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Analysis of Primary Inspection Wait Time at U.S. Ports of Entry

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by

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Report to U.S. Customs and Border Protection

Final Report

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ABOUT CREATE

Now in its tenth year of operation, the National Center for Risk and Economic Analysis of Terrorism Events (CREATE) was the first university-based Center of Excellence (COE) funded by University Programs of the Science and Technology (S&T) Directorate of the Department of Homeland Security (DHS). CREATE started operations in March of 2004 and has since been joined by additional DHS centers. Like other COEs, CREATE contributes university-based research to make the Nation safer by taking a longer-term view of scientific innovations and breakthroughs and by developing the future intellectual leaders in homeland security.

CREATE's mission is to improve our Nation's security through research and development of advanced models and tools to evaluate risks, costs and consequences of terrorism and natural and man-made hazards and to guide economically viable investments in homeland security. We are accomplishing our mission through an integrated program of research, education and outreach that is designed to inform and support decisions faced by elected officials and governmental employees at the national, state, and local levels. We are also working with private industry, both to leverage the investments being made by the Department of Homeland Security in these organizations, and to facilitate the transition of research toward meeting the security needs of our nation.

CREATE employs an interdisciplinary approach merging engineers, economists, decision scientists, and system modelers in a program that integrates research, education and outreach. This approach encourages creative discovery by employing the intellectual power of the American university system to solve some of the country’s most pressing problems. The Center is the lead institution where researchers from around the country come to assist in the national effort to improve homeland security through analysis and modeling of threats. The Center treats the subject of homeland security with the urgency that it deserves, with one of its key goals being producing rapid results, leveraging existing resources so that benefits accrue to our nation as quickly as possible.

By the nature of the research in risk, economics, risk management and operations research, CREATE serves the need of many agencies at the DHS, including the Transportation Security Administration, U.S. Customs and Border Protection (CBP), Immigration and Customs Enforcement, FEMA and the US Coast Guard.. In addition, CREATE has developed relationships with clients in the Offices of National Protection and Programs, Intelligence and Analysis, the Domestic Nuclear Detection Office and many State and Local government agencies. CREATE faculty and students take both the long-term view of how to reduce terrorism risk through fundamental research, and the near-term view of improving the cost-effectiveness of counter-terrorism policies and investments through applied research.

ABOUT ECONOMETRICA

Econometrica is a private research and management organization that has extensive capabilities and experience in evaluation and technical assistance activities. Our work has been conducted on behalf of a diverse range of U.S. Government agencies, including several component agencies of the Department of Homeland Security (the U.S. Coast Guard, Immigration and Customs Enforcement, and the Private Sector Office.) Econometrica’s primary services include program evaluation, economic analysis, statistical analysis, risk analysis, cost-benefit analysis, policy analysis, simulation modeling, survey research, operations research, training, data graphics design and production, and technical writing and editing. Econometrica’s work for U.S. Government agencies encompasses short- and mid-term projects, as well as long-term, ongoing, and quick-turnaround efforts.

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Executive Summary

This study extends the research of "The Impact on the U.S. Economy of Changes in Wait Times At Ports of Entry" completed on March 31, 2013 by a CREATE research team on the economic impacts of wait times at U.S. ports of entry (see Roberts et al. 2013). That study quantified how wait time changes with the addition of one CBP-Office of Field Operations (OFO) primary inspection officer at land passenger and commercial vehicle crossings and international airports. It then estimated the value of saved wait time for existing traffic flows, how the number of cross-border passenger vehicle trips and transport cost for the trucking industry changes with lower wait time, and the impact on U.S. income (GDP) and employment that these changes induce. This study extends the earlier project in several ways. Volume I of this report evaluates how change in passport inspection wait time at U.S. international airports impacts the number of passengers traveling by air to and from the U.S. It also evaluates trends in the volume of international air travelers arriving at U.S. airports and implications for CBP-OFO resources, the impact of passport inspection wait time on missed flight connections at international airports, and CBP-OFO management of existing passport inspection resources. Volume II returns to the first study to significantly improve the analytical methodology for quantifying the relationship between the number of primary inspection officers and wait time at land border crossings. It also reviews available projections of cross-border passenger and vehicle flows and recommends a methodology to project vehicle flows at the port level on the northern and southern borders.

Table ES-1 summarizes the key results of the two studies with respect to the economic impacts of adding one additional CBP-OFO primary inspection officer at 17 land passenger vehicle crossings, 12 land commercial vehicle crossings, and 14 inspection sites at 4 U.S. international airports. Results include the value of wait time saved for existing passenger flows, and income (GDP) and employment impacts related to new passengers traveling to the U.S. as a result of lower wait times. It is very important to note two points about these updated estimates. First, the impact estimates for ground passenger transportation and truck freight transportation significantly underestimate the actual impacts resulting from adding an extra officer, because they are based on the analytical methodology of Roberts et al. (2013). The new methodology developed in Volume II of this study suggests that impacts are significantly greater than these estimates, by a factor of three or more. Second, impact estimates for air passenger travel have upper- and lower-bound values. Upper-bound results treat all wait time as counting towards passenger delay in clearing entry into a U.S. airport, and lower-bound results treat only wait time greater than 30 minutes as counting towards this delay.

Key findings of Volumes I and II beyond these economic impact results are reviewed after table ES-1.

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, 43 CBP Officers total)[A]

			Value of time saved (mil. $)	GDP (mil. $)	Employment (jobs)
Ground Passenger Travel	Value of lowered wait time for U.S. residents[C]		$17.0	n.a.	n.a.
	Net impact on port region and U.S. GDP and employment[B,C]		n.a.	$61.8	1,053
Air Passenger Travel	Value of lowered wait time for U.S. residents	Lower bound	$2.5	n.a.	n.a.
		Upper bound	$9.0		
	Net impact on U.S. GDP and employment[B]	Lower bound	n.a.	$4.2	37
		Upper bound		$11.8	81
Truck Freight Transportation	Net impact on U.S. GDP and employment[B,C,D]		n.a.	$3.0	31
TOTAL U.S. ECONOMY NET IMPACT[B,C]		Lower bound	$19.5	$70.0	1,131
		Upper bound	$26.0	$77.6	1,176
AVERAGE NET IMPACT PER OFFICER[B,C]		Lower bound	$0.5	$1.6	26
		Upper bound	$0.6	$1.8	27

n.a. – not applicable

A: Results are for adding one officer to primary inspection at 17 land passenger vehicle crossings, 12 land truck crossings, and 14 terminal inspection sites in 4 airports.

B: Income and employment impacts reflect the net impact of more foreign-resident passengers traveling to the U.S. and more U.S. residents traveling abroad.

C: These impact estimates significantly underestimate the actual impacts of adding an extra officer to land border crossings, because they are based on the analytical methodology of Roberts et al. (2013). The new methodology developed in Volume II of this study suggests that actual impacts are significantly greater than these estimates.

D: The estimates for truck freight transportation presented in Roberts et al. (2013) have been revised subsequent to the public release of that study.

Passport Inspection Wait Time at U.S. International Airports and Its Economic Impacts: Key Findings

The welfare of international air passengers and resulting impacts on the U.S. economy associated with international travel to the U.S. depend on the ability of U.S. international airports to efficiently serve and process growing travel volumes. One part of the process that an international traveler experiences, passport and customs inspection, has attracted considerable attention in recent years. Passport inspection waits have in particular drawn criticism for being excessively long, particularly for foreign residents, and contributing significantly to missed flight connections. This study analyzes the following topics and makes the following key findings:

- **Trends in outcomes and resources related to passport inspection.** Average passport inspection wait time at 24 U.S. airports rose by 25% during 2010-2013. The number of foreign international air travelers arriving in the U.S. is projected to rise from 40 million in 2012 to 53 million in 2018, and direct spending by these visitors will rise by perhaps $40 billion from 2012 to 2018. Given this increase, and assuming no improvements in technology and process management that would reduce wait time, CBP-OFO inspection resources are estimated to need to rise by 4% per year in order to merely stabilize wait times at 2013 levels.
- **Impact of passport inspection wait times on demand for international travel to and from the U.S.**: We evaluate how passport inspection wait time impacts demand for international travel to and from the U.S. using several sets of data and find that wait time has a very small impact on demand. We quantify how change in passport inspection wait time impacts the number of U.S.-resident and non-U.S.-resident passengers at 4 U.S. international airports (Chicago O'Hare, JFK, LAX, and Miami) if an additional CBP-OFO inspection officer is added at these airports, and if wait time falls by 50% and 100%. Our results suggest that very small increases in international air arrivals result from adding one inspection officer, and larger increases for falls of 50% and 100%. Our results are sensitive to an assumption related to baggage delivery time.
- **Macroeconomic impacts associated with deterred travel at four U.S. airports.** We then quantify the income and GDP impacts of increased international air arrivals at these four airports. We find that for the +1 CBP officer scenario, adding 11 officers to the inspection sites at the four airports results in an upper-bound case of an $11.8 million increase in GDP and 81 additional jobs. A 50% reduction in wait time results in an upper-bound case of a $95.4 million increase in GDP and 539 additional jobs.
- **CBP-OFO management of available inspection resources**: Evaluation of wait time outcomes at several airports suggests that CBP efficiently manages available inspection resources, and the more important issue is the level of resource availability. Although international flight arrivals at many U.S. airports are characterized by large peaks during a few hours of the day, CBP responds by opening booths to meet these peaks, successfully smoothing out variations in average and maximum wait time outcomes to a significant extent. There is also evidence that arrivals can become so large that CBP

hits its upper bound on processing capacity, and, in this situation, wait time outcomes rise. Overall resource availability seems to be a more important issue for CBP-OFO rather than inefficient management of available resources.

- **Contribution of passport inspection wait time to missed flight connections:** Evaluation of missed flight connections at the JFK airport in 2012 suggests that late flight arrivals play a larger part in explaining the risk of a missed connection, and that passport inspection waits also play a role for a minority of passengers. The overwhelming majority (87 percent) of passengers with excess entry delays that elevated the risk of a missed connection were on flights arriving late, and in the majority of these cases (46 percent of all delayed passengers), the passport inspection process did not add any extra time to this delay. In 41 percent of the excess delay cases, passengers also experienced extended passport inspection waits after deplaning from late arriving flights. Extended passport inspection waits were the sole source of missed connection risk for the other 13 percent of passengers who experienced extended delays.

Modeling Flows and Wait Time of Traffic at U.S. Border Crossings: Key Findings

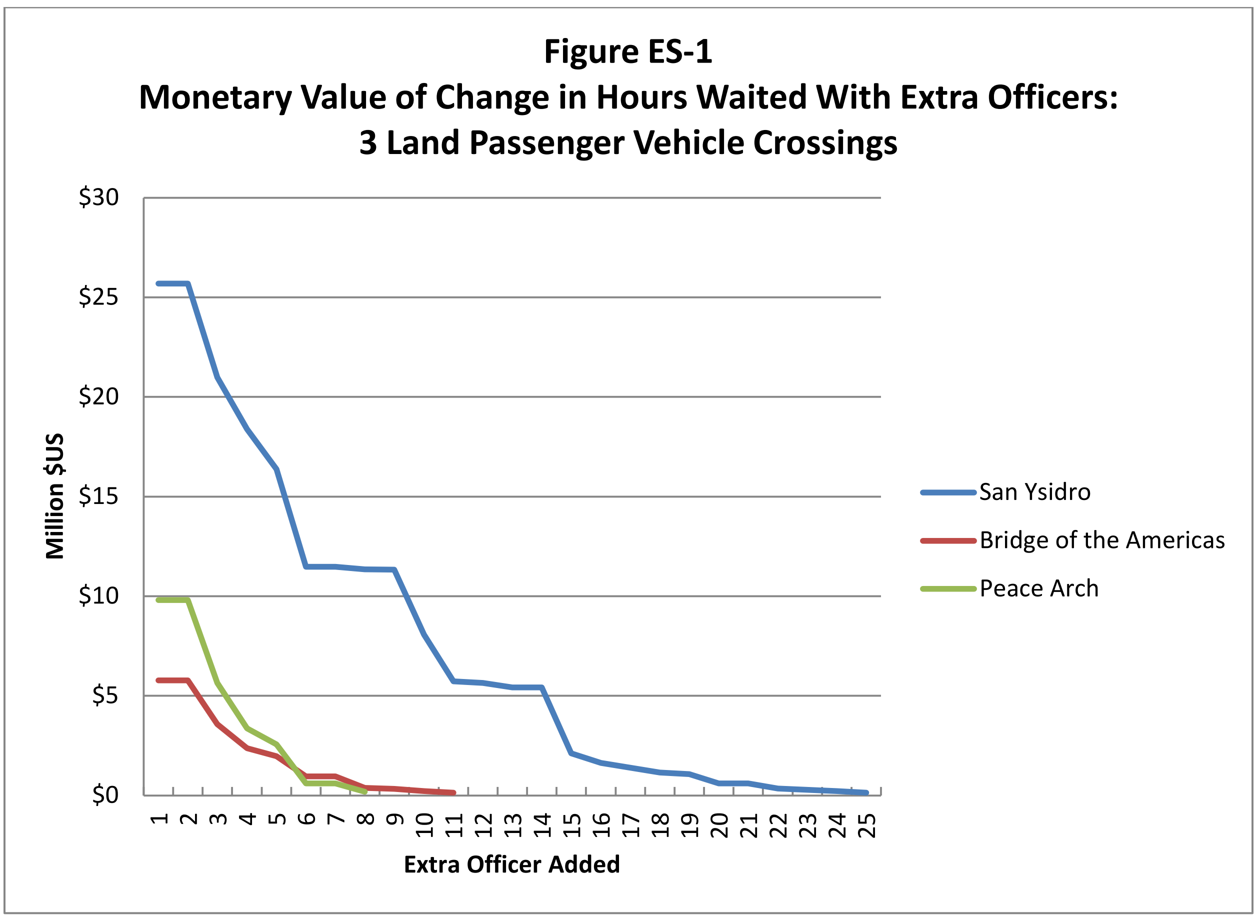
We have significantly developed the methodology used to quantify the impacts of extra primary inspection processing booths on wait time outcomes at land border crossings. As opposed to the methodology used in our earlier study, which was an approximation to the true relationship, the methodology presented here is an exact analysis. We apply the methodology to three land passenger vehicle border crossings (San Ysidro, Bridge of the Americas-El Paso POE, and Peace Arch-Blaine POE) and determine the quantity and value of wait time saved for FY 2013 vehicle traffic if additional officers had been deployed at each crossing. Results show that the reductions in wait time resulting from one extra officer are much greater under the new methodology than in our earlier study:

- The total value of time saved (for both U.S. and non-U.S. residents) from one extra officer at San Ysidro rises from $2.5 million under the old methodology to $25.0 million under the exact methodology, or by a factor of 10;
- The total value of time saved from one extra officer at the Bridge of the Americas crossing rises from $1.8 million to $5.8 million, or by a factor of roughly 3;
- The total value of time saved from one extra officer at the Peace Arch crossing rises from $3.7 million to $9.8 million, or by a factor of roughly 3.

Although we do not calculate here the change in cross-border trips resulting from the new wait time after the addition of the officer and resulting impacts on U.S. GDP and employment, new estimates would also be substantially larger than those presented in Roberts et al. (2013) and table ES-1 above.

Under the new methodology, we are also able to quantify how wait time changes from a second extra officer, third extra officer, etc. Figure ES-1 shows the monetary value of time saved from adding each extra officer at three land passenger vehicle crossings (San Ysidro and Bridge of the Americas on the southern border, and Peace Arch on the northern border.) Results show that the size of these reductions falls as more and more officers are added to a crossing. The results also suggest (unsurprisingly) that San Ysidro highly dominates the other crossings in terms of saved wait time return.

It should now be possible to develop analysis of a particular border crossing based on this methodology that also takes into account factors such as infrastructure constraints, productivity of unstacked versus stacked booths, technologies that affect the traffic processing rate, and other important factors influencing processing outcomes at border crossings. Results from such analysis could be used as an input to estimation of optimal processing capacities at particular crossings.



Volume I:

Passport Inspection Wait Time at U.S. International Airports and Its Economic Impacts

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Chapter 1: Overview

CREATE and Econometrica Research Team

The welfare of international air passengers and impacts on the U.S. economy associated with international travel to the U.S. depend on the ability of U.S. international airports to efficiently serve and process growing travel volumes. One part of the process that an international traveler experiences, passport inspection, has attracted considerable attention in recent years. Passport inspection waits have in particular drawn criticism for being excessively long, particularly for foreign residents, and contributing significantly to missed flight connections. This study develops a range of analysis on the economic impacts of passport inspection wait times and its potential contribution to missed flight connections. We review here our key findings on these issues.

