptions on the proportion of the foregone domestic spending that would have taken place in the POE Region vs. in the rest of the U.S. In the SANDAG study, the implicit assumption used for the offsetting impact is that roughly 68% of the additional spending from the foregone trips to Mexico of the Americans will take place in the San Diego County. We use a similar percentage number in our study for POEs that are located in large MSA regions, and 50% for other POEs.

C. Analytical Steps

This section summarizes the analytical steps we undertake to perform the regional and national economic impact analysis of changes in tourist spending stemming from POE wait time changes.

Step 1. We obtained Year 2010 data on tourist expenditures on goods and services from the BEA Travel and Tourism Satellite Account (BEA, 2011). The BEA tourist expenditure data are categorized in four different visitor types: Resident Households, Domestic Business, Domestic Government, and Non-residents. We map the BEA data to the relevant industries in our 86-sector scheme. Table 6-2 presents the percentages of distribution of the total tourist spending among different sectors for different visitor types.[60] In this study, we use the expenditure percentages for "non-resident" visitors to disaggregate the total expenditures of the foreign travelers among the changes in demand of goods and services from different industries. For changes of Americans' travel demand domestically, we use the expenditure percentages in the "Resident Households" column. Applying the expenditure percentages presented in Table 6-2 to the total increased or decreased tourist spending in each POE region to obtain the vector of

[60] We made one adjustment to the BEA tourist expenditure data. Since we are focusing on the land travelers, we exclude the spending under the category "International Passenger Air Transportation Services" before calculating the percentage breakdown of expenditures on different goods and services made by the foreign visitors traveling by automobiles.

final consumer demand change by industry for the POE region. The vector of direct tourist spending changes in rest of the U.S. is computed similarly.

Step 2. The total gross output impacts of the increased/decreased direct tourist spending on the economy of each POE region are computed by applying the demand-side I-O model of the region to the vector of final demand change. The regional impacts on employment and GDP are computed by multiplying the gross output impacts for each industry by the industrial employment/output and GDP/output coefficients calculated based on the regional I-O models, respectively.

Step 3. Total gross output impacts of the increased/decreased direct tourist spending on the economy of rest of U.S. are computed by applying the U.S. demand-side I-O model to the vector of direct final demand changes in rest of U.S.

Step 4. The direct tourist spending in the POE region also generates spillover effects to rest of the country. This is calculated by applying the U.S. I-O model to the vector of direct final demand changes in the POE region. The results are then adjusted by subtracting the direct and indirect impacts of the POE region from the total impacts.

TABLE 6-2. SHARE OF EXPENDITURES BY TYPE OF VISITOR

	Sector	Resident households	Domestic Business	Domestic Government	Nonresidents
1	111 Crop Farming				
2	112 Livestock				
3	113 Forestry & Logging				
4	114 Fishing- Hunting & Trapping				
5	115 Ag & Forestry Svcs				
6	211 Oil & gas extraction				
7	212 Mining				
8	213 Mining services				
9	221 Utilities				
10	230 Construction				
11	311 Food products	5%	3%	2%	7%
12	312 Beverage & Tobacco	1%	1%	1%	2%
13	313 Textile Mills				
14	314 Textile Products	3%	2%	1%	4%
15	316 Leather & Allied				
16	321 Wood Products				
17	322 Paper Manufacturing				
18	323 Printing & Related				
19	324 Petroleum & coal prod				
20	325 Chemical Manufacturing				
21	326 Plastics & rubber prod				
22	327 Nonmetal mineral prod				
23	331 Primary metal mfg				
24	332 Fabricated metal prod				
25	333 Machinery Mfg				

26	334 Computer & oth electron				
27	335 Electrical eqpmt & appliances				
28	336 Transportation eqpmt				
29	337 Furniture & related prod				
30	339 Miscellaneous mfg	8%	4%	3%	11%
31	42 Wholesale Trade				
32	441 Motor vehicle & parts dealers				
33	442 Furniture & home furnishings				
34	443 Electronics & appliances stores				
35	444 Bldg materials & garden dealers				
36	445 food & beverage stores				
37	446 Health & personal care stores				
38	447 Gasoline stations	13%	10%	4%	2%
39	448 Clothing & accessories stores				
40	451 Sports- hobby- book & music stores				
41	452 General merchandise stores				
42	453 Misc retailers				
43	454 Non-store retailers				
44	481 Air transportation	11%	6%	22%	8%
45	482 Rail Transportation	0%	0%	1%	0%
46	483 Water transportation	2%	0%	0%	0%
47	484 Truck transportation				
48	485 Transit & ground passengers	2%	1%	3%	1%
49	486 Pipeline transportation				
50	487 Sightseeing transportation	1%	0%	0%	1%
51	492 Couriers & messengers				
52	493 Warehousing & storage				
53	511 Publishing industries				
54	512 Motion picture & sound recording	2%	2%	0%	1%
55	515 Broadcasting				
56	516 Internet publishing and broadcasting				
57	517 Telecommunications				
58	518 Internet & data process svcs				
59	519 Other information services				
60	521 Monetary authorities				
61	522 Credit intermediation & related activities				
62	523 Securities & other financial				
63	524 Insurance carriers & related				
64	525 Funds- trusts & other financial vehicles				
65	531 Real estate				
66	532 Rental & leasing svcs	2%	12%	5%	1%
67	533 Lessor of nonfinancial intangible assets				
68	541 Professional- scientific & tech svcs				
69	551 Management of companies				
70	561 Admin support svcs	4%	10%	2%	2%
71	562 Waste mgmt & remediation svcs				

72	611 Educational svcs				
73	621 Ambulatory health care				
74	622 Hospitals				
75	623 Nursing & residential care				
76	624 Social assistance				
77	712 Performing arts & spectator sports	2%	4%	0%	1%
78	712 Museums & similar				
79	713 Amusement- gambling & recreation	11%	1%	0%	10%
80	721 Accommodations	17%	25%	29%	27%
81	722 Food svcs & drinking places	14%	19%	24%	22%
82	811 Repair & maintenance	1%	1%	0%	1%
83	812 Personal & laundry svcs	0%	0%	1%	0%
84	813 Religious- grantmaking- & similar orgs				
85	814 Private households				
86	92 Government & non NAICs				
	Total	100%	100%	100%	100%

Step 5. The employment and GDP impacts to the rest of the U.S. are computed by multiplying the gross output impacts to rest of the U.S. for each industry by the industrial employment/output and GDP/output coefficients calculated based on the U.S. I-O model, respectively.

Step 6. The total gross output, employment, and GDP impacts for the U.S. are computed as the sum of the impacts to the POE region and the impacts to the rest of the U.S.

D. Other Major Assumptions

Other major assumptions adopted in this analysis include:

1. We assume that 100% of the total travel expenditures of the Canadian and Mexican visitors are made in the U.S., and thus 100% of the total spending will stimulate the U.S. economy. Similarly, we assume that 100% of the total travel expenditures of the Americans, who travel to Canada or Mexico, would take place on the other side of the U.S. border. However, in this study, we do not analyze the spending impacts of the traveling Americans to the Canadian and Mexican economies. We will, however, analyze the offsetting impacts of reduced (or increased) spending of the Americans domestically when they increase (or decrease) their trips to Canada or Mexico because of the change in wait time at the land POEs.

2. We assume that if American residents decrease (or increase) their trips to Canada or Mexico, they would increase (or reduce) their domestic spending by 66% of their total travel expenditures in Canada/Mexico. This assumption is adapted from the survey results of the SANDAG study. A survey question was asked to the American travelers that if they would have decided not to take the trip because of the long wait time at the border, what they would have done with the money they spent in Mexico. The survey indicated that the U.S. residents will spend 45% of the money in the U.S. instead if they had not gone for the trip to Mexico. For the remaining money, 21% will be saved and 34% will be spent in future trips to Mexico. We also

assume that the saving rate of the Americans would roughly stay constant. Therefore, we use a percentage of 66% in the offsetting impacts calculation.

V. CALCULATION OF AVERAGE SPENDING PER TRAVELER

A. Average Spending Per Canadian/Mexican Visitor

The average spending per trip by Canadian and Mexican visitors traveling to the U.S. is affected by various factors, such as the transportation mode the visitors use (e.g., air vs. car), the destination of the visit (e.g., border states vs. states far from the land border), and the length of stay (e.g., overnight trip vs. same-day trip). Since our analysis focuses on 8 POEs that spread over 3 U.S.-Canada border states (NY, WA, MI) and 3 U.S.-Mexico border states (CA, AZ, TX), we focus the calculation of average spending per visitor on these 6 states.

1. Canadian Travelers Visiting U.S. Northern Border States

The major data source we use to compute average spending by Canadian travelers who visit NY, WA, and MI is the Statistics Canada report *International Travel 2010*.

TABLE 6-3. AVERAGE SPENDING PER PERSON-VISIT BY CANADIANS TO NY, WA, AND MI (2010)

State	Same-Day Visit	Overnight Visit	Weighted Average[1]
NY	$74	$365	$169
WA	$74	$267	$137
MI	$74	$248	$131

Source: Statistics Canada (2011).

[1] Shares of same-day visits and overnight visits (67% and 33%, respectively) are used to compute the weighted average spending per person-visit.

The first two numerical columns in Table 6-3 present the average spending per person-visit of Canadian residents who visited NY, WA, and MI in 2010. For same-day visit spending, since state-specific numbers are not available, we use the national average for all states.
In 2010, Canadians made 24.5 million same-day trips by car to the U.S. The total number of overnight visits by Canadians using automobile is 11.9 million. Based on these numbers, we computed that the shares of same-day and overnight visits by the Canadians by car in 2010 are 67% and 33%, respectively.

In the last column of Table 6-3, we compute the weighted average per person-visit spending for those who use automobile as the travel mode using the shares of same-day visits vs. overnight visits.

2. Mexican Travelers Visiting U.S. Southern Border States

a. <u>California</u>

The data source we use to compute the average per person-visit spending by Mexican visitors to California is the *International Visitor Profiles (Mexico)*, published by California Tourism Industry.

For land travelers, same-day and overnight Mexican visitors to California in 2010 were 3,571,000 and 2,858,000, respectively. In other words, among all the land travelers coming from Mexico to California, 56% were same-day visitors and 44% were overnight visitors. On average, spending per same-day visitors in California was $54, and the spending for overnight visitors was $389. Then we calculated that the weighted average spending per Mexican visitor in California using an automobile as the transportation mode was $203 (= $54 x 56% + $389 x 44%) in 2010.

b. Arizona

The calculations for Arizona are largely based on the 2008 report *Mexican Visitors to Arizona*, by the University of Arizona and commissioned by the Arizona Office of Tourism. This study summarized the travel and spending characteristics of Mexican visitors traveling to Arizona and analyzed the economic impacts of Mexican visitor spending in Arizona.

In 2007-2008, same-day visitors and overnight visitors represented 81% and 19% of the total Mexican visitors traveling to Arizona by motor vehicles. On average the spending per party for same-day visitors and overnight visitors was $81.22 and $838.62, respectively. In addition, the average party size was 1.8 persons. Therefore, the average per person spending for same-day visitors and overnight visitors was $45 and $467, respectively. We calculated that the weighted average spending per Mexican visitor who traveled by automobile to Arizona in 2007-2008 was $125.1 (= $45 x 81% + $467 x 19%).

In order to estimate the average per person spending of the Mexican visitors in Arizona in 2010 based on the 2007-2008 data, we calculate the spending growth by non-resident visitors to the U.S. between 2007-2008 and 2010. According to BEA (2011), the average of the total non-resident traveler expenditures in 2007 and 2008 were $130.8 billion. In 2010, this number only slightly increased to $133.3 billion, or about a 2% increase from the 2007-2008 level. Therefore, we estimate that the average spending per Mexican visitor who traveled by automobile to Arizona in 2010 was about $127.5.

c. Texas

We only found very limited data for Texas. According to a 2005 report by University of Texas – Pan American, the average expenditures per party per trip by Mexican travelers visiting California by car was about $170 in 2004-2005. The estimate for Texas for Year 2003 was $182. We simply apply the ratio of $182 over $170, which is 1.07 to the average spending per Mexican visitor by car in California in 2010 calculated above to obtain the estimate for Texas. Therefore, the estimated average spending per Mexican visitor traveled by car in Texas in 2010 was about $217 = ($203 x 1.07).

B. Average Spending Per American Traveler to Mexico or Canada

1. American Travelers Visiting Canada

The major data source we use to compute average spending by American travelers to Canada is the Statistics Canada report *International Travel 2010*.

The first two numerical columns in Table 6-4 present the average spending per person-visit of American residents traveling to Canada from Middle Atlantic, East North Central, and Pacific regions in 2010. For same-day visitor spending, since region-specific numbers are not available, we use the national average for all regions.

In 2010, Americans made 7.4 million same-day trips and 6.9 million overnight travels by car to Canada. In other words the shares of same-day and overnight visits to Canada made by the American residents by car in 2010 are 52% and 48%, respectively. In the last column of Table 6-4, we compute the weighted average per person-visit spending for those who use automobile as the transportation mode using the shares of same-day visits vs. overnight visits.

TABLE 6-4. AVERAGE SPENDING PER PERSON-VISIT BY AMERICANS TO CANADA (2010)

Origin Region	Same-Day Visit	Overnight Visit	Weighted Average[1]
NY (Middle Atlantic)	$59	$428	$237
WA (Pacific)	$59	$525	$284
MI (East North Central)	$59	$465	$255

[1] Shares of same-day visits and overnight visits (52% and 48%, respectively) are used to compute the weighted average spending per person-visit.

Source: Statistics Canada (2011).

2. American Travelers Visiting Mexico

The SANDAG study provides the information on the average spending by the American travelers in Mexico who passed the border in the San Diego region in 2004. We increase the 2004 values to contemporary levels using data on per-capita nominal income in the San Diego region. For other southern land POEs, we adjusted the values for the San Diego region to other locations using the ratio of per-capita income in another location to that of San Diego. Table 6-5 presents the average per person-trip spending of the Americans from different regions traveling to Mexico.

TABLE 6-5. AVERAGE SPENDING PER PERSON-VISIT BY AMERICANS TO MEXICO (2010)

Origin County	Average Per Person-Trip Spending
San Diego	$163
Imperial	$100
El Paso	$104
Webb	$86
Santa Cruz	$88

VI. SIMULATION RESULTS

A. Regional and National Economic Impacts of Adding One CBP Officer at the Passenger Land POEs

Tables 6-6 presents the additional number of Mexican or Canadian travelers to the U.S. resulting from adding one CBP officer at each of the 17 selected passenger land POEs. The associated increased expenditures by the foreign tourists are presented in the last column of Table 6-6. Table 6-7 presents the increased number of returning Americans who travel to Mexico or Canada resulting from adding one CBP officer at the land POEs. Their total spending in Mexico and Canada is calculated in the second to last column of Table 6-7. These numbers are then used to compute the corresponding reduced spending of these Americans in the U.S. to offset their spending in the increased trips to Mexico and Canada.

Tables 6-8 to 6-10 present the net impacts on gross output, GDP, and employment of adding one CBP officer at each of the 17 selected passenger land POEs. Appendix 6B presents the POE by POE results. The net impacts are the sum of the stimulus impacts stemming from the increased spending by the Mexican and Canadian travelers and the dampening impacts stemming from the reduced spending by the Americans in the U.S. when they travel more to Mexico and Canada. The net economic impacts are positive for most of the crossings. The net impacts are negative for San Ysidro and Detroit POEs for two main reasons: 1) these two POEs have significantly higher numbers of returning Americans than visiting Mexicans/Canadians; and 2) for Detroit POEs, the average per person-trip spending by the Americans in Canada is higher than the per person-trip spending by the Canadians in the U.S. These two factors combined to result in high reduced spending by the Americans domestically for the two POEs.

The 2006 SANDAG study analyzed the economic impacts due to the total delay times at the San Diego-Baja California border, on both the U.S. economy and the Mexican economy, based on a survey done in 2004 of roughly 3,500 cross-border travelers in the San Diego area. According to the survey, only 30% of the passengers that entered the San Ysidro POE were American residents. In our study, if we use the SANDAG assumption that 30% of passengers are American residents who went to Mexico and are coming back, rather than the 76% that is based on the CBP FY 2012 data, the GDP impacts for San Ysidro would change from -$5.4 M to $18.0 M, and the employment impacts would change from 71 job losses to 240 job gains. Total GDP impacts for 17 Land POEs would increase from $61.8 M to $85.2 M, or an increase of 38%. Total employment impacts for 17 Land POEs would increase from 1,053 job gains to 1,365 job gains, or an increase of 30%.[61]

Table 6-11 presents the summary results on gross output, GDP and employment impacts for all the crossings aggregated together. Adding one CBP officer at each of the 17 selected passenger land POEs can lead to an increase in gross output of $121.6 million or an increase in GDP of $61.8 million. The employment gains are estimated to be 1,053 jobs. The vast majority of gains are captured by the POE regions themselves. The regional gains are a relatively high proportion despite the fact that the

[61] In general, the larger the number of American residents in the passenger flow, the higher the offsetting (negative) impacts to the U.S. economy. However, there are a few other factors that affect the results. First, Americans would not offset 100% of their foreign spending by domestic spending. We assume that if American residents increase their trips to Canada or Mexico, they would reduce their domestic spending by only 66% of their total travel expenditures in Canada/Mexico, because according to the SANDAG study (SANDAG, 2006), the survey indicated that the U.S. residents will offset 34% of the total increased travel expenditures by reduced future trips to Mexico. Therefore, for a POE, if the average spending per person-visit by Canadians/Mexicans to the U.S. is same as the average spending per person-visit by Americans who travel to Canada/Mexico, the offsetting effect would be equal to the stimulus effects if the American traveler to Canadians/Mexican traveler ratio is about 1.5 (=1/66%). Second, the level of average spending per person-visit also affects the impact analysis results. According to Statistics Canada data for Detroit POEs, the average per person-trip spending by the Americans in Canada is higher than the per person-trip spending by the Canadians in the U.S. This is a contributing factor to the negative economic impacts in the +1 Case of the Detroit POEs other than the fact that there are higher numbers of returning Americans than incoming Canadians at these POEs.

multiplier values are higher for national impacts. The main reason for this outcome is the diversion of some of spending to other countries stemming from the increased attractiveness of foreign travel to U.S. residents from decreased wait times. This subtraction to yield net impacts is nationwide and not just limited to the POE regions.