1.1. Trends in Passport Inspection Wait Time and International Air Traveler Satisfaction

We evaluate trends in travel volumes, wait time in passport inspection queues, CBP-OFO inspection resources, and reported satisfaction of passengers going through passport and customs inspection. Our key findings are:

- The volume of international air passengers that CBP-OFO must process has been rising significantly over the past decade and is projected to continue to experience significant growth. The number of foreign international air travelers arriving in the U.S. is projected to rise from 40 million in 2012 to 53 million in 2018. Direct spending by these visitors could rise by roughly $40 billion from 2012 to 2018;[1]
- During 2010-2013, CBP-OFO processing resources, as measured by the number of passport inspection booths open on an average day, has been falling;
- As a result of rising passenger volume and falling processing resources, average passport inspection wait time has risen by roughly 25%, and the total amount of time spent in passport inspection queues has risen by 33% for U.S. resident passengers, 52% for foreign-resident passengers, and 45% for all passengers. These increases have resulted in passenger welfare losses;
- To stabilize wait times at their current levels given projected increase in passenger volumes, a projection based on trends in recent years suggests that CBP-OFO processing resources will need to grow by roughly 4% per year;

[1] This is calculated as the change in air arrivals of 13 million times a value for direct expenditures that is derived from the values given for leisure and business travelers given in table 1-1. It is assumed that the proportion of business travelers will remain stable at 14%, which is the 2012 share for overseas travelers to the U.S.

- Data from a survey of international air travelers also show that time required to clear passport and customs inspection by foreign-resident visitors to the U.S. has risen significantly in recent years;
- The average level of satisfaction with passport inspection waits reported by respondents to this survey has not fallen in recent years. However, statistical analysis of the determinants of satisfaction with passport inspection waits shows that the most important factor by far in explaining this satisfaction is the time to clear passport and customs inspection that the passenger remembers was required. At the individual passenger level, reducing total clearance time will increase satisfaction, and, to the extent that reducing the passport inspection wait reduces total clearance time, reported satisfaction will rise.

1.2. The Impact on International Travel Demand of Passport Inspection Wait Time

We evaluate how passport inspection wait time impacts demand for international travel to and from the U.S. by analyzing data on passenger volumes on international flights to the U.S. during 2010-2013 and also survey evidence that asks foreign travelers to the U.S. about their future travel plans. We then quantify how change in passport inspection wait time impacts the number of U.S.-resident and non-U.S.-resident passengers at 4 U.S. international airports (Chicago O'Hare, JFK, LAX, and Miami) using an opportunity cost approach, and evaluate how the volume of passenger traffic changes if an additional CBP-OFO inspection officer is added at these airports and if wait time falls by 50% and 100%. Our key findings are:

- The total value of time waited in passport inspection queues in FY 2012 was $1.3 billion, and the time waited above 30 minutes per passenger was $517 million. These two values are upper and lower bounds, respectively, to the "true" value of time that passengers had to wait in these queues, which should capture the value of time that the passengers could have used for other purposes. If it is assumed that baggage delivery takes on average 30 minutes, then for any wait in a passport inspection queue of 30 minutes or less, lowering this wait time simply redistributes waiting from the passport inspection queue to waiting for baggage delivery. This redistribution may increase passenger welfare, but we have no credible way to quantify this.
- Adding a CBP-OFO passport inspection officer to inspection sites at 4 U.S. international airports in FY 2012 generates savings in the monetary value of time. This impact ranges from $0.3 to $3.3 million if all wait time counts, with an average inspection site impact of $1.2 million. If only wait time above 30 minutes counts, an extra officer produces wait time savings of $0.1 to $1.2 million, with an average impact of $0.6 million.
- In addition to saving time for existing passenger traffic, lowering wait time could cause demand for international travel to and from the U.S. to rise. We evaluate this demand shift using three different sets of data and methodologies.

  - First, we evaluate whether passenger counts on international flight segments changed during FY 2010-2013 if passport inspection wait time was unusually high or low for that segment in the recent past. This approach tests whether passengers who are committed to flying to the U.S. on a particular flight segment adjust their departure time in response to wait time. We found no evidence of a significant response.
  - Second, we evaluate answers to a question asked of international travelers to the U.S. in the 2012 Survey of International Air Travelers: Do you plan to visit the U.S. again, and, if not, what is the reason for that decision. A small number of survey respondents indicated that they did not intend to return to the U.S. (3.6%), and of these, 6-12% gave a complaint about their interaction with DHS (CBP-OFO) as their reason. Thus, 0.2-0.4% of all foreign visitors surveyed in 2012 indicated that they would not return to the U.S. due to complaints about DHS.
  - Finally, we evaluate the impact of passport inspection wait as a component of the opportunity cost associated with making an international air trip to or from the U.S. The change in wait time brought about by adding an officer to an inspection site is combined with an estimate of the price elasticity of demand for international air travel to yield an estimate of how the number of travelers changes. We find that the change in both U.S.-and non-U.S.-resident passenger flows is quite small in the context of overall passenger flows, but slightly above zero. We also quantify the change in passenger flows that would result from reducing average wait time by 50% and 100% (eliminating this wait entirely) under this methodology.
- Our results are quite small in comparison to the results of a recent study done by the U.S. Travel Association, which finds that 9.6 million potential foreign travelers to the U.S. were deterred from coming to the U.S. by passport inspection waits. We review the USTA estimates to evaluate why they are so large in comparison. Although we believe that the evidence that we develop in this chapter suggests that passport and customs wait times have a small impact on travel decisions, to the degree that one regards the entry process as having a much greater impact on travel, our estimates should be regarded as a conservative lower bound.

1.3. Macroeconomic Impacts of Lower Passport Inspection Wait Time at Four U.S. Airports

We translate changes in the number of airline travelers in response to wait time reduction of CBP inspection at the selected international airports into changes in their expenditures. Since wait time reduction affects both the number of incoming foreign visitors and U.S. residents who return from their international trips, the tourist expenditure changes are analyzed for both groups. The changes in international travel expenditures by U.S. residents are used to evaluate how increased international travel would affect their expenditures within the U.S., thereby offsetting somewhat the gains from an increase in foreign travelers visiting the U.S.

We utilize a well-established methodology used in the literature on the economic impacts of tourism. The methodology was recently refined and applied by the CREATE research team in studies for TSA (Rose et al., 2013) and CBP (Roberts et al., 2013).

Table 1-1 presents the average per visitor expenditure data by spending category for both leisure and business visitors from overseas. The data are adapted from the U.S. Department of Commerce report on the profile of inbound overseas travelers to the United States in 2012 (U.S. DOC, 2013a), including translating commodity expenditure categories to the sector expenditure categories of our macroeconomic impact model. On average, each foreign leisure visitor spent $3,061 per trip in 2012. Among the total expenditures, international airfare accounts for about 45%. The second largest portion of expenditure is related to shopping, gifts and other purchases. For foreign business travelers, the average per person expenditure in 2012 was $4,108, of which nearly 60% was spent on international airfare. The second largest expenditure for business travelers was lodging.

Table 1-1. Average Per Visitor Expenditures by BEA Commodity Category (in 2012$)

	Foreign Leisure Visitors	Foreign Business Visitors
Traveler accommodations	$406	$711
Food services and drinking places	$233	$206
Domestic passenger air transportation services	$80	$96
Passenger rail transportation services	$4	$5
Interurban bus transportation	$4	$6
Interurban charter bus transportation	$8	$12
Urban transit systems and other transport services	$6	$9
Taxi service	$4	$5
Scenic and sightseeing transportation services	$16	$23
Automotive rental	$13	$19
Other vehicle rental	$3	$4
Automotive repair services	$27	$39
Parking lots and garages	$3	$5
Highway tolls	$2	$3
Travel arrangement and reservation services	$19	$10
Motion pictures and performing arts	$23	$13
Spectator sports	$7	$4
Participant sports	$13	$7
Gambling	$163	$88
All other recreation and entertainment	$23	$13
Gasoline	$32	$17
Food and beverages for off-premises consumption	$94	$83
Clothing and footwear	$137	$99
Miscellaneous expenditures	$349	$251
Medical Services	$4	$3
International Airfare	$1,386	$2,376
Total	**$3,061**	**$4,108**

Table 1-2 presents the average per person expenditure on international air transportation and the spending outside the U.S. by U.S. residents traveling abroad (U.S. DOC, 2013b). On average, each American leisure traveler spent $2,612 per trip in 2012. The average per person spending of business trips was $4,538.

Table 1-2. Average Per Visitor Expenditures by U.S. Residents Traveling Abroad (in 2012$)

Expenditure Category	Leisure	Business
Airfare	$1,170	$2,155
Expenditures outside of U.S.	$1,442	$2,080
Total	**$2,612**	**$4,538**

The total change of expenditures by foreign visitors to the U.S. and the changes in expenditures on foreign travel by U.S. residents are computed by multiplying the per visitor expenditures shown in Tables 1-1 and 2 by the total number of increased foreign visitors and returning U.S. residents resulting from change in passport inspection wait time, respectively. Tables 1-3 and 1-4 summarize the upper-bound and lower-bound estimates of expenditure changes by foreign visitors and U.S. residents, respectively.

Table 1-3. Expenditure Changes by Foreign Visitors and U.S. Residents: Upper-bound Estimates (in millions 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Increased Expenditures by Foreign Visitors to the U.S.	$13.1	$1.2	$220.7	$19.2	$441.4	$38.3
Decreased Domestic Expenditures by U.S. Residents due to Increased International Travels	-$14.8	-$1.2	-$270.9	-$21.7	-$541.8	-$43.5
Increased Spending by U.S. Travelers on U.S. Airlines to Travel Abroad	$3.3	$0.3	$63.2	$6.2	$126.4	$12.3

Table 1-4. Expenditure Changes by Foreign Visitors and U.S. Residents: Lower-bound Estimates (in millions 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Increased Expenditures by Foreign Visitors to the U.S.	$4.8	$0.5	$80.4	$7.8	$160.7	$15.5
Decreased Domestic Expenditures by U.S. Residents due to Increased International Travels	-$3.3	-$0.4	-$62.1	-$6.6	-$124.2	-$13.2
Increased Spending by U.S. Travelers on U.S. Airlines to Travel Abroad	$0.8	$0.1	$14.6	$1.9	$29.2	$3.8

We use the estimates on change in travel expenditures shown in Tables 1-3 and 1-4 as inputs into an economic model, and we estimate the indirect and total impacts from the +1 staffing change and the 50% wait time reduction scenarios. Indirect effects stem from several sources. First, direct changes in travel expenditures stimulate additional economic activity "upstream" through an increase in the demand along the supply chain. Additional indirect impacts stem from price changes, both increasing and decreasing, for various products in our example. Increased demand for restaurants and hotels will raise their prices, not just for foreign tourists but for *everyone*. Moreover, these price increases have ripple effects of their own for goods and services downstream. The combination of price and quantity effects is referred to as "general equilibrium" effects and can only be traced through a sophisticated economic model. In our analysis below, we perform our estimates from the ground up.

We use CREATE's US Computable General Equilibrium (CGE) Model. This model and its regional variants, have successfully been used in more than a dozen studies (see, e.g., Rose et al., 2007; Rose et al., 2009; Oladosu et al., 2013; Rose et al., 2014). The model consists of 57 producing sectors. Institutions in the model are households, government, and external accounts. There are nine household income groups and two categories each of government (State/Local and Federal) and external accounts (Rest of the U.S. and Rest of the world).

Results for the extra-officer scenario are summarized in Table 1-5 below. The total net increase in U.S. GDP resulting from deploying additional officers to all 14 inspection sites ranges from $4.2 to $11.8 million, which is an average per-officer impact of $0.3 to $0.8 million.[2]

Table 1-5
Economic Impacts of Increased Demand for International Travel:
Additional CBP-OFO Primary Inspection Officer at 14 Inspection Sites, 4 International Airports

Simulation	Direct Impact	GDP (million 2012$)		Employment (Jobs)	
		Lower bound	Upper bound	Lower bound	Upper bound
A	Increased spending by foreign visitors to the US	$4.1	$11.1	49	132
B	Decreased spending in the US due to increased US leisure travel abroad	-$0.8	-$3.6	-14	-63
C	Decreased spending in the US due to increased US business travel abroad	-$0.4	-$1.4	-7	-24
D	Increased spend by US leisure and business travelers on US airlines to travel abroad	$1.3	$5.7	9	37
Total Net Impact		**$4.2**	**$11.8**	**37**	**82**
Average Net Impact Per Officer		**$0.3**	**$0.8**	**3**	**6**

Results for reducing passport inspection wait time by 50% at all 14 inspection sites yields a $95.4 million increase in GDP and 539 additional jobs.

[2] The lower-bound values are based on changes in passenger volumes that exclude all wait times lower than 30 minutes from having any impact on travel demand. Only passengers experiencing wait times greater than 30 minutes respond to a lower value of their passport inspection wait time.

1.4. CBP-OFO Management of Available Passport Inspection Resources

CBP-OFO has been criticized not only for having insufficient overall resources with which to conduct passport inspection, but also poorly managing available resources, for example by shifting them in response to surges in arriving passenger volumes. We investigate how efficiently CBP has allocated its inspection resources to smooth out average and maximum wait times across passengers arriving on flights at different hours of the day. We evaluate wait time outcomes and passport inspection booth deployment for several airports in FY 2013 and find that CBP-OFO is generally effective in efficiently allocating its available resources. Although international flight arrivals at many U.S. airports are characterized by large peaks during a few hours of the day, CBP responds by opening booths to meet these peaks, successfully smoothing out variations in average and maximum wait time outcomes to a significant extent. There is also evidence that arrivals can become so large that CBP hits its upper bound on processing capacity, and, in this situation, wait time outcomes rise. Overall resource availability seems to be a more important issue for CBP-OFO rather than inefficient management of available resources. It is also important to note that there is substantial variation across hours in the average wait time experienced, particularly during peak periods for arrivals of international flights. A detailed investigation of wait time and resource allocation at the John F. Kennedy International Airport suggests that factors other than CBP allocation of resources account for variations in processing throughput that result in atypically long wait times.

1.5. The Impact of Passport Inspection Waits on the Risk of Missed Flight Connections

Excessive passport inspection waiting times have been cited as accounting for a substantial number of missed connections to domestic flights from international arrivals.

This study evaluates the extent to which extended waiting times at passport inspection sites potentially contribute to the proportion of passengers arriving at the JFK airport in 2012 on international flights who subsequently miss connecting flights. We develop a measure of the total delay that these passengers could experience that comprises two distinct delay components: late arrival of the international flight at JFK, and an above-average passport inspection wait time. We then evaluate the impact of increases in total delay on the risk of passengers missing connecting flights. We also examine the role of airline booking practices in increasing or mitigating this risk.

The model is populated with 2012 flight arrival and airport waiting time (AWT) data for all five JFK airport terminals. These data are used to develop a preliminary assessment of the relative contributions of late arrivals, extended passport waits, and airline scheduling practices toward the total number of passengers arriving at JFK in 2012 from abroad who were at risk of missing their connecting flights.

Key results are:

- Most passengers (75 percent) on international flights arrived at JFK and cleared primary passport inspection within an hour of the scheduled arrival time. However, nearly 3 million passengers (25 percent of total arrivals) experienced a delay of more than 1 hour, putting them at risk of missing a connecting flight, with the 11 percent who had a total delay of more than 2 hours presumably missing connections at a higher rate.
- Arriving passengers experienced more than 2.3 million hours of excess delays (combined waiting time in excess of 1 hour).
- The overwhelming majority (87 percent) of passengers with excess delays were on flights that arrived more than 15 minutes after the scheduled arrival time:
    - In the majority of these cases (46 percent of all delayed passengers), the passport inspection process did not add any extra time to this delay.
    - However, in 41 percent of the excess delay cases, passengers also experienced extended passport inspection waits after deplaning from late arriving flights.
- Extended passport inspection waits were the sole source of missed connection risk for the other 13 percent of passengers who experienced extended delays.

Overall, flight delays contributed to an elevated risk of missed connections for 87 percent of all passengers (2.6 million people) who experienced extended entry delays and were solely responsible for the extended delays encountered by 1.4 million of these passengers. Extended passport waits were contributed to the excess delays experienced by 1.6 million passengers and were solely responsible for the delays encountered by 0.4 million people.

The preliminary analysis developed in this study for JFK in 2012 suggests that relatively few passengers on flights that arrive on time are at risk of missing connections because of extended passport inspection wait times. A substantially larger number of passengers are at risk of missing connections because of delays in flight arrival. However, extended passport waiting times contribute to the excess delays experienced by about half of the passengers who deplane from late arriving flights. We also note that it may be the case that a significant number of passengers who miss a connecting flight due to a late international flight arrival might attribute this to having to go through passport inspection, even when their passport inspection wait is not unusually long, because this is the last stage of a waiting process characterized by a high level of anxiety.

1.6. Recommendations for Further Research

Based on what we have learned carrying out this study, we make the following recommendations for future research:

- Passengers on international flights move through a series of processes upon arrival, and outcomes for these passengers depend upon the joint set of outcomes of these processes.

The time that it takes to complete the entry process depends on passport inspection wait time and baggage delivery time. The chance that a passenger will miss a connecting flight depends on flight arrival time, passport inspection time, and baggage delivery time. We have successfully merged air-industry data on scheduled flight arrival times and CBP data on actual flight arrival times and average and maximum passport inspection wait times. An important task for future research is to augment this data set with passport inspection wait times for individual passengers, which CBP has, and baggage delivery time for individual flights, which the airline industry may have. If not, estimates for average and range of baggage delivery time will suffice. This augmented dataset would permit more precise estimates of time spent achieving entry into U.S. international airports and could potentially enable significantly more sophisticated analysis of the risk of missed flight connections and the relative value of improvements in each of the processes.