Table 6-12 presents the national economic impacts by industry for all the crossings aggregated. Not surprisingly, most stimulated sectors are those that provide goods and services to tourists, such as Food Services and Drinking Places, Accommodations, Amusement and Recreation Services, etc.

TABLE 6-6. INCREASED CANADIAN AND MEXICAN TRAVELERS AND SPENDING IN THE U.S. (+1 CBP OFFICER AT EACH POE)

Port	Crossing	Additional Canadian or Mexican Passengers	Average Per Person-Trip Spending	Increased Spending (million 2010$)
Calexico	Calexico/East	40,536	$203	$8.23
	Calexico/West	28,960	$203	$5.88
El Paso	Ysleta	32,456	$217	$7.04
	Paso Del Norte	34,761	$217	$7.54
	Bridge of the Americas	53,495	$217	$11.61
Laredo	Lincoln-Juarez	28,841	$217	$6.26
	Convent St.	18,493	$217	$4.01
Nogales	Mariposa	33,185	$128	$4.23
	Deconcini	32,212	$128	$4.11
San Ysidro	San Ysidro	24,631	$203	$5.00
Buffalo-Niagara Falls	Rainbow Bridge	21,318	$169	$3.60
	Lewiston Bridge	39,129	$169	$6.61
	Peace Bridge	22,884	$169	$3.87
Blaine	Peace Arch	65,125	$137	$8.92
	Pacific Highway	55,394	$137	$7.59
Detroit	Windsor Tunnel	10,807	$131	$1.42
	Ambassador Bridge	10,631	$131	$1.39
Total		552,857	n.a.	$97.31

TABLE 6-7. INCREASED AMERICAN PASSENGERS TRAVELING TO CANADA/MEXICO AND THE CORRESPONDING REDUCED SPENDING IN THE U.S. (+1 CBP OFFICER AT EACH POE)

Port	Crossing	Additional American Passengers	Average Per Person-Trip Spending of the Americans in Mexico or Canada	Total Increased Spending in Mexico or Canada (million 2010$)	Reduced Spending in the U.S. (million 2010$)
Calexico	Calexico/East	52,370	$100	$5.22	$3.45
	Calexico/West	43,946	$100	$4.38	$2.89
El Paso	Ysleta	29,953	$104	$3.11	$2.05
	Paso Del Norte	32,079	$104	$3.33	$2.20
	Bridge of the Americas	49,369	$104	$5.13	$3.39
Laredo	Lincoln-Juarez	31,941	$86	$2.74	$1.81
	Convent St.	20,480	$86	$1.76	$1.16
Nogales	Mariposa	25,034	$88	$2.20	$1.45
	Deconcini	24,300	$88	$2.14	$1.41
San Ysidro	San Ysidro	77,155	$163	$12.57	$8.30
Buffalo-Niagara Falls	Rainbow Bridge	11,909	$237	$2.83	$1.87
	Lewiston Bridge	21,859	$237	$5.19	$3.42
	Peace Bridge	12,784	$237	$3.03	$2.00
Blaine	Peace Arch	43,417	$284	$12.34	$8.14
	Pacific Highway	36,930	$284	$10.50	$6.93
Detroit	Windsor Tunnel	16,745	$255	$4.27	$2.82
	Ambassador Bridge	16,473	$255	$4.20	$2.77
Total		546,744	n.a.	$84.96	$56.07

TABLE 6-8. GROSS OUTPUT IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT EACH OF 17 U.S. LAND POES (MILLION 2011$)

Port	Crossing	Port Region	Rest of the U.S.	U.S. Total
Calexico	Calexico/East	$8.7	$5.3	$14.0
	Calexico/West	6.0	2.8	8.8
El Paso	Ysleta	8.4	6.1	14.5
	Paso Del Norte	9.0	6.6	15.6
	Bridge of the Americas	13.8	10.1	23.9
Laredo	Lincoln-Juarez	8.1	4.9	13.0
	Convent St.	5.2	3.1	8.3
Nogales	Mariposa	4.3	3.8	8.1
	Deconcini	4.2	3.7	7.9
San Ysidro	San Ysidro	-1.6	-7.6	-9.2
Buffalo-Niagara Falls	Rainbow Bridge	3.8	1.3	5.1
	Lewiston Bridge	7.0	2.4	9.4
	Peace Bridge	4.1	1.4	5.5
Blaine	Peace Arch	8.7	-6.1	2.6
	Pacific Highway	7.4	-5.2	2.2
Detroit	Windsor Tunnel	-1.4	-2.6	-4.0
	Ambassador Bridge	-1.3	-2.6	-3.9
Total		**$94.1**	**$27.5**	**$121.6**

TABLE 6-9. GDP IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT EACH OF 17 U.S. LAND POES (MILLION 2011$)

Port	Crossing	Port Region	Rest of the U.S.	U.S. Total
Calexico	Calexico/East	$4.5	$2.8	$7.3
	Calexico/West	3.1	1.4	4.5
El Paso	Ysleta	4.6	3.2	7.7
	Paso Del Norte	4.9	3.4	8.3
	Bridge of the Americas	7.6	5.2	12.8
Laredo	Lincoln-Juarez	4.3	2.4	6.7
	Convent St.	2.8	1.6	4.3
Nogales	Mariposa	2.3	2.0	4.3
	Deconcini	2.2	1.9	4.1
San Ysidro	San Ysidro	-1.1	-4.3	-5.4
Buffalo-Niagara Falls	Rainbow Bridge	2.1	0.6	2.7
	Lewiston Bridge	3.8	1.1	4.9
	Peace Bridge	2.2	0.6	2.9
Blaine	Peace Arch	4.4	-3.7	0.7
	Pacific Highway	3.8	-3.1	0.6
Detroit	Windsor Tunnel	-0.9	-1.5	-2.3
	Ambassador Bridge	-0.8	-1.4	-2.3
Total		**$49.7**	**$12.1**	**$61.8**

TABLE 6-10. EMPLOYMENT IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT EACH OF 17 U.S. LAND POES (JOBS)

Port	Crossing	Port Region	Rest of the U.S.	U.S. Total
Calexico	Calexico/East	89	25	113
	Calexico/West	61	10	71
El Paso	Ysleta	88	37	125
	Paso Del Norte	95	40	134
	Bridge of the Americas	146	61	207
Laredo	Lincoln-Juarez	95	25	120
	Convent St.	61	16	77
Nogales	Mariposa	50	22	71
	Deconcini	48	21	69
San Ysidro	San Ysidro	-11	-60	-71
Buffalo-Niagara Falls	Rainbow Bridge	32	6	38
	Lewiston Bridge	59	11	70
	Peace Bridge	35	7	41
Blaine	Peace Arch	92	-63	29
	Pacific Highway	78	-53	25
Detroit	Windsor Tunnel	-14	-20	-34
	Ambassador Bridge	-14	-20	-34
Total		**990**	**64**	**1,053**

TABLE 6-11. SUMMARY OF ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT EACH OF 17 U.S. PASSENGER LAND POES

Region	Impact Type	Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
All 8 POE Regions	Impacts of Increased Spending by Canadians/Mexicans	145.5	79.4	1,488
	Impacts of Reduced Spending by Americans	-51.3	-29.7	-499
	Net Impacts	**94.1**	**49.7**	**990**
Rest of the U.S.	Impacts of Increased Spending by Canadians/Mexicans	136.4	72.6	881
	Impacts of Reduced Spending by Americans	-108.9	-60.5	-818
	Net Impacts	**27.5**	**12.1**	**64**
U.S. Total	Impacts of Increased Spending by Canadians/Mexicans	281.9	152.0	2,370
	Impacts of Reduced Spending by Americans	-160.2	-90.2	-1,316
	Net Impacts	**121.6**	**61.8**	**1,053**

TABLE 6-12. NATIONAL ECONOMIC IMPACTS BY INDUSTRY OF ADDING ONE CBP OFFICER AT EACH OF 17 U.S. PASSENGER LAND POES

	Sector	Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impact (jobs)
1	111 Crop Farming	1.3	0.5	11
2	112 Livestock	1.7	0.4	12
3	113 Forestry & Logging	0.1	0.0	1
4	114 Fishing- Hunting &	0.1	0.0	1
5	115 Ag & Forestry Svcs	0.2	0.1	4
6	211 Oil & gas extraction	0.6	0.5	2
7	212 Mining	0.2	0.1	1
8	213 Mining services	0.0	0.0	0
9	221 Utilities	2.1	1.5	3
10	230 Construction	0.8	0.4	6
11	311 Food products	9.6	1.8	21
12	312 Beverage & Tobacco	2.0	0.5	3
13	313 Textile Mills	0.5	0.2	2
14	314 Textile Products	2.5	1.0	29
15	316 Leather & Allied	0.0	0.0	0
16	321 Wood Products	0.2	0.1	1
17	322 Paper Manufacturing	1.3	0.4	3
18	323 Printing & Related	0.3	0.1	2
19	324 Petroleum & coal prod	1.9	0.4	0
20	325 Chemical Manufacturing	2.9	0.7	2
21	326 Plastics & rubber prod	0.8	0.3	3
22	327 Nonmetal mineral prod	0.3	0.1	1
23	331 Primary metal mfg	0.5	0.1	1
24	332 Fabricated metal prod	0.9	0.4	4
25	333 Machinery Mfg	0.3	0.1	1
26	334 Computer & oth electron	0.8	0.3	1
27	335 Electrical eqpmt &	0.2	0.1	1
28	336 Transportation eqpmt	0.7	0.2	1
29	337 Furniture & related prod	0.1	0.0	1
30	339 Miscellaneous mfg	6.6	3.1	37
31	42 Wholesale Trade	3.0	2.3	18
32	441 Motor vehicle & parts	0.5	0.3	6
33	442 Furniture & home	0.1	0.1	2
34	443 Electronics & appliances	0.2	0.1	2
35	444 Bldg materials & garden	0.2	0.1	3
36	445 food & beverage stores	0.5	0.4	9
37	446 Health & personal care	0.3	0.2	3
38	447 Gasoline stations	-5.2	-3.7	-67
39	448 Clothing & accessories	0.3	0.1	5
40	451 Sports- hobby- book &	0.1	0.1	2
41	452 General merchandise	0.5	0.4	9
42	453 Misc retailers	0.2	0.1	4