- CBP has introduced several programs to pre-clear trusted travelers so that their passport inspection wait is minimized (e.g. the Global Entry program.) Introduction of these programs creates the possibility of evaluating the impact of significant reduction in passport inspection wait time on international travel volumes by comparing pre- and post-program outcomes using CBP data on individual flights. This type of natural experiment could potentially identify the true impact of wait time on international travel demand.[3] Stark changes in the level of wait time that are stable over time across all flights could provide the estimates of the external margin of demand.
- The data of the Survey of International Air Travelers provides information on primary inspection outcomes for hundreds of thousands of individual passengers over many years. Deeper analysis of this data could yield important insights into the determinants of CBP-OFO customer satisfaction outcomes.
- Statistical analysis of wait time outcomes and passport inspection resources can be further developed and refined in order to inform what level of CBP-OFO inspection resources are required to achieve desired outcomes (e.g. reducing passenger wait times by a given number of minutes or percentage.) As discussed in more depth in volume II of this study, it should now be possible to build simulator models for border crossings that permit a sophisticated and transparent development of resource requirements necessary to achieve particular outcomes.

[3] The statistical analysis of passenger counts for flight segments carried out in this study could not estimate change in the demand for trips to and from the U.S. because of a change in wait time.

Chapter 2: International Passenger Processing and Wait Time Outcomes at U.S. Airports

Bryan Roberts, Timothy Beggs, and Omeed Baghelai

2.1. Chapter Summary

The welfare outcomes of international air passengers and cost outcomes for airlines that are associated with international travel to the U.S. depend on several factors. Recent studies have highlighted various constraints that U.S. airports face in efficiently serving growing travel volumes. One constraint that has attracted considerable attention is the time required to clear passport and customs inspection at U.S. international airports. In this chapter, we evaluate trends in travel volumes, wait time in passport inspection queues, CBP-OFO inspection resources, and reported satisfaction of passengers going through passport and customs inspection. Key conclusions are as follows:

- The volume of international air passengers that CBP-OFO must process has been rising significantly over the past decade and is projected to continue to experience significant growth;
- During 2010-2013, CBP-OFO processing resources, as measured by the number of passport inspection booths open on an average day, has been falling;
- As a result of rising passenger volume and falling processing resources, average passport inspection wait time has risen by roughly 25%, and the total amount of time spent in passport inspection queues has risen by 33% for U.S. resident passengers and 52% for foreign-resident passengers. These increases have resulted in passenger welfare losses;
- To stabilize wait times at their current levels given projected increase in passenger volumes, a projection based on trends in recent years suggests that CBP-OFO processing resources will need to grow by roughly 4% per year;
- Data from a survey of international air travelers also show that time required to clear passport and customs inspection by foreign-resident visitors to the U.S. has risen significantly in recent years;
- The average level of satisfaction with passport inspection waits reported by respondents to this survey has not fallen in recent years. However, statistical analysis of the determinants of satisfaction with passport inspection waits shows that the most important factor by far in explaining this satisfaction is the time to clear passport and customs inspection that the passenger remembers was required. At the individual passenger level, reducing total clearance time will increase satisfaction, and, to the extent that reducing the passport inspection wait reduces total clearance time, reported satisfaction will rise.

2.2. International Airport Processing Capacities

The welfare outcomes of international air passengers and cost outcomes for airlines that are associated with international travel to the U.S. depend on several factors. Airports must have adequate runway capacity to enable the efficient scheduling of flight arrivals. Terminals must be well designed and capacious enough to facilitate passenger flow through entrances and exits, terminals, check-in areas, and security and inspection checkpoints. Baggage handling systems must be able to load baggage onto or remove it from airplanes and deliver it to passengers efficiently. Passport and customs inspection must be done efficiently so that associated wait times are both minimized and smoothed across arriving flights. Several different processes are relevant to determining outcomes for passengers and the airline industry, and these processes are managed and implemented by different private- and public-sector authorities.

Recent reports have called attention to challenges that U.S. airports face with respect to processing capacities. U.S. Travel Association (2013) (henceforth referred to as USTA) focuses on bottlenecks in the passport and customs inspection process and quantifies the degree to which this process has deterred travel and impacted the U.S. economy. The study, whose findings and methodologies are reviewed in detail in chapter 3, finds very large travel deterrence and economic impacts. The Eno Center for Transportation (2013) evaluates capacity constraints at several large U.S. international gateway airports and identifies major capacity constraints with respect to airport infrastructure (e.g. runways), access to the airport, and existing rules and regulations. The study discusses how delays at hub airports can cause delays at smaller, usually uncongested airports and how the interconnectivity of the air transport system means that capacity constraints at one airport can have impacts nationwide. The findings of this report are an important reminder that the air transport system is a complex system, and that the passport and customs inspection process is one of several potential constraints on processing capacity that affect travel outcomes.[4]

In this chapter, we review historical and projected trends in international air passenger volumes flowing through U.S. airports that CBP-OFO is required to inspect. We then evaluate recent trends in time waited in passport inspection queues and resources available to conduct passport inspection, and we develop an estimate of how these resources will need to increase in order to stabilize wait times at recent levels given projected passenger volumes. We finally

[4] The report notes that "Although inbound international travel to the U.S. is increasing, the U.S. has lost significant market share globally over the past decade. In part due to increased economic activity in other regions of the world and in part due to security and visa restrictions imposed after September 11, 2001, the U.S. market has declined from 17 percent of the global market in 2000 to 12.4 percent today. In efforts to raise this market share, (travel industry) groups are encouraging Congress to reform security and visa procedures. However, if U.S. hub and international airports lack capacity to move these would-be passengers, such efforts will not be as effective as they could be." (Eno Center for Transportation 2013, p.6.)

review survey evidence on the satisfaction of international visitors to the U.S. with their passport and customs inspection experience.

2.3. Trends in International Air Passenger Volumes

Flows of International air passenger that CBP-OFO must inspect when entering the U.S. consist of two key components: non-U.S. residents who are coming to the U.S. on a trip, and U.S. residents who have travelled abroad and are returning from a trip to a foreign country. Figure 2-1 shows the historical number of non-U.S. residents on international flights arriving in the U.S., and U.S. residents traveling abroad by air, for the period 1996-2012. Table 2-1 provides historical data on the period 1990-2012 and forecast/projection data for 2013-2018 for air arrivals and all arrivals.[5] After falling significantly during 2001-2003, the number of non-U.S. residents has steadily risen since at an average annual rate of 6.1%. The recent recession did cause this flow to fall in 2009, but it recovered immediately and barely deviated from its longer-run growth path. The most recent forecast by the Office of Travel and Tourism Industries of the U.S. Department of Commerce of this flow projects that it will continue to grow at an average annual rate of 4.7% during 2013-2018. The flow of U.S. residents traveling abroad was less affected in 2001-2003 but more impacted by the recent recession, and it fell during 2007-2011. However, it experienced positive growth in 2012. Available data for 2013 suggests that both flows continued to grow in that year.

If the non-U.S. resident arrival flow continues to grow strongly, and the flow of U.S. residents traveling abroad experiences a post-recession recovery, then CBP-OFO can expect to face a steadily increasing flow of passengers that must be inspected at U.S. international airports.

[5] Table 2-1 includes data on air arrivals from Canada, Mexico, and overseas countries, sea and land arrivals from Canada, and sea and limited land arrivals from Mexico. Land arrivals from Mexico only include those entering the U.S. who submit an I-94 form; the large majority of land arrivals from Mexico enter on a Border Crossing Card and are not included in table 2-1 values.

Figure 2-1
International Air Passengers Arriving in the U.S.
(Department of Commerce data)

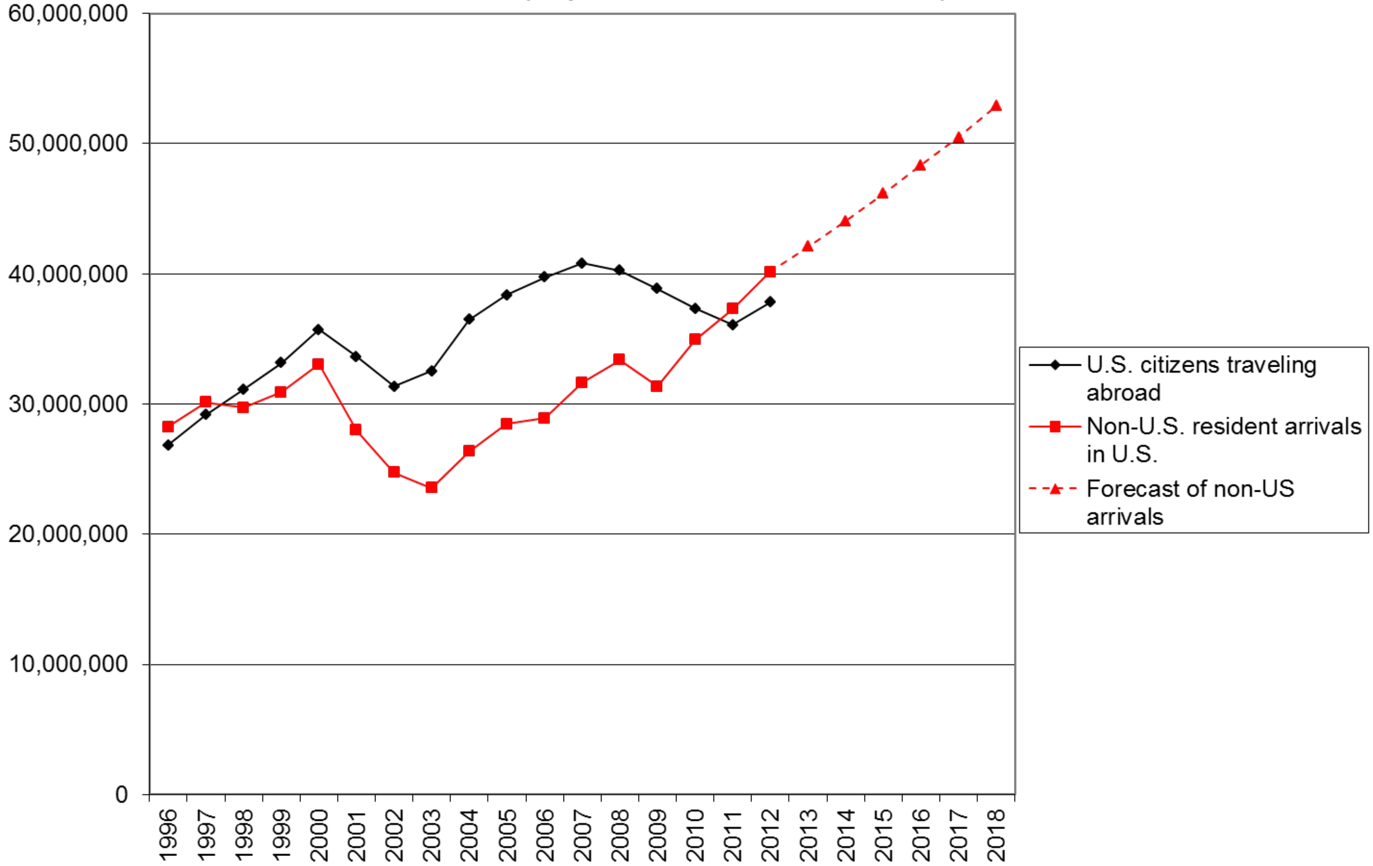


Table 2-1
Historical and Projected Non-U.S.-Resident Arrivals to the U.S.

	Total Overseas (air)	Canada: air, sea, land	*Canada: air only*	Mexico: air, sea, limited land	*Mexico: air only*	**Total Arrivals**	***Total Air Arrivals***
1990	*15,059,010*	17,262,996			*1,341,108*		
1991	*16,154,520*	19,113,424			*1,442,771*		
1992	*17,791,029*	18,598,248			*1,556,792*		
1993	*18,661,817*	17,293,000			*1,382,452*		
1994	*18,457,946*	14,970,000	*3,710,000*		*1,430,872*		***23,598,818***
1995	*20,638,966*	14,663,000	*3,802,000*		*889,404*		***25,330,370***
1996	*22,658,166*	15,300,790	*4,497,000*	1,336,628	*1,091,812*	**39,295,584**	***28,246,978***
1997	*24,194,476*	15,130,173	*4,638,000*	2,887,552	*1,303,786*	**42,212,201**	***30,136,262***
1998	*23,697,587*	13,421,832	*4,595,000*	3,371,880	*1,420,832*	**40,491,299**	***29,713,419***
1999	*24,466,187*	14,110,462	*4,963,000*	3,574,186	*1,489,170*	**42,150,835**	***30,918,357***
2000	*25,974,701*	14,593,881	*5,353,000*	4,040,076	*1,736,600*	**44,608,658**	***33,064,301***
2001	*21,832,868*	13,507,446	*4,637,000*	3,826,989	*1,512,980*	**39,167,303**	***27,982,848***
2002	*19,116,707*	12,968,103	*4,181,000*	3,845,801	*1,436,727*	**35,930,611**	***24,734,434***
2003	*18,026,213*	12,659,739	*4,173,000*	3,772,406	*1,359,418*	**34,458,358**	***23,558,631***
2004	*20,322,257*	13,849,488	*4,583,000*	3,992,811	*1,439,971*	**38,164,556**	***26,345,228***
2005	*21,678,528*	14,864,741	*5,125,000*	4,605,268	*1,668,432*	**41,148,537**	***28,471,960***
2006	*21,668,290*	15,992,000	*5,523,000*	5,840,839	*1,713,158*	**43,501,129**	***28,904,448***
2007	*23,892,277*	17,760,000	*5,883,000*	6,732,058	*1,878,000*	**48,384,335**	***31,653,277***
2008	*25,341,451*	18,910,000	*6,348,000*	6,235,336	*1,708,000*	**50,502,051**	***33,397,451***
2009	*23,756,184*	17,964,454	*6,099,000*	6,023,225	*1,511,000*	**47,737,530**	***31,366,184***
2010	*26,362,616*	19,959,496	*6,910,000*	13,422,852	*1,675,000*	**59,744,964**	***34,947,616***
2011	*27,883,157*	21,028,177	*7,472,000*	13,414,020	*1,950,000*	**62,325,354**	***37,305,157***
2012	*29,761,038*	22,698,986	*8,272,972*[B]	14,282,000	*2,118,000*	**66,658,669**	***40,152,010***
2013	*31,477,000*[A]	23,378,000[A]	*8,520,448*[B]	14,139,000[A]	*2,096,793*[C]	**68,994,000**	***42,094,242***
2014	*33,135,000*[A]	24,079,000[A]	*8,775,938*[B]	14,564,000[A]	*2,159,820*[C]	**71,778,000**	***44,070,758***
2015	*34,806,000*[A]	25,042,000[A]	*9,126,917*[B]	15,000,000[A]	*2,224,478*[C]	**74,848,000**	***46,157,395***
2016	*36,600,000*[A]	26,044,000[A]	*9,492,110*[B]	15,150,000[A]	*2,246,723*[C]	**77,794,000**	***48,338,833***
2017	*38,426,000*[A]	26,825,000[A]	*9,776,757*[B]	15,453,000[A]	*2,291,658*[C]	**80,704,000**	***50,494,415***
2018	*40,501,000*[A]	27,630,000[A]	*10,070,151*[B]	15,763,000[A]	*2,337,630*[C]	**83,894,000**	***52,908,781***
2019							
2020							
2021						**100,000,000**[D]	
Average annual growth:							
1996-2012	*1.7%*	2.5%	*3.9%*	16.0%	*4.2%*	**3.4%**	***2.2%***
2003-2012	*5.7%*	6.7%	*7.9%*	15.9%	*5.1%*	**7.6%**	***6.1%***
2012-2018	*5.3%*	3.3%	*3.3%*	1.7%	*1.7%*	**3.9%**	***4.7%***
2012-2021						**4.6%**	

All values for 2013-2018 are based on forecasted values.
A : forecast of Department of Commerce-Office of Travel and Tourism Industries
B : estimated using 2011 ratio of Canada-air-only to Canada-total
C : estimated using 2012 ratio of Mexico-air-only to Mexico-total
D : National Travel and Tourism Strategy goal for 2021

2.4. Trends in Wait Time and CBP-OFO Inspection Resources at U.S. International Airports

CBP-OFO has been measuring time waited in passport inspection lines by individual passengers who have arrived at a U.S. airport on an international air flight since late 2009. Wait time is measured based on when the plane docks at its gate and when the passenger underwent passport inspection, with allowances made for a standard walk-time from the gate to the inspection area and a small percentage of stragglers whose wait times are excluded from analysis.[6]

Wait time summary measures are available for each international flight arrival and include the number of passengers who are U.S. citizens (hereafter, USCs), legal permanent residents (LPRs), and non-U.S. residents (NIMs), the total amount of time waited by each of these three groups, and the maximum wait time experienced by a passenger on the flight. The average wait time for each group can be calculated by dividing total wait time for the group by its number of passengers. These summary measures are calculated from passenger-specific data. Flight-specific data also includes the number of passport inspection booths that processed at least one passenger from the flight. The numbers of booths that processed only USCs and LPRs or only NIMs are not available, due to the fact that a booth's assignment to one group or the other can be changed during the course of processing a flight.

Figure 2-2 shows the number of U.S.-resident and non-U.S.-resident passengers inspected by CBP-OFO at the 24 U.S. international airports with the largest arrivals for the period fiscal year (FY) 2010-2013 (the first group of passengers is the sum of USC and LPR passengers, and the second group is the NIM passengers.) The number of NIM passengers grew by 23% in this period, which is consistent with the data of figure 2-1. The number of USC+LPR passengers grew by 7%, which is more rapid growth than shown by figure 2-1.[7] Processing volume has thus grown significantly in recent years.

Figure 2-3 illustrates CBP-OFO resource availability to conduct processing during FY2010-2013 using a measure of booth-hour availability, which represents the total number of booth-hours available in the typical day of a given year across the 24 airports.[8] The number of total booth-hours fell by roughly 6% from 2010 to 2013, with the fall taking place primarily in 2013.

[6] Standard walk times are established for individual inspection sites (terminals) in airports and range from 2 minutes (Cincinnati/Northern Kentucky International Airport) to 25 minutes (Dulles International Airport.)

[7] The difference may be accounted for by the fact that the CBP-OFO data is for 24 airports only, and/or by treatment of U.S. legal permanent residents in the Department of Commerce passenger counts.

[8] The booth-hour measure is calculated in several steps. First, the average number of booths conducting passport inspections in a given hour and year at an airport is calculated. (CBP data on a particular international flight arrival at an airport is divided into hour blocks based on the actual arrival time of a flight.) Second, these hour averages are summed to get a value for the typical day of the year at a particular airport. Finally, these hour sums are added up across the 24 airports. The resulting number shows how many booth-hours were available in aggregate for these 24 airports for the typical day of a year.

The rise in number of passengers requiring inspection coupled with the fall in available inspection booths should have led to a rise in average wait time, and figure 2-4 shows that this happened. The average wait time for both groups of passengers rose by roughly 25% from 2010 to 2013. The average wait time for NIM passengers is almost twice as high as for USC+LPR passengers, which is due primarily to a more lengthy inspection time for NIM passengers and will be discussed at greater length below.

Figure 2-5 reveals that as a result of both increasing passenger volume and increasing wait time per passenger, the total amount of minutes waited in passport inspection lines rose by one-third for USC+LPR passengers and by one-half for NIM passengers from 2010 to 2013, with the total for all passengers rising by 45%. These are substantial increases in the amount of time waited in these lines, the value of which is a direct measure of lost welfare to the passengers.[9]

As will be discussed in more detail below, the degree to which increased time spent in passport inspection lines translates into increased time spent on clearing and exiting the airport depends on the time that passengers have to wait for their baggage to be delivered, and the increase in time waited shown in figure 2-5 overstates the true rise in welfare loss. Nonetheless, some fraction of this rise does represent the true fall in welfare resulting from increased waiting.

2.5. The Relationship Between Wait Time and CBP-OFO Inspection Resources

A simple way to quantify the relationship between average wait time and its determinants is to regress annual percentage changes in average wait time airport at individual airports on annual percentage change in the total number of passengers processed and average number of booths across the typical day during the period FY 2010-2013. Table 2-2 gives results of estimations for all passengers under four different specifications.[10] Results show that coefficients on change in passenger count and available booths always have the expected sign (positive on passenger count growth, negative on available booths growth), and that the relationship between change in average wait time and explanatory variables is weakest for USC+LPR passengers and strongest for NIM passengers. The best specification is column (D), which includes as explanatory variables change in passenger count, change in available booths, and dummy variables for 2010-2011 and 2011-2012 that capture change in average wait time common across all airports in those periods.

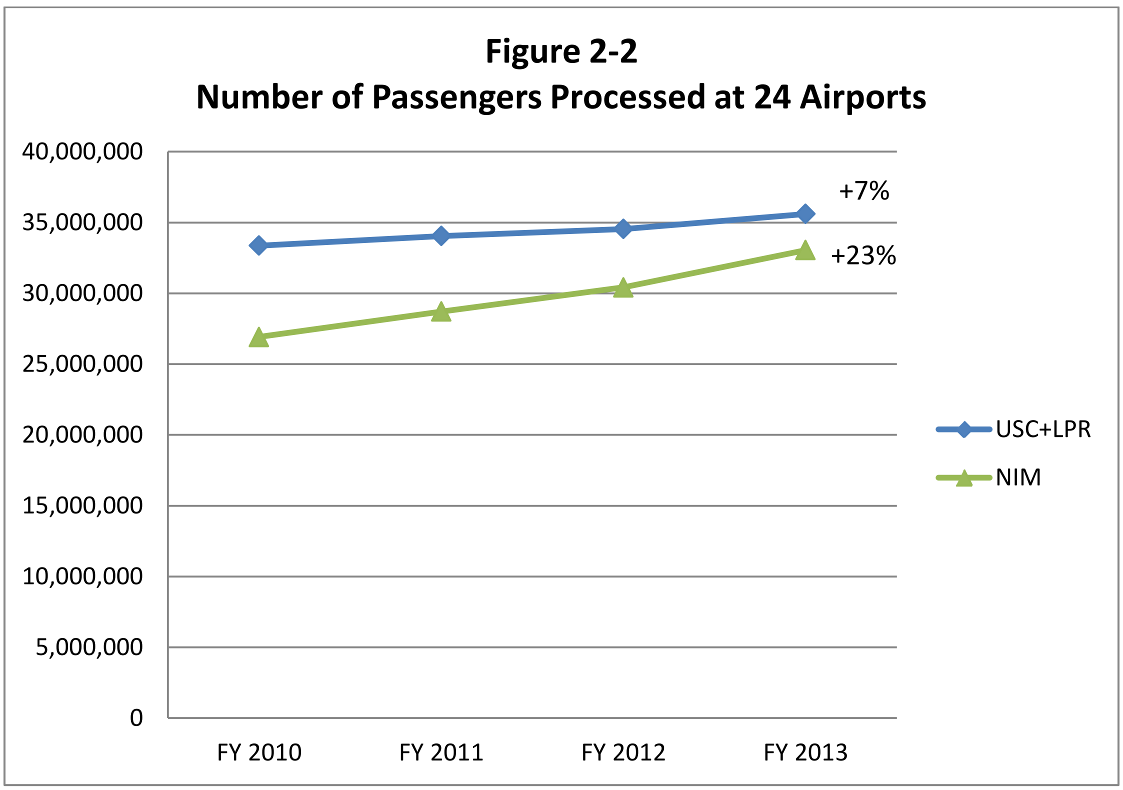
---

[9] The value of time spent in passport inspection queues at these 24 airports in 2012 ranges from a lower bound of roughly $500 million to an upper bound of roughly $1.3 billion. See chapter 3 for a detailed development of these estimates.

[10] The dependent variable in these regressions is change in total number of passengers, which is the sum of USC, LPR, and NIM passengers. Regressions cannot be run for USC+LPR and NIM passengers separately, because we do not have values for the number of booths that processed only USC+LPR passengers and only NIM passengers.

The forecast of non-U.S.-resident arrivals in figure 2-1 has these arrivals growing by 4.7% per year during 2013-2018. If we assume that U.S. citizen arrivals grow at the same rate, so that total passengers grow at 4.7% per year through 2018, then the regression results for total passengers can be used to determine what growth rate in available booths is required if growth in average wait time is to be kept at zero. Using the coefficients for specification (D), it is straightforward to show that available booths must grow at 4.2% per year.[11]

This is a very simple approach to determining resource requirements for CBP-OFO booth resources in order to achieve a desired outcome in wait time growth given expected changes in passenger volumes. It should be possible to develop resource requirements using more sophisticated modeling of the passport inspection process as discussed in more detail in volume II of this study. However, given actual developments in the recent period FY 2010-2013, this exercise does give some sense of the magnitude of how CBP-OFO inspection resources will need to change in order to keep wait times from rising significantly from current levels.



[11] It is also straightforward to show that if available booths growth equals zero, then average wait time would rise by 1.7% per year. If growth in available booths is negative in the future, as it generally was during 2010-2013, then growth in average wait time can be expected to be higher than this.

Figure 2-3
Total Number of Booth-Hours Available in Typical Day: Sum for 24 U.S. International Airports

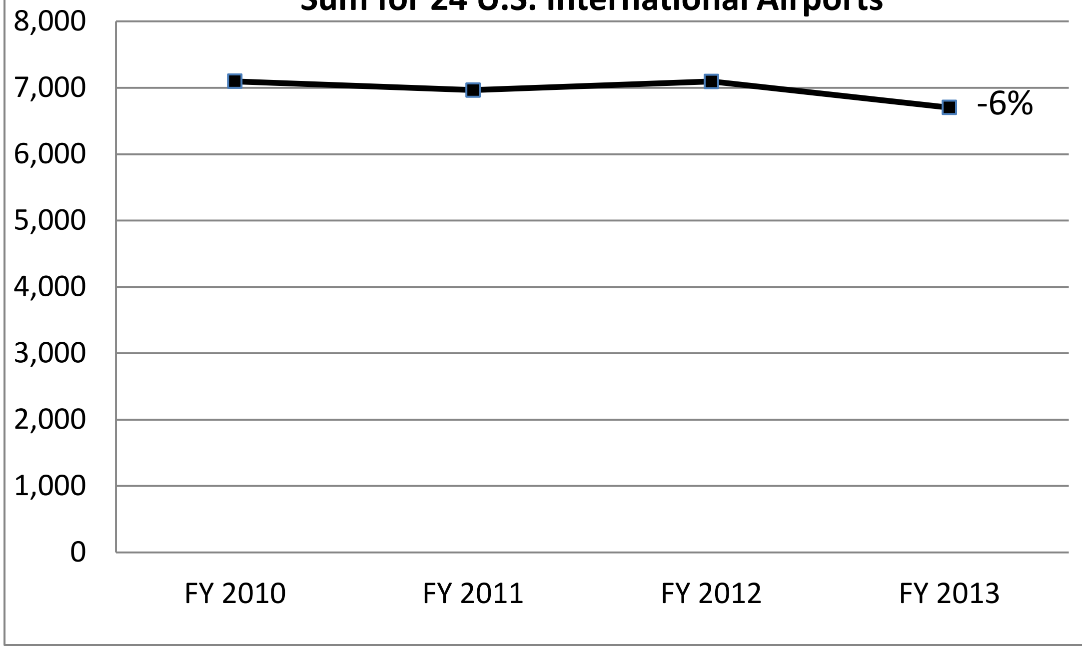
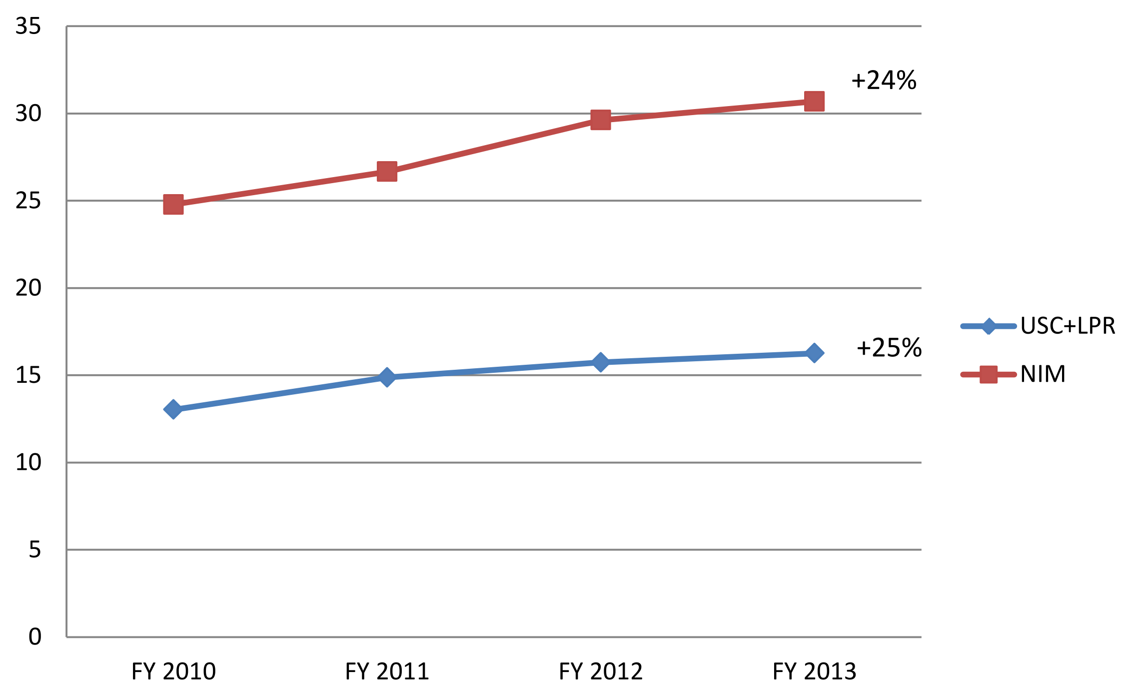


Figure 2-4
Average Wait Time In Minutes Across 24 Airports



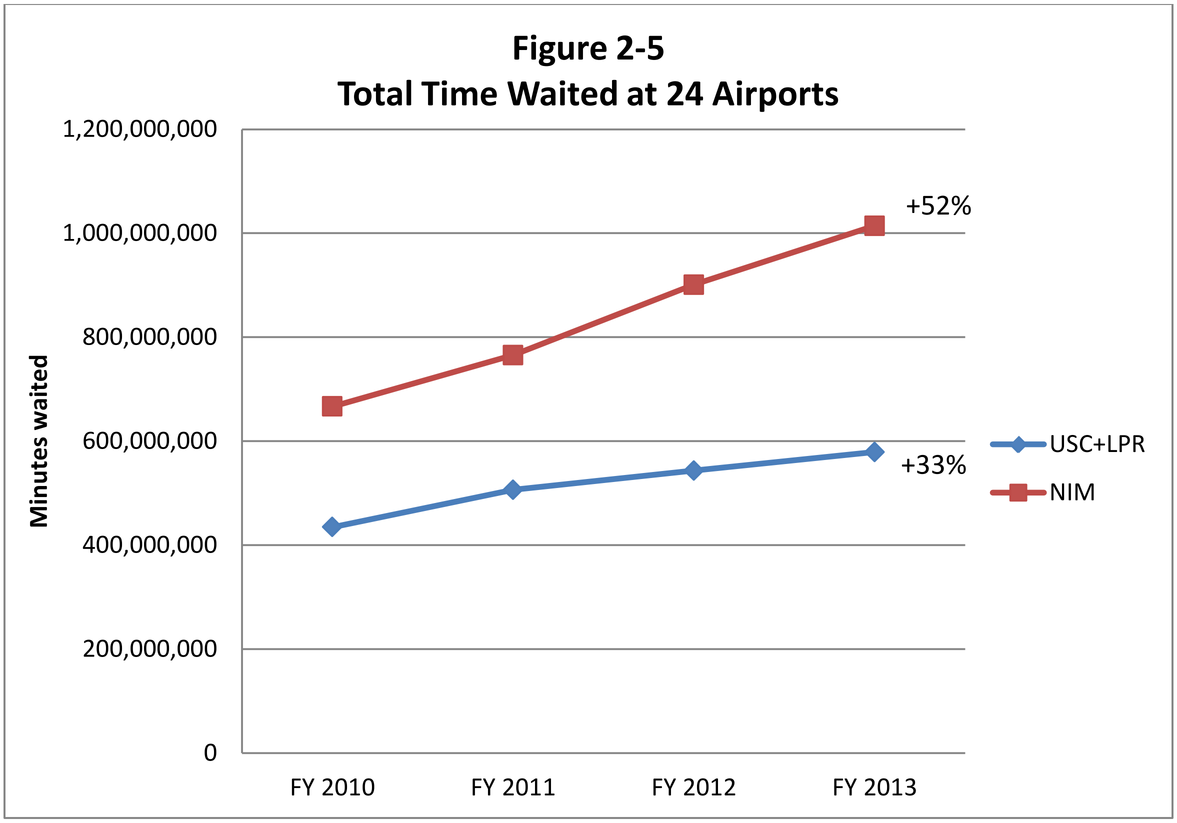


Figure 2-5
Total Time Waited at 24 Airports
Minutes waited
1,200,000,000
1,000,000,000
800,000,000
600,000,000
400,000,000
200,000,000
0
FY 2010
FY 2011
FY 2012
FY 2013
+52%
+33%
USC+LPR
NIM

Table 2-2
Average Wait Time, Passenger Count, and Procesing Booths

Dependent Variable: % Change in Average Wait Time (All Passengers)				
Number of observations for each regression: 69				
	(A)	(B)	(C)	(D)
Constant	0.05** (2.35)	0.07*** (4.08)	0.04** (2.04)	-0.02 (-0.47)
% Change in Total Passenger Count	0.62*** (2.72)		0.63*** (2.80)	0.70*** (3.08)
% Change in Available Booths		-0.27 (-1.43)	-0.29 (1.59)	-0.42** (-2.19)
2010-11 Dummy				0.07* (1.79)
2011-12 Dummy				0.08* (1.89)
R2(adj.)	0.09	0.01	0.11	0.14

All regressions estimated using ordinary least squares procedure. T-statistics are in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

2.6. Trends in Total Clearance Time and Customer Satisfaction with CBP-OFO Inspection Processes

In addition to CBP-OFO data on international flight arrivals and wait time outcomes, insights on passenger satisfaction with the passport inspection process can be obtained from responses to the Survey of International Air Travelers (SIAT), which has been administered by the Office of Travel and Tourism Industries of the U.S. Department of Commerce since the 1980s to foreign residents making trips to the U.S. and U.S. residents traveling abroad. The SIAT questionnaire is administered to foreign and American residents at airport departure gates, so that foreign residents take the survey at the end of their trip to the U.S., and American residents at the beginning of their trip to a foreign country. The questionnaire asks a broad range of questions about the traveler's trip (e.g. purpose, length, expenditures, itinerary), socio-economic characteristics of the traveler, and satisfaction with a range of variables, including their departure airport, airline, and (for foreign residents) trip experience in the U.S. Between 25,000-50,000 foreign residents have completed the questionnaire each year during 1996-2012.[12]

Starting in 1996, foreign residents making trips to the U.S. have been asked to recall the passport and customs inspection process that they experienced when they entered the U.S. and rate their satisfaction with the passport inspection wait time that they experienced, courtesy of the passport inspection officer, customs (baggage) wait time that they experienced, and courtesy of the customs inspection officer. They are also asked to recall how many minutes that it took to fully clear passport and customs control. This reported clearance time includes wait time at passport control, but it also includes waiting for baggage delivery and time spent going through customs inspection. Figure 2-6 shows the stages involved in clearing an airport after an international flight arrival and the data available to evaluate the process.