43	454 Non-store retailers	0.3	0.2	5
44	481 Air transportation	2.6	1.2	9
45	482 Rail Transportation	0.3	0.2	1
46	483 Water transportation	-1.2	-0.5	-2
47	484 Truck transportation	0.9	0.5	7
48	485 Transit & ground	0.0	0.0	-1
49	486 Pipeline transportation	0.1	0.1	0
50	487 Sightseeing	0.5	0.3	6
51	492 Couriers & messengers	0.1	0.1	2
52	493 Warehousing & storage	0.2	0.1	2
53	511 Publishing industries	0.6	0.3	2
54	512 Motion picture & sound	0.2	0.1	4
55	515 Broadcasting	0.4	0.1	2
56	516 Internet publishing and	0.1	0.1	1
57	517 Telecommunications	1.8	1.0	4
58	518 Internet & data process	0.2	0.2	1
59	519 Other information	0.0	0.0	0
60	521 Monetary authorities	2.0	0.9	5
61	522 Credit intermediation &	1.5	0.8	11
62	523 Securities & other	1.6	0.4	11
63	524 Insurance carriers &	2.6	1.7	12
64	525 Funds- trusts & other	0.3	0.2	1
65	531 Real estate	7.5	6.4	21
66	532 Rental & leasing svcs	0.1	0.1	0
67	533 Lessor of nonfinancial	0.7	0.6	0
68	541 Professional- scientific &	5.6	3.8	49
69	551 Management of	2.1	1.3	11
70	561 Admin support svcs	1.6	0.9	34
71	562 Waste mgmt &	0.4	0.2	2
72	611 Educational svcs	0.7	0.4	11
73	621 Ambulatory health care	2.4	1.5	26
74	622 Hospitals	1.8	1.0	14
75	623 Nursing & residential care	0.5	0.4	9
76	624 Social assistance	0.4	0.3	11
77	712 Performing arts &	0.4	0.1	9
78	712 Museums & similar	0.0	0.0	0
79	713 Amusement- gambling &	3.7	2.1	87
80	721 Accommodations	17.2	9.1	183
81	722 Food svcs & drinking	16.0	8.4	293
82	811 Repair & maintenance	0.9	0.5	10
83	812 Personal & laundry svcs	0.6	0.3	7
84	813 Religious- grantmaking- &	0.9	0.4	11
85	814 Private households	0.1	0.1	7
86	92 Government & non NAICs	2.4	2.3	27
	Total	**121.6**	**61.8**	**1,053**

B. Regional and National Economic Impacts of Reducing One CBP Officer at the Passenger Land POEs

Tables 13 presents the decreased number of Mexican or Canadian travelers to the U.S. resulting from reducing one CBP officer at each of the 17 selected passenger land POEs. The associated decreased expenditures by the foreign tourists are presented in the last column of Table 6-13. Table 6-14 presents the decreased number of American travelers to Mexico or Canada resulting from reducing one CBP officer at the land POEs. Their total spending in Mexico and Canada is calculated in the second to last column of Table 6-14. These numbers are then used to compute the corresponding increased spending of these Americans in the U.S. to substitute their reduced travel spending in Mexico and Canada.

TABLE 6-13. DECREASED CANADIAN AND MEXICAN TRAVELERS AND SPENDING IN THE U.S. (-1 CBP OFFICER AT EACH POE)

Port	Crossing	Reduced Canadian or Mexican Passengers	Average Per Person-Trip Spending	Decreased Spending (million 2010$)
Calexico	Calexico/East	20,268	$203	$4.12
	Calexico/West	14,480	$203	$2.94
El Paso	Ysleta	16,228	$217	$3.52
	Paso Del Norte	17,381	$217	$3.77
	Bridge of the Americas	26,748	$217	$5.81
Laredo	Lincoln-Juarez	14,421	$217	$3.13
	Convent St.	9,247	$217	$2.01
Nogales	Mariposa	16,593	$128	$2.12
	Deconcini	16,106	$128	$2.06
San Ysidro	San Ysidro	12,316	$203	$2.50
Buffalo-Niagara Falls	Rainbow Bridge	10,659	$169	$1.80
	Lewiston Bridge	19,565	$169	$3.31
	Peace Bridge	11,442	$169	$1.94
Blaine	Peace Arch	32,563	$137	$4.46
	Pacific Highway	27,697	$137	$3.80
Detroit	Windsor Tunnel	5,404	$131	$0.71
	Ambassador Bridge	5,316	$131	$0.70
Total		276,429	n.a.	$48.66

TABLE 6-14. DECREASED AMERICAN PASSENGERS TRAVELING TO CANADA/MEXICO AND THE CORRESPONDING INCREASED SPENDING IN THE U.S. (-1 CBP OFFICER AT EACH POE)

Port	Crossing	Reduced American Passengers	Average Per Person-Trip Spending of the Americans in Mexico or Canada	Total Decreased Spending in Mexico or Canada (million 2010$)	Increased Spending in the U.S. (million 2010$)
Calexico	Calexico/East	26,185	$100	$2.61	$1.73
	Calexico/West	21,973	$100	$2.19	$1.45
El Paso	Ysleta	14,977	$104	$1.56	$1.03
	Paso Del Norte	16,040	$104	$1.67	$1.10
	Bridge of the Americas	24,685	$104	$2.57	$1.70
Laredo	Lincoln-Juarez	15,971	$86	$1.37	$0.91
	Convent St.	10,240	$86	$0.88	$0.58
Nogales	Mariposa	12,517	$88	$1.10	$0.73
	Deconcini	12,150	$88	$1.07	$0.71
San Ysidro	San Ysidro	38,578	$163	$6.29	$4.15
Buffalo-Niagara Falls	Rainbow Bridge	5,955	$237	$1.42	$0.94
	Lewiston Bridge	10,930	$237	$2.60	$1.71
	Peace Bridge	6,392	$237	$1.52	$1.00
Blaine	Peace Arch	21,709	$284	$6.17	$4.07
	Pacific Highway	18,465	$284	$5.25	$3.47
Detroit	Windsor Tunnel	8,373	$255	$2.14	$1.41
	Ambassador Bridge	8,237	$255	$2.10	$1.39
Total		273,372	n.a.	$42.48	$28.04

Tables 6-15 to 6-17 present the net impacts on gross output, GDP, and employment of reducing one CBP officer at each of the 17 selected passenger land POEs. Appendix 6B presents the crossing by crossing results. The net impacts are the sum of the dampening impacts stemming from the decreased spending by the Mexican and Canadian travelers and the stimulus impacts stemming from the increased spending by the Americans in the U.S. when they increase their domestic travel to substitute travels to Mexico and Canada. The net economic impacts are negative for most of the crossings.

Table 6-18 presents the summary results on gross output, GDP and employment impacts for all the crossings aggregated together. Reducing one CBP officer at each of the 17 selected passenger land POEs can lead to a decrease in gross output of $60.8 million or a decrease in GDP of $30.9 million to the U.S. economy. The employment losses are estimated to be 527 jobs. The vast majority of the negative impacts take place in the POE regions.