Figure 2-7 shows the average reported total clearance time across all SIAT survey respondents during 1996-2012, and average passport inspection wait time from CBP-OFO data across 24 airports.[13] The difference between these presumably reflects time spent waiting for baggage delivery and clearing customs inspection. Reported clearance time rose significantly during 2002-2004, stabilized, and then rose again in 2011-2012. Although average passport inspection wait time as measured by CBP-OFO also rose during 2010-2012, the rise in reported clearance time rose even more sharply, so that the difference also rose. These trends suggest that

[12] We would like to thank the Office of Travel and Tourism Industries (OTTI) of the U.S. Department of Commerce and CRC Research for their support on obtaining and analyzing the SIAT data. We would like to thank Richard Champley of OTTI and Lois Watson and Laura Gibney-Falk of CRC Research in particular for their efforts.

[13] Individual responses to this question are aggregated using weights that reflect distribution of nationality and port of entry of the total number of arrivals of foreign residents to U.S. international airports.

pressure is building at international airports with respect to both passport inspection and baggage processing, and that these are both contributing to a rising total clearance time.[14]

The SIAT questionnaire asks foreign residents to rate their satisfaction with passport inspection wait time, customs inspection wait time, and officer courtesy on a 1-to-5 scale, with 1 being "Poor," 2 being "Fair", 3 being "Average," 4 being "Good," and 5 being "Excellent." Figure 2-8 shows the average reported satisfaction with passport inspection wait time across all SIAT survey respondents during 1996-2012.[15]The average value has been between 3.25-3.5 for the entire period and shows no trend or obvious correlation with either CBP-OFO average wait time or SIAT total reported clearance time. In particular, the recent rise in measured wait time has not resulted in any obvious deterioration in overall customer satisfaction.

Figure 2-9 shows the average reported satisfaction with passport inspection officer courtesy. Average satisfaction was very stable and equaled roughly 3.5 during 1996-2011, but in 2012 it rose significantly to 3.67.[16]

The trends apparent in figures 2-8 and 2-9 may be misleading, because even though they aggregate individual response values using weights, these weights only capture the nationality of the respondent and port of entry at which they were surveyed. If the composition of the respondent population was changing along other characteristics not controlled for by these weights (e.g. purpose of trip, age, income level), average values might change because of systematic changes in these characteristics. In order to better understand the relationship between reported satisfaction with passport inspection wait time and its underlying determinants, we have carried out statistical analysis of individual responses to the survey during 1996-2012 that is presented in detail in an appendix below. This analysis shows that the most important determinant of the level of reported satisfaction with passport inspection wait time is recalled total clearance time. The estimated correlation between total clearance time and satisfaction suggests that a significant rise in clearance time will cause a significant fall in satisfaction, and vice versa. These results suggest that if CBP can reduce passport inspection wait time at the individual traveler level, and this in turn reduces total clearance time, satisfaction with the passport inspection wait will rise.

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[14]Without data on actual baggage delivery times (the time that it takes to move luggage from an arrived flight to the baggage carousel for passenger pickup), it is not possible to evaluate directly how baggage delivery performance has impacted total clearance time.

[15] Individual responses to this question are aggregated using weights that reflect distribution of nationality and port of entry of the total number of arrivals of foreign residents to U.S. international airports.

[16] It should be noted that the non-response rates for the SIAT passport inspection wait time and officer courtesy satisfaction questions rose significantly in 2012 from average values of 16% and 18% respectively during 1996-2011 to 22% and 24% respectively. These changes in non-response rates may have affected average response values.

Figure 2-6
Airport Clearance Stages and Available Related Data

Plane docks at arrival gate, walk to passport inspection area	Wait in passport inspection queue	Wait in baggage delivery area, get luggage	Undergo customs inspection
	CBP wait time		
	SIAT satisfaction with passport inspection wait time		SIAT satisfaction with customs inspection wait time
SIAT reported clearance time			

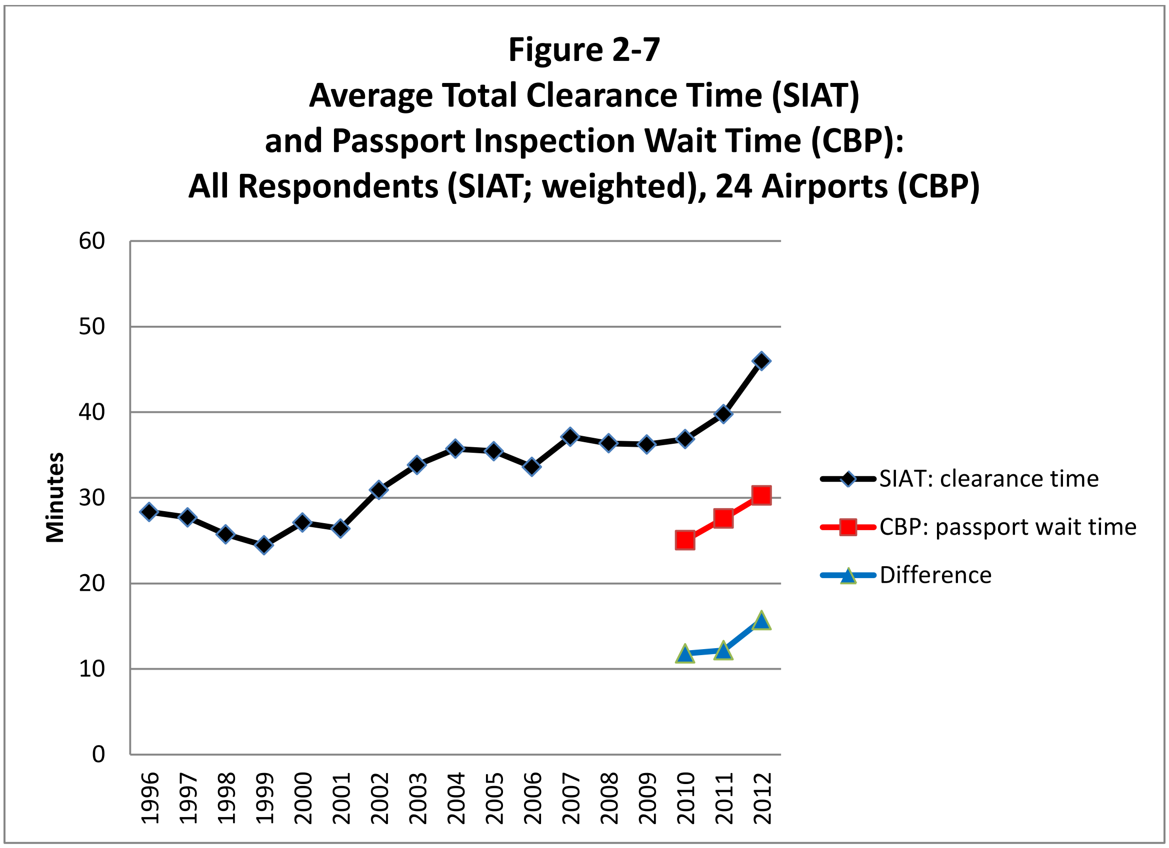


Figure 2-8
Average Satisfaction with Passport Inspection Wait Time
(all SIAT respondents; weighted)

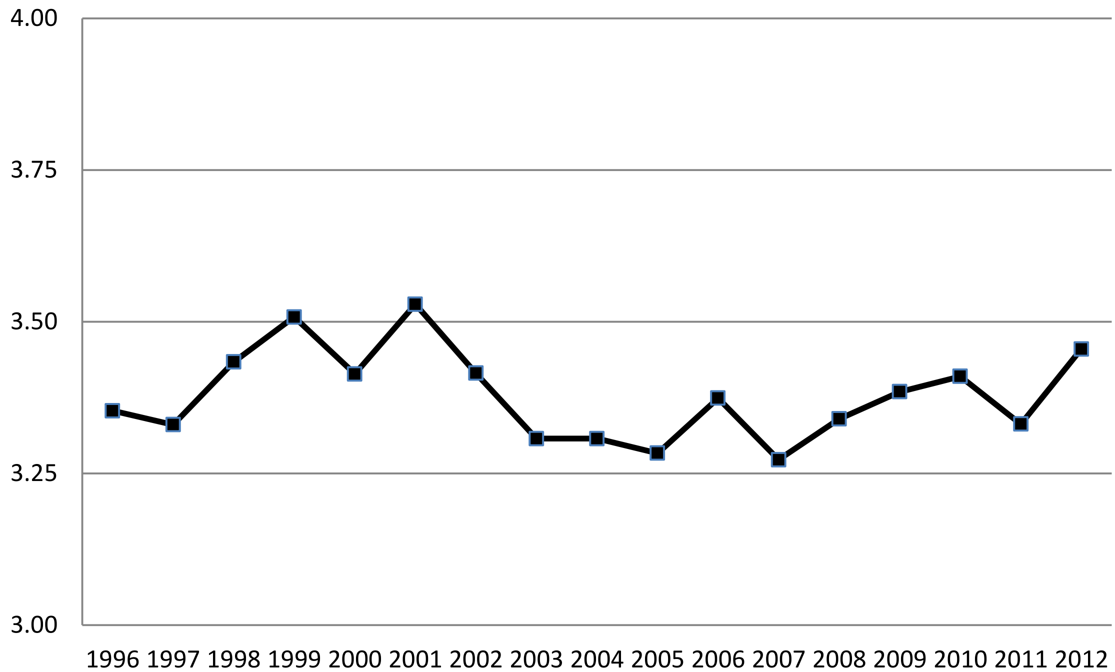
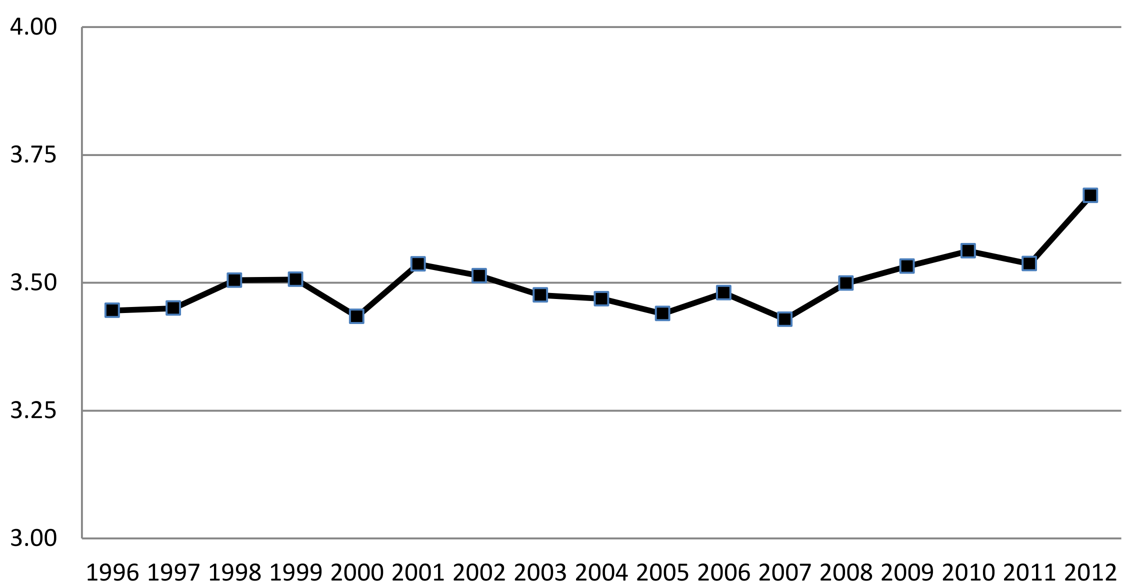


Figure 2-9
Average Satisfaction with Passport Inspection Officer Courtesy
(all SIAT respondents; weighted)



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Appendix 2-A: Statistical Analysis of Customer Satisfaction with Passport Inspection Wait Time

The average response values for satisfaction with passport inspection wait time that are shown in figure 2-7 can be misleading, because even if these values are weighted, they could be changing due to change in composition of the respondent population along characteristics not controlled for by the weights. In order to estimate how this satisfaction ranking changes with variables that might influence it (e.g. recalled total clearance time), statistical analysis can be applied to data at the level of individual respondent. We use data from 369,458 completed survey questionnaires during the period 1996-2012 and estimate a cumulative probit model that relates the ordinal passport inspection wait time satisfaction ranking to explanatory variables that include recalled total clearance time, age, gender, household income level, main purpose of trip, length of trip (number of nights spent in the U.S.), country of residence, and the month and year in which the questionnaire was filled out.[17] A specification that includes squared terms for recalled total clearance time, income level, and length of trip is also estimated.

Table A-1 gives estimation results for both specifications. The coefficients on explanatory variables all have signs consistent with what might be expected *a priori*. Reported satisfaction falls with recalled total clearance time. It rises with age, and women are slightly more likely to report higher satisfaction than men. Those traveling to the U.S. for business purposes or to attend a convention report lower satisfaction scores than those traveling for leisure purposes or to visit friends and family, which is consistent with business travelers feeling more pressure to arrive at destinations according to a fixed time schedule. Reported satisfaction falls with household income level, which is consistent with several hypotheses about income, the shadow value of time, and impatience. Finally, reported satisfaction rises with the number of days between the actual inspection experience and the taking of the questionnaire, which is consistent with the memory of an experience becoming more favorable over time.[18] Significant coefficients on squared terms of total clearance time, income level, and length of trip in specification (B) suggests that the relationship between satisfaction score and these variables are nonlinear.

Table A-2 shows that recalled total clearance time is by far the most important single variable that explains reported satisfaction. The two columns under "-2*Log(L)" report the value of this variable for an estimation that includes only an intercept term, and an estimation that includes

[17] The data of this survey is not longitudinal in nature, because it does not follow a set of potential foreign travelers to the U.S. over time. We thus estimate correlations rather than causal relationships.

[18] Length of trip captures the elapsed time between when the person arrived in the U.S. and underwent passport inspection and when they responded to the survey. The positive coefficient on this variable suggests that all else equal, a person's memory of their satisfaction with an inspection wait experience becomes more favorable the longer in the past that experience took place.

an intercept term and explanatory variables.[19] By adding the explanatory variable to the intercept term, the dependent variable is better explained by the model, and this is indicated by a falling value of -2*Log(L). The first row of the table reports how -2*Log(L) changes when all explanatory variables are included. The ratio of the two values of 89% thus reflects the improvement achieved by including the explanatory variables. The other rows of the table report how -2*Log(L) changes when all of the explanatory variables are included with the exception of the variable listed in the row. For all variables except recalled total clearance time, excluding the variable did not materially change the explanatory power of the estimated model. However, excluding recalled total clearance time eliminated most of the explanatory power of the model.[20]

[19] The variable is -2 times the natural logarithm of the likelihood function for the estimated model.

[20] 73% of the explanatory power (8%/11%) is eliminated if recalled total clearance time is excluded.

Table 2A-1
Passport Inspection Wait Time Regressions

	(A)	(B)
Estimation Technique: Cumulative Probit		
Number of observations used	369,458	369,458
Dependent Variable: Satisfaction With Passport Inspection Wait Time (1-5 scale)		
Independent Variables		
Recalled Total Clearance Time	-0.022*** (0.000)	-0.038*** (0.000)
Recalled Total Clearance Time^2		0.0001*** (0.000)
Age	0.006*** (0.000)	0.007*** (0.000)
Gender	-0.040*** (0.004)	-0.037*** (0.004)
Income	-0.017*** (0.001)	-0.041*** (0.003)
Income ^2		0.002*** (0.0002)
Number of Nights Spent in U.S.	0.001*** (0.000)	0.002*** (0.000)
Number of Nights^2		-0.000006*** (0.000)
Main Purpose of Trip (base purpose of trip is for Leisure purposes):		
Business	-0.180*** (0.004)	-0.185*** (0.004)
Attend Convention	-0.150*** (0.007)	-0.141*** (0.007)
Visit Friends/ Family	0.014 (0.038)	0.018 (0.039)
Student	-0.053*** (0.012)	-0.061*** (0.012)
Health Treatment	0.060* (0.033)	0.053 (0.033)
Other Purpose	0.010 (0.023)	0.003 (0.023)
Control Variables	Dummy variables for country of residence, month-in-year	
Model Fit Statistics	Regressions significant at 1% level	
Association of Predicted Probabilities and Observed Responses		
Percent concordant	74.5%	75.0%
Percent discordant	25.1%	24.6%
Percent tied	0.4%	0.4%

Table 2A-2

Quantitative Significance of Passport Inspection Wait Time Influences

Model of table A-1, column (A)	**-2*Log(L)**		
	Intercept only	Intercept and covariates	Ratio
Including all variables	1,121,351	1,000,181	89%
Including all variables except:			
Recalled total clearance time	1,121,351	1,092,465	97%
Purpose of trip	1,121,351	1,002,031	89%
Income	1,121,351	1,000,880	89%
Age	1,121,351	1,002,127	89%
Gender	1,121,351	1,000,281	89%
Trip length	1,121,351	1,000,417	89%

Note: all regressions are estimated on the same underlying set of observations.

Chapter 3: Management of the Passport Inspection Process at U.S. International Airports

Steve McGonegal, Timothy Beggs, and Bryan Roberts

3.1. Chapter Summary

Growth in resources to conduct passport inspections has not kept pace with rising passenger volumes, and average wait times have risen as a result. In this chapter, we investigate how efficiently CBP allocates these increasingly scarce resources to smooth out average and maximum wait times across passengers arriving on flights at different hours of the day. We evaluate wait time outcomes and passport inspection booth deployment for several airports in FY 2013 and find that CBP-OFO is generally effective in efficiently allocating its available resources. Although international flight arrivals at many U.S. airports are characterized by large peaks in a few hours of the day, CBP responds by opening booths to meet these peaks, successfully smoothing out variations in average and maximum wait times to a significant extent. There is also evidence that arrivals can become so large that CBP hits its upper bound on processing capacity, and in this situation, wait time outcomes rise. Overall resource availability seems to be a more important issue for CBP-OFO rather than inefficient management of available resources. It is also important to note that there is substantial variation across hours in the average wait time experienced, particularly during peak periods for arrivals of international flights. A detailed investigation of wait time and resource allocation at the John F. Kennedy International Airport suggests that factors other than CBP allocation of resources account for variations in processing throughput that result in atypically long wait times.

3.2. Passport Inspection Throughput and Efficiency at Six Large International Four Airports

CBP has been criticized both having an insufficient overall level of staff and for poorly managing its available staff.[21] Results in chapter 1 do suggest that overall CBP-OFO processing resources have not kept pace with rising international passenger volumes, and that average wait time has risen as a result. That analysis does not show, however, whether CBP-OFO is efficiently managing its available resources to respond to fluctuations in passenger volume. There are reasons to think that CBP has made substantial progress in the ability to respond to changing processing volumes and smooth out wait times across time periods. CBP has recently deployed tools at airports that permit it to learn about flight arrivals and their passenger loads and composition in terms of number of USC, LPR, and NIM passengers in real time. CBP has also

[21] U.S. Travel Association (2013), for example, argues that "In today's system, CBP staffing is insufficient and simply not matched with arriving passenger traffic."

implemented new trusted-traveler programs that will ease processing pressures by diverting low-risk passengers away from congested lines. On the other hand, CBP may face constraints on deployment of staffing that prevent rapid reallocation of inspection officer in response to changing conditions. The degree to which CBP effectively manages its available resources is an empirical question that can be evaluated by examination of key outcomes.

CBP data on average and maximum waiting time can be used in conjunction with numbers of flights, passengers, or primary inspection booths open to develop metrics to characterize the intensity of demand for passport inspection services (i.e., the number of passengers requiring inspection per booth open) and the efficiency with which that demand is met (i.e., the average amount of time it takes to process one person per available booth). These variables exhibit a great deal of variation along a number of dimensions, including airport, date (especially month and day of the week), and time of flight arrival. We first explore the extent of this variability by developing and presenting a series of summary metrics for Washington Dulles International Airport (IAD). We then discuss these metrics for several other U.S. international airports, including Baltimore/Washington International Thurgood Marshall Airport (BWI), Fort Lauderdale–Hollywood International Airport (FLL), Chicago O'Hare International Airport (ORD), Dallas/Fort Worth International Airport (DFW), and Miami International Airport (MIA). We conclude with a review of evidence for the John F. Kennedy International Airport (JFK) that more intensively analyzes variability in average and maximum wait times and CBP-OFO resource allocation.

We identify and evaluate a range of metrics that can be used to characterize various aspects of passport inspection throughput and efficiency. We begin with a review of these metrics for IAD in FY 2013:

1. **Number of International Flights Arriving.** CBP data on the number of arriving international flights provide a first-level overview of the extent to which current flight arrivals are widely distributed or tightly bunched across the over the working hours of the airport. Figure 3-1 shows that the largest numbers of international arrivals at IAD occur in the two hour blocks between 3 and 5 PM. This window represents the peak demand on passport inspection capacity.

2. **Number of NIM Passenger Arrivals per Hour.** CBP data also include counts of total passenger arrivals, and non-U.S.-resident (NIM) passengers specifically. Figure 3-2 shows that this metric of intake processing demand exhibits more variability over time than do flight counts, because a varying percentage of the seats (the "load factor") are occupied on each arrival of a regularly scheduled flight. In addition, the proportion of passengers who are foreign nationals may vary from flight to flight.

3. **Average Wait Time by Hour of Arrival.** Average wait time is a key variable for evaluating intake processing performance. It can be expected to increase at times with more passenger arrivals because the level of CBP passport inspection services available may not be perfectly elastic. Figure 3-3 shows average wait time for NIM passengers during hours of the day. This figure shows that CBP is able to successfully smooth the average

wait time in the face of large variation in the number of flight arrivals and passengers to be processed. However, a more critical concern is that there is substantial variation across hours in the average wait time experienced, particularly during the peak arrival periods. Figure 3-4 compiles the actual hourly average wait times for NIM passengers by hour block in FY 2013 (the darker the circle in a given spot in the graph, the more number of times that average wait time value occurred in that hour on that day of the week in FY 2013.) As Figure 3-4 shows, atypically long average wait times occur intermittently during hour blocks with peak and relatively modest levels of demand.

4. **Number of Primary Booths Open by Hour of Arrival.** The data presented in Figure 3-3 show that the increase in IAD average waiting time observed for the heaviest arrival window (3-5 PM) is proportionally much smaller than the increase in passengers reported in Figure 3-2. Figure 3-5 shows the number of primary inspection booths open by hour in FY 2013.[22] These data show that CBP is able to open a significant number of additional primary inspection booths during these hours. However, there is significant variation in the number of booths open on any particular day during each hour interval.

5. **Average and Maximum Wait Time by Number of Booths Open.** Figure 3-6 shows that average and maximum wait time does rise with the number of booths open, suggesting that there are limits on CBP capability to expand processing capacity during peak arrival periods.

6. **Number of Booths Open by Day of Week.**, Figure 3-7 shows that the wide range of variation in the number of booths open does not seem to vary systematically by the day of the week, a pattern which might be evident if there are a substantial number of international arrivals of non-daily flights that are clustered on particular days (e.g., Mondays or Fridays).

These results for IAD suggest that CBP has been able to responsively and efficiently allocate processing resources to mitigate the potential impact of higher passenger arrival volumes during specific hour blocks on average waiting times at Dulles. As a result, the typical average wait time has been greatly smoothed across hours of the day and days of the week in the face of large fluctuations in arriving flights and passenger loads that must be processed. In spite of this successful smoothing, there does continue to be significant variability in the average wait time experienced by passengers arriving during both peak and off-peak hour blocks.

Evaluation of the same metrics for the BWI and FLL airports show that the conclusions for IAD hold for these airports as well. BWI and FLL process a significantly smaller number of international flights that IAD. However, IAD is itself significantly smaller in comparison with Chicago O'Hare (ORD), and evaluation of metrics for this airport shows that passenger volumes can overwhelm existing CBP-OFO processing capacities in peak hours in spite of CBP-OFO's

[22] Darker circles in a given spot in the graph indicate that there were more times that this specific number of booths were open during that hour block on that day of the week in FY 2013.

efforts to respond to those higher passenger volumes. International flight and passenger arrivals at ORD are characterized by a large peak during the hour blocks between 1 PM and 6 PM, and average and maximum wait times are significantly higher during these hour blocks than at other times in the day, even though CBP-OFO doubles the number of booths open in this period. In the case of ORD, even though CBP-OFO is efficiently adjusting its resources over the course of the day, passenger volumes reach a level where they overwhelm the available resources, no matter how efficiently they are allocated.

It is also worthwhile to evaluate these metrics for the Dallas/Fort Worth International Airport (DFW) and the Miami International Airport (MIA), because these airports were mentioned prominently in a recent report on problems with wait time and the passport and customs inspection process.[23] Flight arrivals at DFW display early morning and midday peaks. Average NIM wait time is smoothed to some extent across hours of the day, but it does rise during the two flight-arrival peaks. As in the case of IAD, average NIM and maximum wait time both rise with the number of booths open. The metrics for DFW suggest that CBP-OFO is able to smooth wait times significantly, but to a lesser degree than in the case of IAD.

The picture is somewhat different for MIA. The numbers of flight arrivals at MIA are high and stable in the hour blocks between 8 AM to 5 PM but with a very sharp spike at 4 PM. Average and maximum wait time levels are generally high but smoothed over the course of the day, with some increase during 3-4 AM and 9-10 AM hour blocks. Unlike IAD and ORD, average NIM and maximum wait time do not show any tendency to rise with the number of booths open. Thus, although average and maximum wait times tend to be high at MIA, the degree of wait time smoothing is quite significant and possibly greater than the level of smoothing achieved at IAD, ORD, and DFW.

[23] See U.S. Travel Association (2013). This report's findings on deterrence of international travel to the United States due to the passport and customs inspection process is discussed more extensively in chapter 3. To illustrate how CBP-OFO has mismanaged allocation of resources to this process, the report cited observations of a journalist on what was seen at DFW during a trip, and a formal complaint by MIA to CBP-OFO about lack of staffing of passport inspection booths on a day in March 2013 that caused long wait lines and a substantial number of missed flight connections.

Figure 3-1
International Flight Arrivals by Hour in FY 2013: IAD

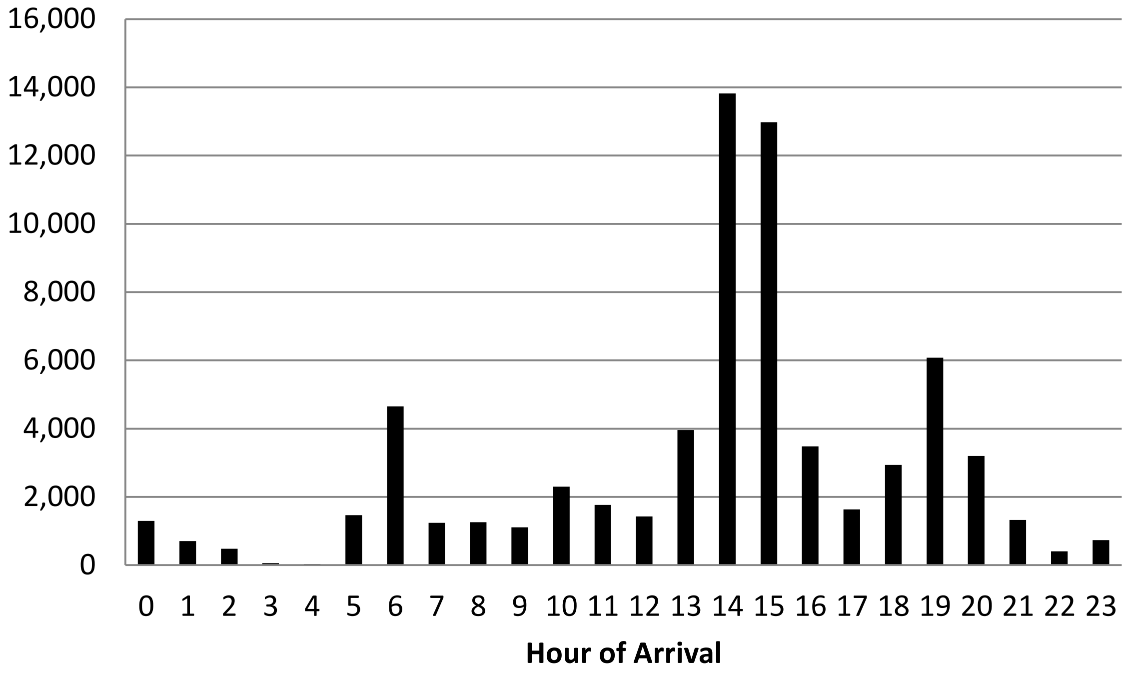
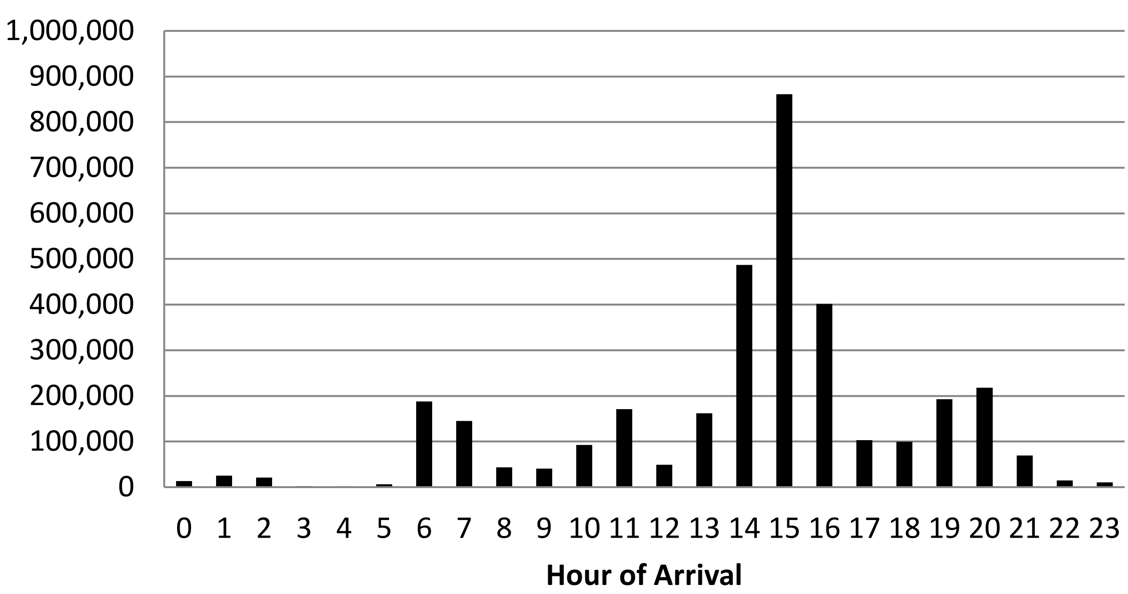


Figure 3-2
Average Number of NIM Passengers Processed by Hour in FY 2013: IAD



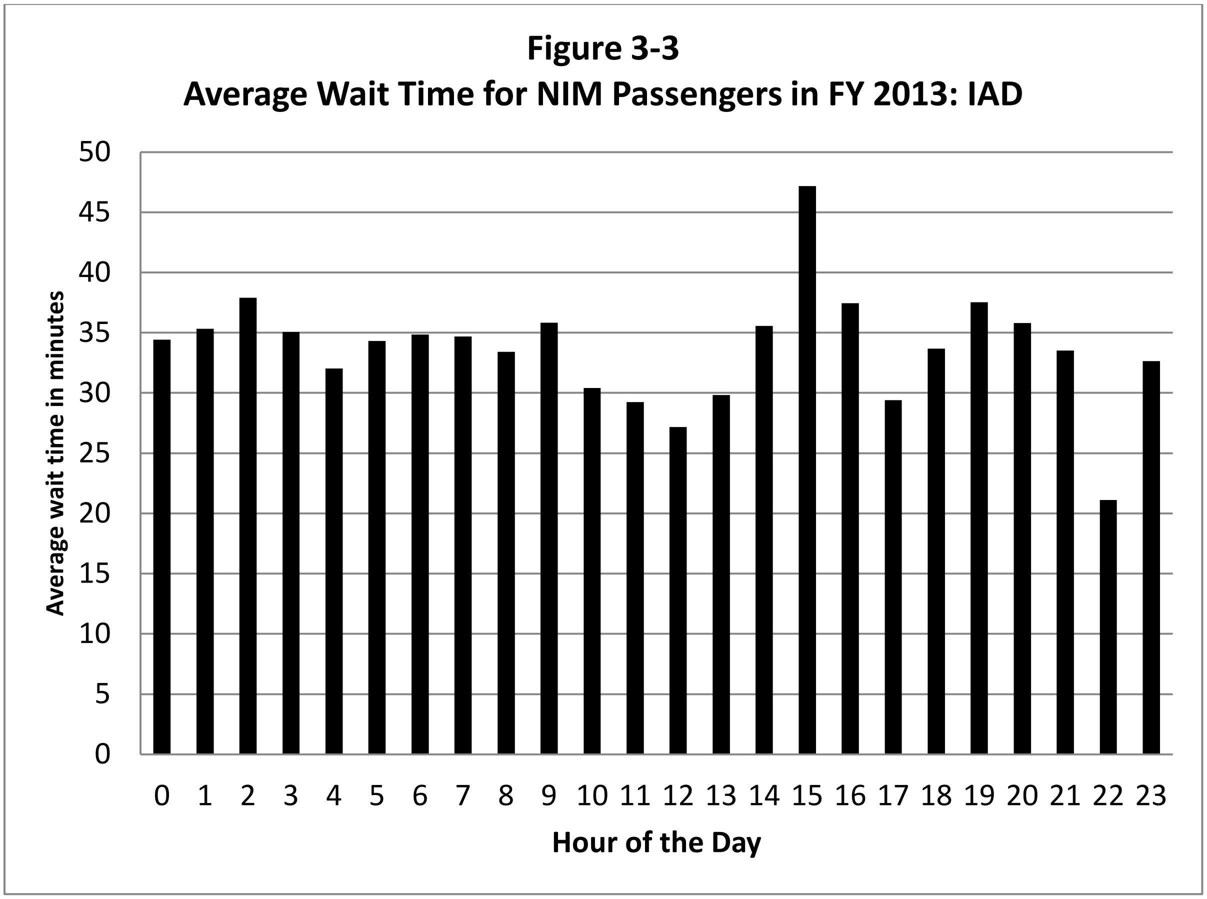


Figure 3-3
Average Wait Time for NIM Passengers in FY 2013: IAD
Average wait time in minutes
0
5
10
15
20
25
30
35
40
45
50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour of the Day