TABLE 6-15. GROSS OUTPUT IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT EACH OF 17 U.S. LAND POES (MILLION 2011$)

Port	Crossing	Port Region	Rest of the U.S.	U.S. Total
Calexico	Calexico/East	-$4.3	-$2.7	-$7.0
	Calexico/West	-3.0	-1.4	-4.4
El Paso	Ysleta	-4.2	-3.1	-7.3
	Paso Del Norte	-4.5	-3.3	-7.8
	Bridge of the Americas	-6.9	-5.1	-12.0
Laredo	Lincoln-Juarez	-4.0	-2.4	-6.5
	Convent St.	-2.6	-1.6	-4.2
Nogales	Mariposa	-2.1	-1.9	-4.0
	Deconcini	-2.1	-1.8	-3.9
San Ysidro	San Ysidro	0.8	3.8	4.6
Buffalo-Niagara Falls	Rainbow Bridge	-1.9	-0.7	-2.6
	Lewiston Bridge	-3.5	-1.2	-4.7
	Peace Bridge	-2.0	-0.7	-2.7
Blaine	Peace Arch	-4.3	3.0	-1.3
	Pacific Highway	-3.7	2.6	-1.1
Detroit	Windsor Tunnel	0.7	1.3	2.0
	Ambassador Bridge	0.7	1.3	1.9
Total		**-$47.1**	**-$13.7**	**-$60.8**

TABLE 6-16. GDP IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT EACH OF 17 U.S. LAND POES (MILLION 2011$)

Port	Crossing	Port Region	Rest of the U.S.	U.S. Total
Calexico	Calexico/East	-$2.2	-$1.4	-$3.6
	Calexico/West	-1.5	-0.7	-2.2
El Paso	Ysleta	-2.3	-1.6	-3.9
	Paso Del Norte	-2.5	-1.7	-4.1
	Bridge of the Americas	-3.8	-2.6	-6.4
Laredo	Lincoln-Juarez	-2.2	-1.2	-3.4
	Convent St.	-1.4	-0.8	-2.2
Nogales	Mariposa	-1.1	-1.0	-2.1
	Deconcini	-1.1	-1.0	-2.1
San Ysidro	San Ysidro	0.5	2.2	2.7
Buffalo-Niagara Falls	Rainbow Bridge	-1.0	-0.3	-1.3
	Lewiston Bridge	-1.9	-0.5	-2.5
	Peace Bridge	-1.1	-0.3	-1.4
Blaine	Peace Arch	-2.2	1.9	-0.4
	Pacific Highway	-1.9	1.6	-0.3
Detroit	Windsor Tunnel	0.4	0.7	1.2
	Ambassador Bridge	0.4	0.7	1.1
Total		**-$24.9**	**-$6.1**	**-$30.9**

TABLE 6-17. EMPLOYMENT IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT EACH OF 17 U.S. LAND POES (JOBS)

Port	Crossing	Port Region	Rest of the U.S.	U.S. Total
Calexico	Calexico/East	-44	-12	-57
	Calexico/West	-31	-5	-36
El Paso	Ysleta	-44	-19	-63
	Paso Del Norte	-47	-20	-67
	Bridge of the Americas	-73	-31	-103
Laredo	Lincoln-Juarez	-47	-13	-60
	Convent St.	-30	-8	-38
Nogales	Mariposa	-25	-11	-36
	Deconcini	-24	-11	-35
San Ysidro	San Ysidro	5	30	36
Buffalo-Niagara Falls	Rainbow Bridge	-16	-3	-19
	Lewiston Bridge	-30	-6	-35
	Peace Bridge	-17	-3	-21
Blaine	Peace Arch	-46	31	-14
	Pacific Highway	-39	27	-12
Detroit	Windsor Tunnel	7	10	17
	Ambassador Bridge	7	10	17
Total		**-495**	**-32**	**-527**

TABLE 6-18. SUMMARY OF ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT EACH OF 17 U.S. PASSENGER LAND POES

Region		Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
All 8 POE Region	Impacts of Reduced Spending by Canadians/Mexicans	-72.7	-39.7	-744
	Impacts of Increased Spending by Americans	25.7	14.9	249
	Net Impacts	**-47.1**	**-24.9**	**-495**
Rest of the U.S.	Impacts of Reduced Spending by Canadians/Mexicans	-68.2	-36.3	-441
	Impacts of Increased Spending by Americans	54.5	30.2	409
	Net Impacts	**-13.7**	**-6.1**	**-32**
U.S. Total	Impacts of Reduced Spending by Canadians/Mexicans	-140.9	-76.0	-1,185
	Impacts of Increased Spending by Americans	80.1	45.1	658
	Net Impacts	**-60.8**	**-30.9**	**-527**

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APPENDIX 6A. ECONOMIC IMPACTS FROM ADDING ONE CBP OFFICER AT PASSENGER LAND POES

TABLE 6A-1. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT CALEXICO/EAST CROSSING OF CALEXICO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Calexico POE Region	Impacts of Increased Spending by Mexicans	10.3	5.4	104
	Impacts of Reduced Spending by Americans	-1.6	-0.9	-15
	Net Impacts	**8.7**	**4.5**	**89**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	13.5	7.4	88
	Impacts of Reduced Spending by Americans	-8.2	-4.7	-64
	Net Impacts	**5.3**	**2.8**	**25**
U.S. Total	Impacts of Increased Spending by Mexicans	23.8	12.8	192
	Impacts of Reduced Spending by Americans	-9.8	-5.5	-79
	Net Impacts	**14.0**	**7.3**	**113**

TABLE 6A-2. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT CALEXICO/WEST CROSSING OF CALEXICO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Calexico POE Region	Impacts of Increased Spending by Mexicans	7.4	3.8	74
	Impacts of Reduced Spending by Americans	-1.4	-0.7	-13
	Net Impacts	**6.0**	**3.1**	**61**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	9.7	5.3	63
	Impacts of Reduced Spending by Americans	-6.9	-3.9	-53
	Net Impacts	**2.8**	**1.4**	**10**
U.S. Total	Impacts of Increased Spending by Mexicans	17.0	9.1	138
	Impacts of Reduced Spending by Americans	-8.3	-4.7	-66
	Net Impacts	**8.8**	**4.5**	**71**

TABLE 6A-3. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT YSLETA CROSSING OF EL PASO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
El Paso POE Region	Impacts of Increased Spending by Mexicans	10.8	6.0	115
	Impacts of Reduced Spending by Americans	-2.4	-1.4	-26
	Net Impacts	**8.4**	**4.6**	**88**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	9.6	5.0	62
	Impacts of Reduced Spending by Americans	-3.5	-1.9	-25
	Net Impacts	**6.1**	**3.2**	**37**
U.S. Total	Impacts of Increased Spending by Mexicans	20.4	11.0	177
	Impacts of Reduced Spending by Americans	-5.9	-3.3	-51
	Net Impacts	**14.5**	**7.7**	**125**

TABLE 6A-4. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT PASO DEL NORTE CROSSING OF EL PASO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
El Paso POE Region	Impacts of Increased Spending by Mexicans	11.6	6.4	123
	Impacts of Reduced Spending by Americans	-2.6	-1.5	-28
	Net Impacts	**9.0**	**4.9**	**95**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	10.3	5.4	66
	Impacts of Reduced Spending by Americans	-3.7	-2.0	-27
	Net Impacts	**6.6**	**3.4**	**40**
U.S. Total	Impacts of Increased Spending by Mexicans	21.8	11.8	189
	Impacts of Reduced Spending by Americans	-6.3	-3.5	-55
	Net Impacts	**15.6**	**8.3**	**134**

TABLE 6A-5. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT BRIDGE OF THE AMERICAS CROSSING OF EL PASO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
El Paso POE Region	Impacts of Increased Spending by Mexicans	17.8	9.8	189
	Impacts of Reduced Spending by Americans	-4.0	-2.3	-43
	Net Impacts	**13.8**	**7.6**	**146**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	15.8	8.3	102
	Impacts of Reduced Spending by Americans	-5.7	-3.1	-41
	Net Impacts	**10.1**	**5.2**	**61**
U.S. Total	Impacts of Increased Spending by Mexicans	33.6	18.1	291
	Impacts of Reduced Spending by Americans	-9.7	-5.4	-84
	Net Impacts	**23.9**	**12.8**	**207**

TABLE 6A-6. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT LINCOLN-JUAREZ CROSSING OF LAREDO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Laredo POE Region	Impacts of Increased Spending by Mexicans	9.1	4.9	106
	Impacts of Reduced Spending by Americans	-1.0	-0.6	-12
	Net Impacts	**8.1**	**4.3**	**95**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	9.1	4.8	57
	Impacts of Reduced Spending by Americans	-4.2	-2.3	-32
	Net Impacts	**4.9**	**2.4**	**25**
U.S. Total	Impacts of Increased Spending by Mexicans	18.1	9.6	164
	Impacts of Reduced Spending by Americans	-5.2	-2.9	-44
	Net Impacts	**13.0**	**6.7**	**120**

TABLE 6A-7. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT CONVENT ST. CROSSING OF LAREDO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Laredo POE Region	Impacts of Increased Spending by Mexicans	5.8	3.1	68
	Impacts of Reduced Spending by Americans	-0.6	-0.4	-8
	Net Impacts	**5.2**	**2.8**	**61**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	5.8	3.1	37
	Impacts of Reduced Spending by Americans	-2.7	-1.5	-21
	Net Impacts	**3.1**	**1.6**	**16**
U.S. Total	Impacts of Increased Spending by Mexicans	11.6	6.2	105
	Impacts of Reduced Spending by Americans	-3.3	-1.9	-28
	Net Impacts	**8.3**	**4.3**	**77**

TABLE 6A-8. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT MARIPOSA CROSSING OF NOGALES POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Nogales POE Region	Impacts of Increased Spending by Mexicans	5.0	2.6	58
	Impacts of Reduced Spending by Americans	-0.7	-0.4	-8
	Net Impacts	**4.3**	**2.3**	**50**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	7.3	3.9	48
	Impacts of Reduced Spending by Americans	-3.5	-2.0	-27
	Net Impacts	**3.8**	**2.0**	**22**
U.S. Total	Impacts of Increased Spending by Mexicans	12.3	6.6	106
	Impacts of Reduced Spending by Americans	-4.2	-2.3	-35
	Net Impacts	**8.1**	**4.3**	**71**