Figure 3-4

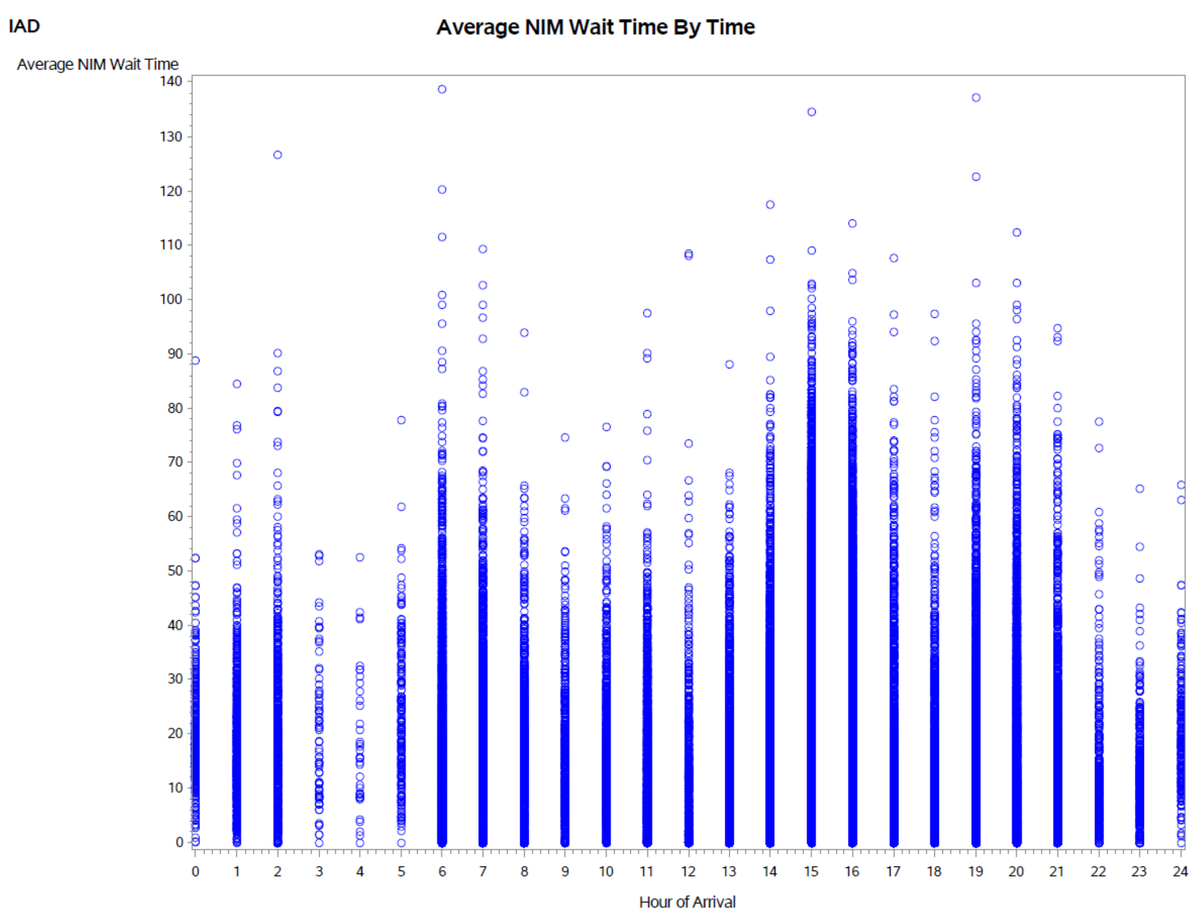

IAD
Average NIM Wait Time By Time
Average NIM Wait Time
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Arrival

Figure 3-5

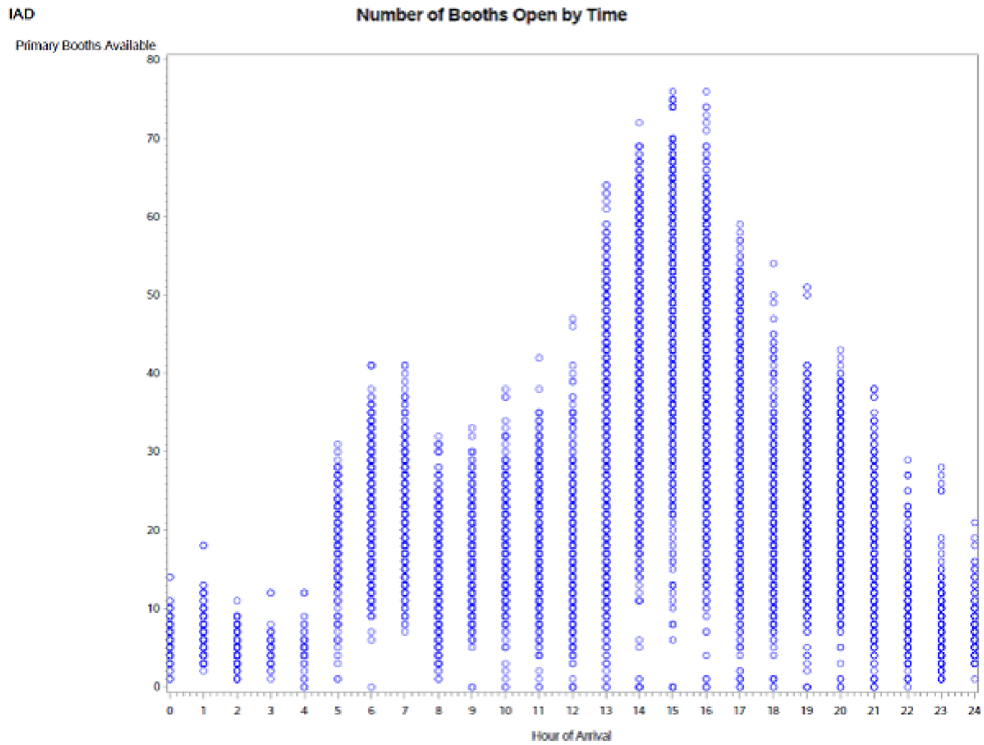


Figure 3-6
Average and Maximum Wait Time and Booths Open: IAD

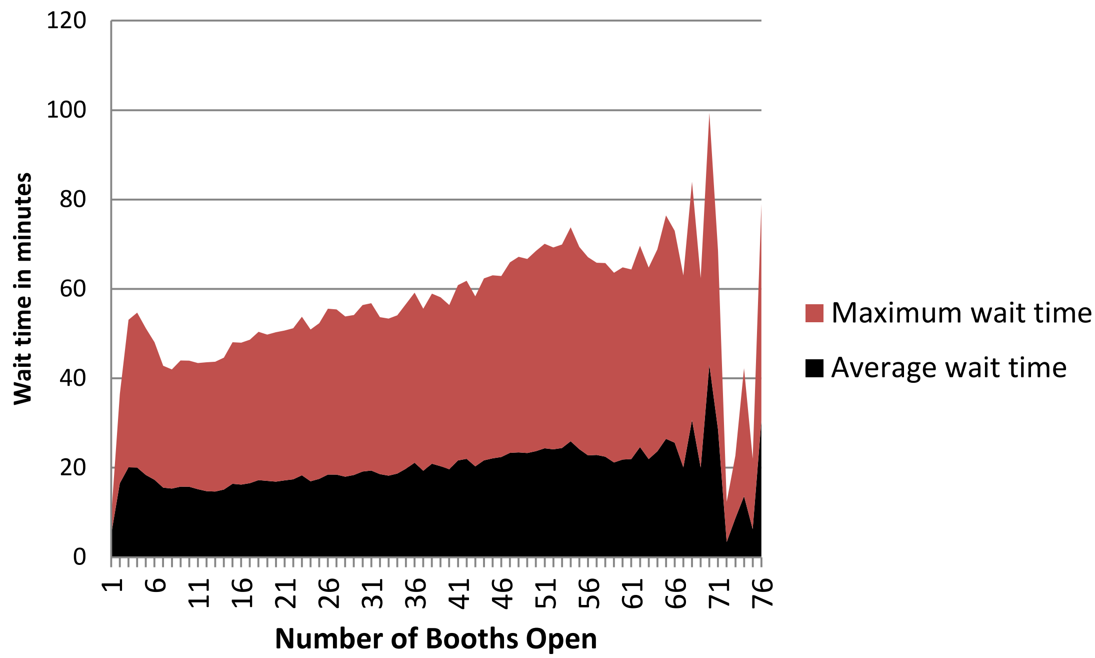
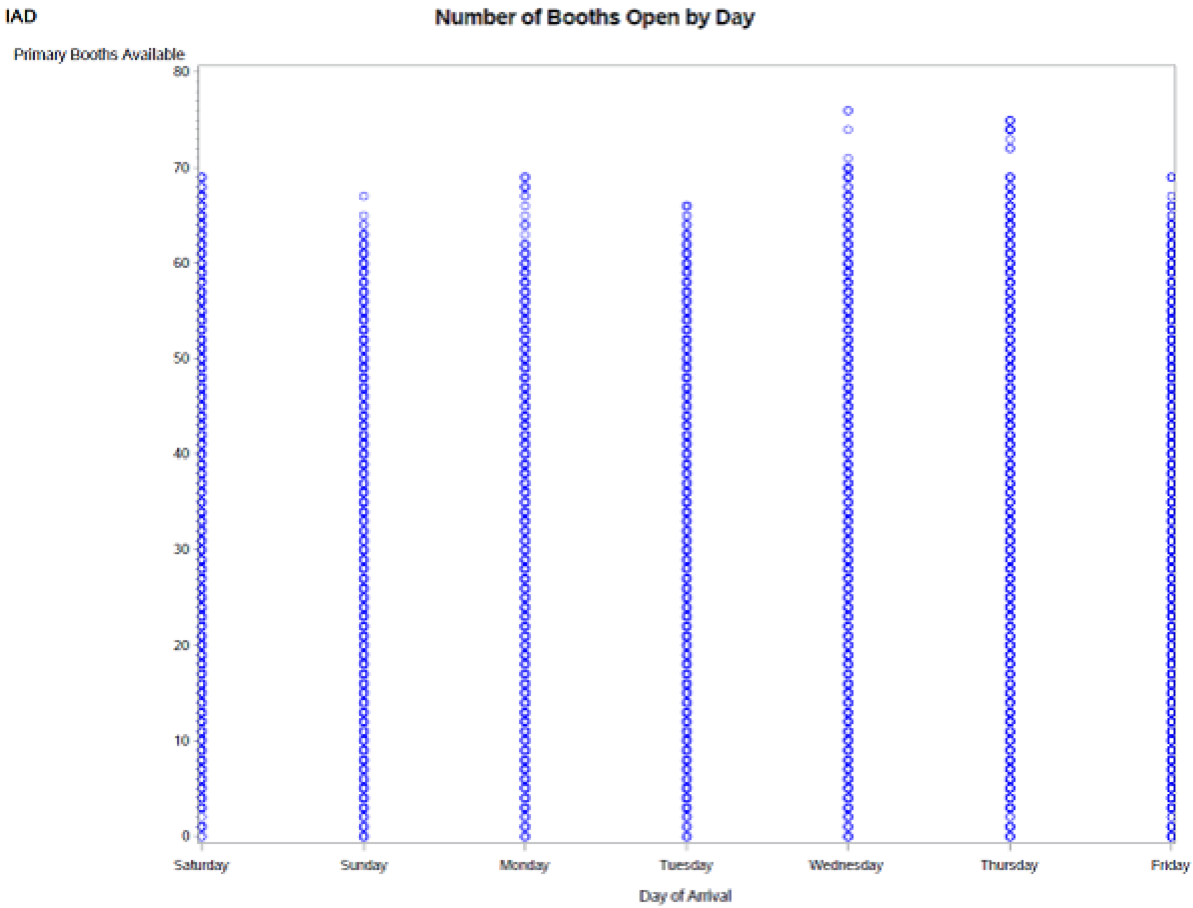


Figure 3-7



3.3. The Relationship Between Arriving Passenger Volume and Average Waiting Time: A Case Study Using JFK Data for 2012

The metrics developed and presented in the previous section indicate that there is a wide degree of variation in the average wait time (AWT) and maximum wait time (MWT) for passport inspection for flights arriving at the same hour block on different days. Consistent with the USTA critique, one possible explanation for this variability is that CBP lacks the flexibility to adjust staffing (measured by available booths) adequately in response to changes in the volume of arriving passengers. The relationship between arriving passenger volume and waiting time can be investigated using detailed data obtained by querying the online CBP passport wait time database.

For this preliminary analysis, we used 2012 passport wait time data for JFK International Airport in the New York metropolitan area. In addition to having one of the largest volumes of international arrivals of any large hub airport in the United States, JFK has five separate terminals which handle incoming international flights, which provides a large pool of flight delay and airport wait time data for each day and arrival hour block. Data on the numbers of flights, passengers, primary inspection booths, AWT and MWT were available for more than 24,000 specific terminal/day/arrival hour blocks during 2012 at these five terminals. Summary statistics are provided in Table 3-1.

Table 3-1

2012 JFK Flight, Passenger, Booth, and Wait Time Statistics by Terminal

Terminal/ Carrier	Flights	Passengers	Booths	PPB*	AWT (minutes)**	MWT (minutes)**
American	11,827	2,207,719	82,678	26.7	26.2	57.5
British	5,602	1,294,073	51,166	25.3	24.6	51.2
Delta	6,216	1,211,597	39,072	31.0	25.9	55.5
Terminal 1	10,456	2,403,743	101,150	23.8	29.4	61.8
Terminal 4	27,688	5,097,381	199,704	25.5	28.0	61.2
JFK Total	**61,789**	**12,214,513**	**473,770**	**25.8**	**27.2**	**58.4**

*Passengers per booth per hour.

**Average for individual block hours.

The statistics in Table 3-1 indicate that there is some variation in average AWT and MWT for passengers arriving in different terminals. Arrivals to Terminals 1 and 4 includes those arriving on all non-U.S. carriers, with the exception of British Airways, so this variation may be attributable to higher shares of NIM passengers being processed at these two passport inspection locations.[24]

Additional evidence on CBP allocation efficiency is available from tabulations of average AWT and MWT by the hour block of flight arrival. These data are presented in Table 3-2.

Average AWT is highest for the early morning arrivals in the two hour blocks from 5 to 7 AM, and to a lesser extent, during the mid-day period from noon to 2 PM. However, these higher-than-average wait times are only partially explained by increases in arriving passenger volume relative to the number of primary passport inspection booths open (passengers per booth, or PPB). The extent of flexibility in staffing is actually quite striking, with CPB able to ramp up the number of booths dramatically from 5 to 7 AM and again from noon to 1 PM on a typical day.

[24]The CBP AWT site (http://awt.cbp.gov/) queries do not provide separate data for USC+LPR and NIM arrivals.