TABLE 6A-9. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT DECONCINI CROSSING OF NOGALES POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Nogales POE Region	Impacts of Increased Spending by Mexicans	4.8	2.6	56
	Impacts of Reduced Spending by Americans	-0.7	-0.4	-8
	Net Impacts	**4.2**	**2.2**	**48**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	7.1	3.8	47
	Impacts of Reduced Spending by Americans	-3.4	-1.9	-26
	Net Impacts	**3.7**	**1.9**	**21**
U.S. Total	Impacts of Increased Spending by Mexicans	11.9	6.4	103
	Impacts of Reduced Spending by Americans	-4.0	-2.3	-34
	Net Impacts	**7.9**	**4.1**	**69**

TABLE 6A-10. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT SAN YSIDRO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
San Ysidro POE Region	Impacts of Increased Spending by Mexicans	8.7	5.1	73
	Impacts of Reduced Spending by Americans	-10.4	-6.2	-84
	Net Impacts	**-1.6**	**-1.1**	**-11**
Rest of the U.S.	Impacts of Increased Spending by Mexicans	5.7	2.9	34
	Impacts of Reduced Spending by Americans	-13.4	-7.2	-95
	Net Impacts	**-7.6**	**-4.3**	**-60**
U.S. Total	Impacts of Increased Spending by Mexicans	14.5	8.1	107
	Impacts of Reduced Spending by Americans	-23.7	-13.5	-179
	Net Impacts	**-9.2**	**-5.4**	**-71**

TABLE 6A-11. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT RAINBOW BRIDGE CROSSING OF BUFFALO-NIAGARA FALLS POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Buffalo-Niagara Falls POE Region	Impacts of Increased Spending by Canadians	6.3	3.5	55
	Impacts of Reduced Spending by Americans	-2.5	-1.4	-22
	Net Impacts	**3.8**	**2.1**	**32**
Rest of the U.S.	Impacts of Increased Spending by Canadians	4.2	2.1	27
	Impacts of Reduced Spending by Americans	-2.9	-1.5	-21
	Net Impacts	**1.3**	**0.6**	**6**
U.S. Total	Impacts of Increased Spending by Canadians	10.4	5.7	81
	Impacts of Reduced Spending by Americans	-5.3	-3.0	-43
	Net Impacts	**5.1**	**2.7**	**38**

TABLE 6A-12. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT LEWISTON BRIDGE CROSSING OF BUFFALO-NIAGARA FALLS POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Buffalo-Niagara Falls POE Region	Impacts of Increased Spending by Canadians	11.5	6.5	100
	Impacts of Reduced Spending by Americans	-4.6	-2.6	-41
	Net Impacts	**7.0**	**3.8**	**59**
Rest of the U.S.	Impacts of Increased Spending by Canadians	7.6	3.9	49
	Impacts of Reduced Spending by Americans	-5.2	-2.8	-38
	Net Impacts	**2.4**	**1.1**	**11**
U.S. Total	Impacts of Increased Spending by Canadians	19.1	10.4	149
	Impacts of Reduced Spending by Americans	-9.8	-5.5	-79
	Net Impacts	**9.4**	**4.9**	**70**

TABLE 6A-13. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT PEACE BRIDGE CROSSING OF BUFFALO-NIAGARA FALLS POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Buffalo-Niagara Falls POE Region	Impacts of Increased Spending by Canadians	6.7	3.8	59
	Impacts of Reduced Spending by Americans	-2.7	-1.5	-24
	Net Impacts	**4.1**	**2.2**	**35**
Rest of the U.S.	Impacts of Increased Spending by Canadians	4.5	2.3	29
	Impacts of Reduced Spending by Americans	-3.1	-1.7	-22
	Net Impacts	**1.4**	**0.6**	**7**
U.S. Total	Impacts of Increased Spending by Canadians	11.2	6.1	87
	Impacts of Reduced Spending by Americans	-5.7	-3.2	-46
	Net Impacts	**5.5**	**2.9**	**41**

TABLE 6A-14. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT PEACE ARCH CROSSING OF BLAINE POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Blaine POE Region	Impacts of Increased Spending by Canadians	13.2	6.9	139
	Impacts of Reduced Spending by Americans	-4.6	-2.5	-47
	Net Impacts	**8.7**	**4.4**	**92**
Rest of the U.S.	Impacts of Increased Spending by Canadians	12.6	6.9	83
	Impacts of Reduced Spending by Americans	-18.7	-10.6	-145
	Net Impacts	**-6.1**	**-3.7**	**-63**
U.S. Total	Impacts of Increased Spending by Canadians	25.8	13.8	222
	Impacts of Reduced Spending by Americans	-23.3	-13.1	-193
	Net Impacts	**2.6**	**0.7**	**29**

TABLE 6A-15. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT PACIFIC HIGHWAY CROSSING OF BLAINE POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Blaine POE Region	Impacts of Increased Spending by Canadians	11.3	5.9	118
	Impacts of Reduced Spending by Americans	-3.9	-2.1	-40
	Net Impacts	**7.4**	**3.8**	**78**
Rest of the U.S.	Impacts of Increased Spending by Canadians	10.7	5.8	70
	Impacts of Reduced Spending by Americans	-15.9	-9.0	-124
	Net Impacts	**-5.2**	**-3.1**	**-53**
U.S. Total	Impacts of Increased Spending by Canadians	22.0	11.7	189
	Impacts of Reduced Spending by Americans	-19.8	-11.1	-164
	Net Impacts	**2.2**	**0.6**	**25**

TABLE 6A-16. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT WINDSOR TUNNEL CROSSING OF DETROIT POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Detroit POE Region	Impacts of Increased Spending by Canadians	2.6	1.5	25
	Impacts of Reduced Spending by Americans	-4.0	-2.4	-39
	Net Impacts	**-1.4**	**-0.9**	**-14**
Rest of the U.S.	Impacts of Increased Spending by Canadians	1.5	0.7	9
	Impacts of Reduced Spending by Americans	-4.1	-2.2	-29
	Net Impacts	**-2.6**	**-1.5**	**-20**
U.S. Total	Impacts of Increased Spending by Canadians	4.1	2.3	34
	Impacts of Reduced Spending by Americans	-8.1	-4.6	-68
	Net Impacts	**-4.0**	**-2.3**	**-34**

TABLE 6A-17. ECONOMIC IMPACTS RESULTING FROM ADDING ONE CBP OFFICER AT AMBASSADOR BRIDGE CROSSING OF DETROIT POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Detroit POE Region	Impacts of Increased Spending by Canadians	2.6	1.5	25
	Impacts of Reduced Spending by Americans	-3.9	-2.4	-38
	Net Impacts	**-1.3**	**-0.8**	**-14**
Rest of the U.S.	Impacts of Increased Spending by Canadians	1.5	0.7	9
	Impacts of Reduced Spending by Americans	-4.0	-2.2	-29
	Net Impacts	**-2.6**	**-1.4**	**-20**
U.S. Total	Impacts of Increased Spending by Canadians	4.0	2.2	34
	Impacts of Reduced Spending by Americans	-7.9	-4.5	-67
	Net Impacts	**-3.9**	**-2.3**	**-34**

APPENDIX 6B. ECONOMIC IMPACTS FROM REDUCING ONE CBP OFFICER AT PASSENGER LAND POES

TABLE 6B-1. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT CALEXICO/EAST CROSSING OF CALEXICO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Calexico POE Region	Impacts of Reduced Spending by Mexicans	-5.1	-2.7	-52
	Impacts of Increased Spending by Americans	0.8	0.4	8
	Net Impacts	**-4.3**	**-2.2**	**-44**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-6.8	-3.7	-44
	Impacts of Increased Spending by Americans	4.1	2.3	32
	Net Impacts	**-2.7**	**-1.4**	**-12**
U.S. Total	Impacts of Reduced Spending by Mexicans	-11.9	-6.4	-96
	Impacts of Increased Spending by Americans	4.9	2.8	40
	Net Impacts	**-7.0**	**-3.6**	**-57**

TABLE 6B-2. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT CALEXICO/WEST CROSSING OF CALEXICO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Calexico POE Region	Impacts of Reduced Spending by Mexicans	-3.7	-1.9	-37
	Impacts of Increased Spending by Americans	0.7	0.4	6
	Net Impacts	**-3.0**	**-1.5**	**-31**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-4.8	-2.7	-32
	Impacts of Increased Spending by Americans	3.5	2.0	27
	Net Impacts	**-1.4**	**-0.7**	**-5**
U.S. Total	Impacts of Reduced Spending by Mexicans	-8.5	-4.6	-69
	Impacts of Increased Spending by Americans	4.1	2.3	33
	Net Impacts	**-4.4**	**-2.2**	**-36**

TABLE 6B-3. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT YSLETA CROSSING OF EL PASO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
El Paso POE Region	Impacts of Reduced Spending by Mexicans	-5.4	-3.0	-57
	Impacts of Increased Spending by Americans	1.2	0.7	13
	Net Impacts	**-4.2**	**-2.3**	**-44**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-4.8	-2.5	-31
	Impacts of Increased Spending by Americans	1.7	0.9	12
	Net Impacts	**-3.1**	**-1.6**	**-19**
U.S. Total	Impacts of Reduced Spending by Mexicans	-10.2	-5.5	-88
	Impacts of Increased Spending by Americans	2.9	1.6	26
	Net Impacts	**-7.3**	**-3.9**	**-63**

TABLE 6B-4. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT PASO DEL NORTE CROSSING OF EL PASO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
El Paso POE Region	Impacts of Reduced Spending by Mexicans	-5.8	-3.2	-61
	Impacts of Increased Spending by Americans	1.3	0.7	14
	Net Impacts	**-4.5**	**-2.5**	**-47**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-5.1	-2.7	-33
	Impacts of Increased Spending by Americans	1.9	1.0	13
	Net Impacts	**-3.3**	**-1.7**	**-20**
U.S. Total	Impacts of Reduced Spending by Mexicans	-10.9	-5.9	-95
	Impacts of Increased Spending by Americans	3.1	1.8	27
	Net Impacts	**-7.8**	**-4.1**	**-67**

TABLE 6B-5. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT BRIDGE OF THE AMERICAS CROSSING OF EL PASO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
El Paso POE Region	Impacts of Reduced Spending by Mexicans	-8.9	-4.9	-95
	Impacts of Increased Spending by Americans	2.0	1.1	22
	Net Impacts	**-6.9**	**-3.8**	**-73**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-7.9	-4.2	-51
	Impacts of Increased Spending by Americans	2.8	1.6	20
	Net Impacts	**-5.1**	**-2.6**	**-31**
U.S. Total	Impacts of Reduced Spending by Mexicans	-16.8	-9.1	-146
	Impacts of Increased Spending by Americans	4.8	2.7	42
	Net Impacts	**-12.0**	**-6.4**	**-103**

TABLE 6B-6. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT LINCOLN-JUAREZ CROSSING OF LAREDO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Laredo POE Region	Impacts of Reduced Spending by Mexicans	-4.5	-2.4	-53
	Impacts of Increased Spending by Americans	0.5	0.3	6
	Net Impacts	**-4.0**	**-2.2**	**-47**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-4.5	-2.4	-29
	Impacts of Increased Spending by Americans	2.1	1.2	16
	Net Impacts	**-2.4**	**-1.2**	**-13**
U.S. Total	Impacts of Reduced Spending by Mexicans	-9.1	-4.8	-82
	Impacts of Increased Spending by Americans	2.6	1.5	22
	Net Impacts	**-6.5**	**-3.4**	**-60**

TABLE 6B-7. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT CONVENT ST. CROSSING OF LAREDO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Laredo POE Region	Impacts of Reduced Spending by Mexicans	-2.9	-1.6	-34
	Impacts of Increased Spending by Americans	0.3	0.2	4
	Net Impacts	**-2.6**	**-1.4**	**-30**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-2.9	-1.5	-18
	Impacts of Increased Spending by Americans	1.3	0.8	10
	Net Impacts	**-1.6**	**-0.8**	**-8**
U.S. Total	Impacts of Reduced Spending by Mexicans	-5.8	-3.1	-53
	Impacts of Increased Spending by Americans	1.7	0.9	14
	Net Impacts	**-4.2**	**-2.2**	**-38**

TABLE 6B-8. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT MARIPOSA CROSSING OF NOGALES POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Nogales POE Region	Impacts of Reduced Spending by Mexicans	-2.5	-1.3	-29
	Impacts of Increased Spending by Americans	0.3	0.2	4
	Net Impacts	**-2.1**	**-1.1**	**-25**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-3.6	-2.0	-24
	Impacts of Increased Spending by Americans	1.7	1.0	13
	Net Impacts	**-1.9**	**-1.0**	**-11**
U.S. Total	Impacts of Reduced Spending by Mexicans	-6.1	-3.3	-53
	Impacts of Increased Spending by Americans	2.1	1.2	17
	Net Impacts	**-4.0**	**-2.1**	**-36**

TABLE 6B-9. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT DECONCINI CROSSING OF NOGALES POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Nogales POE Region	Impacts of Reduced Spending by Mexicans	-2.4	-1.3	-28
	Impacts of Increased Spending by Americans	0.3	0.2	4
	Net Impacts	**-2.1**	**-1.1**	**-24**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-3.5	-1.9	-24
	Impacts of Increased Spending by Americans	1.7	0.9	13
	Net Impacts	**-1.8**	**-1.0**	**-11**
U.S. Total	Impacts of Reduced Spending by Mexicans	-5.9	-3.2	-52
	Impacts of Increased Spending by Americans	2.0	1.1	17
	Net Impacts	**-3.9**	**-2.1**	**-35**

TABLE 6B-10. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT SAN YSIDRO POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
San Ysidro POE Region	Impacts of Reduced Spending by Mexicans	-4.4	-2.6	-37
	Impacts of Increased Spending by Americans	5.2	3.1	42
	Net Impacts	**0.8**	**0.5**	**5**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-2.9	-1.5	-17
	Impacts of Increased Spending by Americans	6.7	3.6	47
	Net Impacts	**3.8**	**2.2**	**30**
U.S. Total	Impacts of Reduced Spending by Mexicans	-7.2	-4.0	-54
	Impacts of Increased Spending by Americans	11.9	6.7	89
	Net Impacts	**4.6**	**2.7**	**36**

TABLE 6B-11. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT RAINBOW BRIDGE CROSSING OF BUFFALO-NIAGARA FALLS POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Buffalo-Niagara Falls POE Region	Impacts of Reduced Spending by Mexicans	-3.1	-1.8	-27
	Impacts of Increased Spending by Americans	1.2	0.7	11
	Net Impacts	**-1.9**	**-1.0**	**-16**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-2.1	-1.1	-13
	Impacts of Increased Spending by Americans	1.4	0.8	10
	Net Impacts	**-0.7**	**-0.3**	**-3**
U.S. Total	Impacts of Reduced Spending by Mexicans	-5.2	-2.8	-41
	Impacts of Increased Spending by Americans	2.7	1.5	22
	Net Impacts	**-2.6**	**-1.3**	**-19**

TABLE 6B-12. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT LEWISTON BRIDGE CROSSING OF BUFFALO-NIAGARA FALLS POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Buffalo-Niagara Falls POE Region	Impacts of Reduced Spending by Mexicans	-5.8	-3.2	-50
	Impacts of Increased Spending by Americans	2.3	1.3	21
	Net Impacts	**-3.5**	**-1.9**	**-30**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-3.8	-2.0	-24
	Impacts of Increased Spending by Americans	2.6	1.4	19
	Net Impacts	**-1.2**	**-0.5**	**-6**
U.S. Total	Impacts of Reduced Spending by Mexicans	-9.6	-5.2	-75
	Impacts of Increased Spending by Americans	4.9	2.7	40
	Net Impacts	**-4.7**	**-2.5**	**-35**

TABLE 6B-13. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT PEACE BRIDGE CROSSING OF BUFFALO-NIAGARA FALLS POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Buffalo-Niagara Falls POE Region	Impacts of Reduced Spending by Mexicans	-3.4	-1.9	-29
	Impacts of Increased Spending by Americans	1.3	0.8	12
	Net Impacts	**-2.0**	**-1.1**	**-17**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-2.2	-1.2	-14
	Impacts of Increased Spending by Americans	1.5	0.8	11
	Net Impacts	**-0.7**	**-0.3**	**-3**
U.S. Total	Impacts of Reduced Spending by Mexicans	-5.6	-3.0	-44
	Impacts of Increased Spending by Americans	2.9	1.6	23
	Net Impacts	**-2.7**	**-1.4**	**-21**

TABLE 6B-14. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT PEACE ARCH CROSSING OF BLAINE POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Blaine POE Region	Impacts of Reduced Spending by Mexicans	-6.6	-3.5	-70
	Impacts of Increased Spending by Americans	2.3	1.3	24
	Net Impacts	**-4.3**	**-2.2**	**-46**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-6.3	-3.4	-41
	Impacts of Increased Spending by Americans	9.4	5.3	73
	Net Impacts	**3.0**	**1.9**	**31**
U.S. Total	Impacts of Reduced Spending by Mexicans	-12.9	-6.9	-111
	Impacts of Increased Spending by Americans	11.6	6.5	96
	Net Impacts	**-1.3**	**-0.4**	**-14**

TABLE 6B-15. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT PACIFIC HIGHWAY CROSSING OF BLAINE POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Blaine POE Region	Impacts of Reduced Spending by Mexicans	-5.6	-2.9	-59
	Impacts of Increased Spending by Americans	1.9	1.1	20
	Net Impacts	**-3.7**	**-1.9**	**-39**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-5.4	-2.9	-35
	Impacts of Increased Spending by Americans	8.0	4.5	62
	Net Impacts	**2.6**	**1.6**	**27**
U.S. Total	Impacts of Reduced Spending by Mexicans	-11.0	-5.9	-94
	Impacts of Increased Spending by Americans	9.9	5.6	82
	Net Impacts	**-1.1**	**-0.3**	**-12**

TABLE 6B-16. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT WINDSOR TUNNEL CROSSING OF DETROIT POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Detroit POE Region	Impacts of Reduced Spending by Mexicans	-1.3	-0.8	-13
	Impacts of Increased Spending by Americans	2.0	1.2	20
	Net Impacts	**0.7**	**0.4**	**7**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-0.7	-0.4	-5
	Impacts of Increased Spending by Americans	2.0	1.1	15
	Net Impacts	**1.3**	**0.7**	**10**
U.S. Total	Impacts of Reduced Spending by Mexicans	-2.0	-1.1	-17
	Impacts of Increased Spending by Americans	4.0	2.3	34
	Net Impacts	**2.0**	**1.2**	**17**

TABLE 6B-17. ECONOMIC IMPACTS RESULTING FROM REDUCING ONE CBP OFFICER AT AMBASSADOR BRIDGE CROSSING OF DETROIT POE

Region		Gross Output Impacts (M $)	GDP Impacts (M $)	Employment Impacts (jobs)
Detroit POE Region	Impacts of Reduced Spending by Mexicans	-1.3	-0.8	-12
	Impacts of Increased Spending by Americans	2.0	1.2	19
	Net Impacts	**0.7**	**0.4**	**7**
Rest of the U.S.	Impacts of Reduced Spending by Mexicans	-0.7	-0.4	-5
	Impacts of Increased Spending by Americans	2.0	1.1	14
	Net Impacts	**1.3**	**0.7**	**10**
U.S. Total	Impacts of Reduced Spending by Mexicans	-2.0	-1.1	-17
	Impacts of Increased Spending by Americans	4.0	2.3	34
	Net Impacts	**1.9**	**1.1**	**17**

CHAPTER 7. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

by

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I. INTRODUCTION

USC/CREATE estimated the economic impacts of changes in Customs and Border Protection (CBP) staffing for border security at major U.S. Ports of Entry (POEs). The impacts were traced through an analysis of how a change in staffing affects wait times and hence freight transportation costs and travel demand of both businesses and travelers. On the freight side, the analysis begins with consideration of changes in transportation costs and how this affects international trade competitiveness and the macroeconomy of the U.S. economy in terms of output and jobs. On the passenger side, the analysis begins with changes in the number of tourism and business travels into the U.S. and how this affects the associated travel spending and the macroeconomy of the port region and U.S. economies. The value of wait time itself for individual travelers and truck drivers does not show up in the formal national income accounts, but was inferred by estimating the opportunity cost of their time.

Most of the data on which the analysis is based was in the form of publicly available data proved by CBP. This was supplemented by a synthesis of the existing peer-reviewed literature on the topic. Macroeconomic data were contained in two sets of well-established models.

Operations research and economic analysis methods were used to translate changes in security expenditures into changes in wait times and then to business transportation costs and to the value of an individual's time. We utilized a computable general equilibrium (CGE) model to analyze competiveness and macroeconomic impacts for the U.S. CGE is considered the state-of-the-art approach to analyzing such issues as international trade policy and macroeconomic impact analysis. We used an input-output (I-O) analysis approach to estimate the impacts of changes in passenger vehicle travel demand on the port region economies and the economy of the U.S. as a whole. I-O is a less sophisticated approach than CGE but is adequate to the task at hand because of the absence of price changes and competitiveness effects associated with changes in passenger travel expenditures.

II. RESULTS

Simulations were run for both an increase and decrease in CBP staffing at key border sites. The basic units of analysis are: +1 and -1 CBP staff, each working eight hours per day and 153 days of the year. The results of the analysis are presented in the tables below in the following categories:

1. Ground passenger travel
    a. Value of time for U.S. residents
    b. Value of time for Canadian and Mexican residents
    c. Net impact on port region and U.S. GDP and employment

2. Air passenger travel

   a. Value of time for U.S. residents
   b. Value of time for foreign travelers

3. Truck Freight Transportation
   a. Value of time for U.S. truckers
   b. Value of time for Canadian and Mexican truckers
   c. Net impact on U.S. GDP and employment
   d. Net impacts on the Canadian and Mexican economies.

Note that the results are presented separately for each of the components because they involve different estimating methods, data, assumptions, and stakeholder groups. This enables us to sum the appropriate results for the impacts on the U.S. economy and its residents separately from the impacts on other countries.

The impacts on the U.S. economy as a whole for the +1 staffing case are:

GAINS:

- $65.8 million in GDP
- 1,094 annual jobs
- $21.2 million in value of time gained

The impacts on the U.S. economy for the -1 staffing case are:

LOSSES:

- \- $32.9 million in GDP
- \- 547 annual jobs
- \- $10.6 million in value of time lost

Some major conclusions are, first, that the value of time gained in the +1 staffing case are approximately $640,000 per staff member on average for the land ports and the airports as a whole evaluated in this study. Second, given that each of the two tables represents the addition of 33 staff members (one at each of 17 land passenger ports, 12 land freight ports, and 4 passenger airports), each new staff member on average generates 33 additional jobs throughout the U.S. economy.

Most of the economic gains and losses from CBP staffing changes will accrue to the regions surrounding the POEs. For example, adding one CBP officer at each of the 17 passenger land crossings is projected to lead to an increase in GDP of $61.8 million and employment gains of 1,053 jobs in the U.S. as a whole. However 80% of the GDP gains and 94% of employment gains are captured by the POE regions alone.

III. RECOMMENDATIONS FOR FOLLOW-ON EFFORTS

Notwithstanding the rigor of the current effort, additional activities could be undertaken to better the range of applicability of the results and increase the robustness of the models. These include

(a) Develop the analytical model used to derive wait time-officer elasticities more fully to address the linearity of the extrapolation of the results

(b) Based on results of (a), select a few border crossings and develop a complete relationship between number of officers and wait time levels. This will give really good insight into how results can best be extrapolated to +N/-N scenarios.
(c) Expanding the air component to factor in deterrence of long wait time, for example, developing better wait time-officer elasticity estimates by fully developing the analytical model that they are based on, specifically by using all data related to clustered flights, analyzing the value of additional/increased flights at off-hours, and developing the deterrence model
(d) Examining the observed risk/security vs. wait time results and analysis to account for CBP's established wait-time-based procedures, such as suspending certain operations and exercising certain steps subject to the discretion of the POE's operating procedures, and associated risk analysis studies related to the effect of lower wait times on security
(e) Further improving the freight impact estimates

Additional efforts beyond the current study could include

- Economic impact analysis of changes in border infrastructure in terms of rate of return on investment for introducing new technologies
- Risk analysis studies related to the effect of lower wait times on security
- Quantification of the marginal benefits and costs of adding or subtracting more than one primary inspection officer at a crossing, with an emphasis on testing for non-linearities. Optimization analysis of staff deployment at each crossing by hour and day.
- Optimization analysis of staff deployment across crossings.
- Evaluation of staffing requirements to achieve a standard of wait time never to exceed 30 minutes at any crossing
- Controlled experiments at border crossings to provide more extensive results on wait time-booth and trip demand elasticities
- More formal analysis of the July 2012 experiment at San Ysidro
- Completion of the methodology for analyzing processing of air travelers in terms of all flights in a cluster, intermingling of passengers from different flights in a queue, etc.
- Study of the relationship between congestion, staffing, and enforcement outcomes
- Development of a simulation model that CBP can use to analyze scenarios involving changes in staffing levels, traffic levels, etc.

APPENDIX A. DATA MANAGEMENT AND REFINEMENT

by

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CBP provided publicly available primary data collected on land and air ports of entry. Land port data were summarized to hourly observations of traffic volume, average wait times, and processing booths available. The airport dataset is summarized by flight observations. The table below describes how the datasets were refined for this study and how they are used to estimate changes in wait time.

Dataset	Data Refinements	Use of Data in the Project	Notes
Passenger Vehicles	Data was exported from the Access database to Excel worksheets, by lane type and result from inspection for all border crossings. Missing hour observations were added to each port's set of observations so that all ports contained the same number of observations.	Data provided baseline numbers from which changes in passenger vehicle traffic and wait time were calculated, based on an additional processing booth being added to the eight most congested hours in a day throughout fiscal year 2012.	Focused on regular lanes as wait times for other lanes are at or near zero for many hourly observations.
COV Wait Time and Booths	Matched by hourly observations with COV Trips and Processing Time dataset for border crossings to be analyzed. Missing hour observations were added to each port's set of observations so that all ports contained the same number of observations.	Data provided baseline numbers from which changes in commercial vehicle traffic and wait time were calculated, based on an additional processing booth being added to the eight most congested hours in a day throughout fiscal year 2012.	Focused on wait times for regular lanes, using total trips and total lanes as proxies for regular lanes trips and number of open regular lanes.
COV Trips and Processing Times	Trip and processing time observations are provided by daily row observations and hourly column observations.	*Same as above.	*Same as above.
International Airport Passengers	A clustering rule was developed for flights in which arrival and processing intersect. We focused analysis on three kinds of flights: 1) flights in which processing queues do not cluster with other flights; 2) the first flight in a processing cluster; 3) and flights arriving closely together which are treated as one grouped flight for processing purposes.	Data provided baseline numbers from which changes in and airline passenger wait time were calculated, based on an additional processing booth being added to the eight most congested hours in a day throughout fiscal year 2012.	Flights other than the three kinds we analyzed are not excluded from our dataset because we do not know the size of the queue as new flights arrive and add to the existing queue.