Table 3-2

2012 JFK Flight, Passenger, Booth, and Wait Time Statistics by Hour Block of Arrival

Terminal/ Carrier	Flights	Passengers	Booths	PPB*	AWT (minutes)**	MWT (minutes)**
0:00-1:00	972	145,533	5,736	25.4	26.3	53.0
1:00-2:00	476	62,712	3,743	16.8	18.7	35.1
2:00-3:00	302	38,489	2,542	15.1	19.0	36.7
3:00-4:00	103	13,149	786	16.7	24.4	49.4
4:00-5:00	501	83,095	4,668	17.8	27.7	59.8
5:00-6:00	1,857	349,659	11,305	30.9	39.8	88.4
6:00-7:00	3,352	665,102	21,082	31.5	35.8	76.9
7:00-8:00	1,639	307,917	16,351	18.8	30.2	58.2
8:00-9:00	920	178,025	10,322	17.2	27.3	54.2
9:00-10:00	873	173,846	11,225	15.5	23.6	46.7
10:00-11:00	1,384	316,999	16,263	19.5	24.9	49.6
11:00-12:00	2,202	495,909	20,687	24.0	27.9	60.7
12:00-13:00	5,020	1,049,136	34,403	30.5	31.0	67.9
13:00-14:00	5,190	1,063,672	37,155	28.6	33.2	71.3
14:00-15:00	4,116	898,448	34,998	25.7	30.3	65.4
15:00-16:00	5,203	1,132,190	37,902	29.9	29.5	65.2
16:00-17:00	5,661	1,189,515	37,514	31.7	29.0	65.6
17:00-18:00	3,896	755,538	32,485	23.3	25.6	54.6
18:00-19:00	3,355	620,639	28,364	21.9	20.8	45.4
19:00-20:00	4,241	833,477	29,047	28.7	23.8	54.1
20:00-21:00	3,802	679,405	26,177	26.0	24.4	53.8
21:00-22:00	2,828	511,020	21,341	23.9	22.7	48.3
22:00-23:00	2,677	460,324	18,898	24.4	19.9	43.8
23:00-24:00	1,219	190,714	10,776	17.7	20.2	43.5

Alternatively, it is possible that CBP may do a poor job of accommodating typically high volumes of arriving passengers, relative to the numbers of booths open, during specific terminal/date/hour (TDH) block windows. One way to test for CBP efficiency in responding to transient surges in volume is to examine the relationship between the number of arriving passengers (i.e. demand for passport inspection services) per booth (the supply of inspection service resources), measured by PPB, and the performance achieved, measured by the AWT and MWT recorded for the same hour block. Specifically, efficiency can be measured as AWT or MWT for a specific block divided by PPB for the same block. The average values of AWT/PPB and MWT/PPB for JFK TDH blocks in 2012 were 1.1 and 2.3, respectively.

The specific test used was to determine what share of the hour blocks with atypically high strain on inspection resources (measured as a PPB value more than one standard deviation above the mean) were also characterized by atypically high wait times relative to the resources available (measured as AWT/PPB or MWT/PPB values with natural logarithms more than one standard deviation above the mean).[25] The results of this test are presented in Table 3-3.

Table 3-3

Relationship Between High Demand and Low Throughput Hour Blocks

Hours Blocks with:	Threshold Value	Number of Hour Blocks	Percent of Total Blocks
High PPB Values	39.1	3,544	14.7%
High AWT/PPB	1.9	3,642	15.1%
High MWT/PPB	3.7	3,588	14.8%
High PPB AND high AWT/PPB OR high MWT/PPB	--	26	0.1%

Table 3-3 shows that about 15 percent of the TDH blocks for JFK in 2012 were characterized by arriving passenger volumes of 39.1 or higher per open booth. Similarly, about 15 percent of the hour blocks for the year were characterized by atypically slow processing throughput, measured as an AWT/PPB of 1.9 minutes or more or a MWT/PPB of 3.7 minutes or more. What is striking about these results is that these two conditions—high demand relative to the number of open booths and slow processing throughput—are almost completely uncorrelated. Thus, allocating more CBP resources to the hour blocks with the highest volumes of passengers per open booth would have had a negligible effect, if any, on reducing wait times for passengers who arrived during periods where processing throughput was slower than usual.

These results suggest that other factors, rather than CBP allocation of resources, account for variations in processing throughput that result in atypically long wait times, relative to the AWT and MWT that would be expected given the volume of arriving passengers and the numbers of inspection booths open.

REFERENCES

U.S. Travel Association (2013). *Gateway to Jobs and Growth*.

[25] The distributions of natural logarithms for each of these two metrics are normally distributed.

Chapter 4: Impact of Passport Inspection Wait Time on International Air Travel to and From the U.S.

Bryan Roberts, Charles Baschnagel, and Timothy Beggs

4.1. Chapter Summary

We evaluate in this chapter the total value of time waited by U.S.- and non-U.S.-resident passengers in passport inspection queues at U.S. international airports in 2012, how the value of this time changes with the addition of a CBP-OFO inspection officer at inspection sites at 4 airports, and how the volume of passenger traffic changes if wait time falls. Key conclusions of the chapter are:

- The total value of time waited in passport inspection queues in FY 2012 was $1.3 billion, and the time waited above 30 minutes per passenger was $517 million. These two values are upper and lower bounds, respectively, to the “true” value of time that passengers had to wait in these queues, which should capture the value of time that the passengers could have used for other purposes. If it is assumed that baggage delivery takes on average 30 minutes, then for any wait in a passport inspection queue of 30 minutes or less, lowering this wait time simply redistributes waiting from the passport inspection queue to waiting for baggage delivery. This redistribution may increase passenger welfare, but we have no credible way to quantify this.
- We evaluate how adding a CBP-OFO passport inspection officer to inspection sites at 4 U.S. international airports lowers average wait time in FY 2012. The monetary value of time saved ranges from $0.3 to $3.3 million if all wait time counts, with an average inspection site impact of $1.2 million. If only wait time above 30 minutes counts, an extra officer produces wait time savings of $0.1 to $1.2 million, with an average impact of $0.6 million.
- In addition to saving time for existing passenger traffic, lowering wait time could cause demand for international travel to and from the U.S. to rise. We evaluate this demand shift using three different sets of data and methodologies.
    - First, we evaluate whether passenger counts on international flight segments changed during FY 2010-2013 if passport inspection wait time was unusually high or low for that segment in the recent past. This approach tests whether passengers who are committed to flying to the U.S. on a particular flight segment adjust their departure time in response to wait time. We found no evidence of a significant response.
    - Second, we evaluate answers to a question asked of international travelers to the U.S. in the 2012 Survey of International Air Travelers: Do you plan to visit the U.S. again, and, if not, what is the reason for that decision. A small number of survey respondents indicated that they did not intend to return to the U.S.

(3.6%), and of these, 6-12% gave a complaint about their interaction with DHS (CBP-OFO) as their reason. Thus, 0.2-0.4% of all foreign visitors surveyed in 2012 indicated that they would not return to the U.S. due to complaints about DHS. Finally, we evaluate the impact of passport inspection wait as a component of the opportunity cost associated with making an international air trip to or from the U.S. The change in wait time brought about by adding an officer to an inspection site is combined with an estimate of the price elasticity of demand for international air travel to yield an estimate of how the number of travelers changes. We find that the change in both U.S.-and non-U.S.-resident passenger flows is quite small in the context of overall passenger flows, but slightly above zero. We also quantify the change in passenger flows that would result from reducing average wait time by 50% and 100% (eliminating this wait entirely) under this methodology.

- Our results are quite small in comparison to the results of a recent study done by the U.S. Travel Association, which finds that 9.6 million potential foreign travelers to the U.S. were deterred from coming to the U.S. by passport inspection waits. We review the USTA estimates to evaluate why they are so large in comparison. Although we believe that the evidence that we develop in this chapter suggests that passport and customs wait times have a small impact on travel decisions, to the degree that one regards the entry process as having a much greater impact on travel, our estimates should be regarded as a conservative lower bound.

4.2. The Value of Time Spent In Passport Inspection Wait Queues

The value of time spent in passport inspection wait queues in FY 2012 can be calculated by multiplying the total number of hours spent by different passenger types (USC, LPR, and NIM) in wait queues by the value of an hour waited. For each of the 24 U.S. international airports for which we have international flight data, we first determine how many arriving passengers by type in FY 2012 were traveling for leisure or business purposes.[26] We then value this time using monetary values of an hour spent in border crossing queues for leisure and business passengers that were developed in Roberts et al. (2013) and are based on methodologies recommended by U.S. Department of Transportation (2011) and Robinson (2007).

Estimates are developed for two cases that are related to a key issue discussed in chapter 2. First, we assume that all waiting in a passport inspection queue should count towards the welfare cost of a passenger's clearing an arrival airport. Second, we assume that only time spent in an inspection queue that actually increases the time to achieve entry should count towards this welfare cost. If a passenger with checked luggage clears an inspection queue but

[26] For U.S. residents traveling by air to foreign countries, the leisure/business purpose of trip breakdown is given for 15 airports in Office of Travel and Tourism Industries (2013a), and for foreign residents traveling by air to the U.S., for 15 airports in Office of Travel and Tourism Industries (2013b). For other airports, assumptions on this breakdown are made based on patterns in the available data for this breakdown.

then has to wait for their luggage, then the determinant of how long it takes that passenger to enter the country is the baggage delivery time, not the passport inspection time. In this case, lowering the passport inspection wait time only serves to redistribute where the passenger waits, not the total amount of time waited. There may be a differential in the monetized value of waiting in a passport inspection queue as opposed in a baggage delivery area. For example, the disutility of waiting in a passport inspection queue might be higher than the disutility of waiting in the baggage delivery area. However, because we have no measure of the difference between these monetized disutilities, we are unable to value the change in welfare that might result from redistribution of where a passenger waits. To be conservative, we assume that the difference is zero. Our two cases are thus an upper bound (all time counts) and lower bound (only time that adds to total time to enter the U.S. counts) to the monetary value of time spent in these queues that should be used to evaluate the disutility of waiting and the benefits of lowering these wait times.

To estimate the second case, we assume a standard baggage delivery time of 30 minutes across all international flights arriving in the U.S. in FY 2012. No data on actual baggage delivery time is available. This data is not collected by CBP but is kept by airlines. An important task for future research is to match airline data on baggage delivery time to CBP data on passport inspection wait time for specific flights. One justification that could be appealed to for using a 30-minute baggage delivery standard is that existing analysis of passport inspection wait time recommends that wait time never exceed a 30-minute maximum for any passenger.[27] However, it is not clear that baggage delivery typically takes 30 minutes. Greater insight is also needed into whether baggage delivery for international flights arriving at U.S. airports is synchronized with the movement of passengers through passport inspection. To the extent that average baggage delivery time is less than 30 minutes, or could be less than 30 minutes if it is synchronized with passenger movement, the approach we follow below underestimates the amount of time that should be taken into account in evaluating the welfare impacts of passport inspection queues.

We use data on the time waited in passport inspection queues at the individual level for all passengers processed at 14 inspection sites in 4 airports for FY 2012 to determine the percentage of passengers who waited more than 30 minutes.[28] Figure 4-1 shows these percentages for the three types of passenger for these 14 sites. We assume that the average across these sites holds for the other 20 airports. Passengers arriving at airports with no checked luggage should not be subject to this 30-minute baggage delivery standard, as all of the time waited by these passengers in passport inspection queues increases their time to enter. Data on the percentage of U.S. and foreign resident passengers on international flights in

[27] See, for example, U.S. Travel Association (2013).

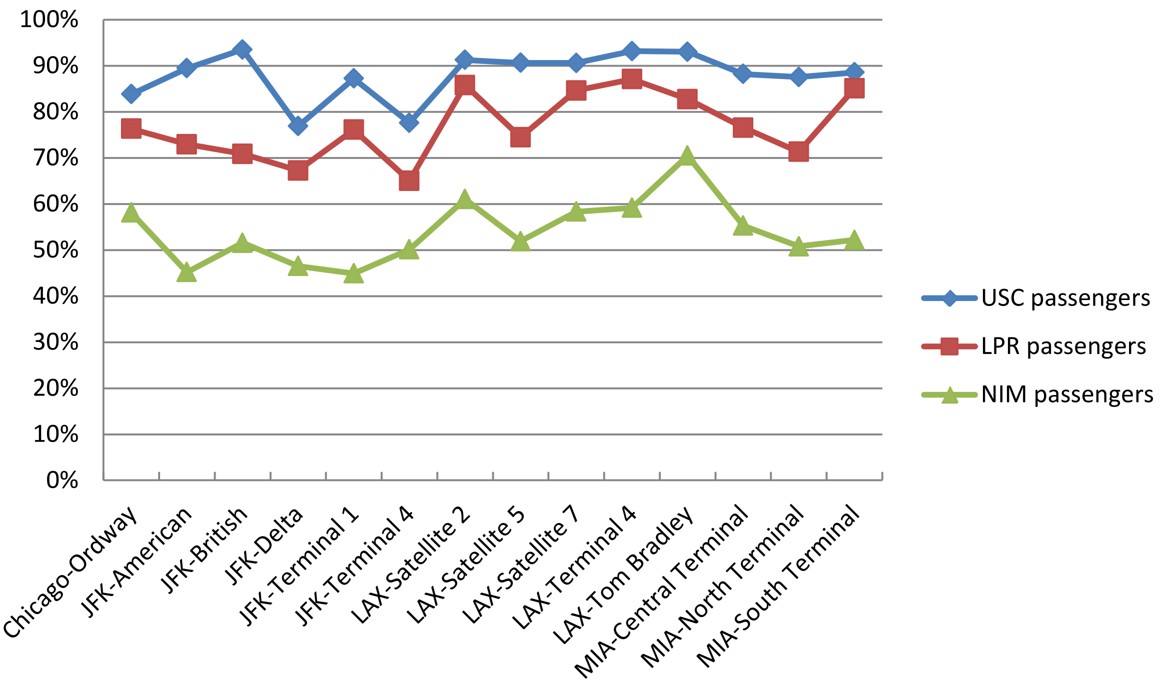
[28] The four airports are Chicago O'Hare International Airport (ORD), John F. Kennedy International Airport (JFK), Los Angeles International Airport (LAX), and Miami International Airport (MIA). These airports were studied in Roberts et al. (2013) and will be the focal point of study later in this chapter.

2012 who did not check any luggage are available for the John F. Kennedy and Newark International Airports and are assumed to hold across all 24 airports studied here.[29]

Table 4-1 summarizes the value of time waited by specific passenger group and in total in FY 2012 for the two cases. The value of time spent in passport inspection queues in the 24 airports ranges from a lower bound of roughly $500 million to an upper bound of roughly $1.3 billion.

To perform this adjustment we needed estimates on the number of international travelers who did not have any checked baggage. We obtained data from the Port Authority of New York and New Jersey (PANYJY) Annual Spring Terminal-By-Terminal Customer Satisfaction Study to estimate the number of international travelers who checked bags. Data from 2012 and 2013 on the number of international travelers who did not check any luggage broken down by U.S. or foreign residence and reason for travel was generous made available to us by the PANYJY.

Figure 4-1
Percentage of Passengers Experiencing Waits of 30 Minutes or Less At 14 Terminal Inspection Sites in FY 2012



[29] We would like to thank the Port Authority of New York and New Jersey for providing us with data from their 2012 and 2013 Annual Spring Terminal-By-Terminal Customer Satisfaction Studies. This data shows that for U.S. residents, 12.4% of leisure travelers and 21.1% of business traveler departing from JFK and Newark did not check any baggage. For international residents, 6.3% of leisure travelers and 12.0% of business traveler departing from JFK and Newark did not check any baggage. These percentages are applied to all U.S. international airports to calculate estimates. They may not be reflective of passengers at international airports other than JFK and Newark International, but no data on other airports is available.

Table 4-1

Total Value of Time Waited in Passport Inspection Queues at 24 Airports in FY 2012

Million $US	All time counts	Only time above 30-minute standard counts
U.S. Residents: Leisure	$388	$101
U.S. Residents: Business	$162	$52
Foreign Residents: Leisure	$488	$248
Foreign Residents: Business	$221	$116
TOTAL	**$1,260**	**$517**

4.3. Does Passport Inspection Impact Travel Decisions?

In the Roberts et al. (2013) study, the impact on the number of cross-border trips of lower inspection wait time was quantified for passenger vehicles at land border crossings. However, this impact was not quantified for air passengers, and the elasticity of trip demand with respect to inspection wait time was assumed to be zero. Change in passport inspection wait time might have an impact on trip demand, because the total cost to a traveler to making an international air trip to or from the U.S. changes with wait time. Passport inspection waits potentially deter air travelers from coming to the U.S. because of an intrinsic dislike of spending time in wait queues, and because a higher wait time increases the chance of a missing a plane connection for those having to make a connection at an U.S. arrival airport.

We evaluate the impact of passport inspection wait time on travel decisions using three different methodologies and data sets. First, we evaluate if change in passport inspection wait time causes travelers who are committed to flying to the U.S. to change their flight decision to avoid inspection sites where wait time might be perceived to be unusually high. Second, we examine evidence from the Survey of International Air Travelers on the degree to which foreign visitors say that they will not return to the U.S. because of complaints about DHS procedures. Third, we treat passport inspection wait time as a component of the total opportunity cost of making an international air trip to or from the U.S., and we quantify how change in this opportunity cost induces change in the number of foreign visitors to the U.S., and U.S. residents traveling abroad.

4.4. International Air Flight Passenger Counts and Passport Inspection Wait Time

The CBP-OFO data on international air flights arriving at U.S. airports provides the opportunity to evaluate if unusually high or low passport inspection wait times causes travelers who are committed to coming to the U.S. to change their travel plans. We focus on how passenger counts change on a particular flight segment (pair of origin and destination cities) in response to wait time. In particular, we evaluate whether travelers substitute between flights on a segment arriving at different times of the day due to unusually high or low expected wait times at certain hours of the day. We are not evaluating under this approach the degree to which travelers decided to not come to or leave the U.S. Rather, we are evaluating the degree to which passenger counts on regularly scheduled flights for a flight segment change in response to unusually high or low wait times during set hour blocks.

During FY 2010-2013 there were 990 active flight segments with an international departure and a domestic arrival. We first choose which of these segments to include in our analysis using the criterion that for a given segment, there must be an adequate level of choice among flights arriving at different times of the day for that segment. We selected 74 segments for which 90 flights or more arrived in the U.S. in the average month during 2010-2013, or 3 flights in the average day.

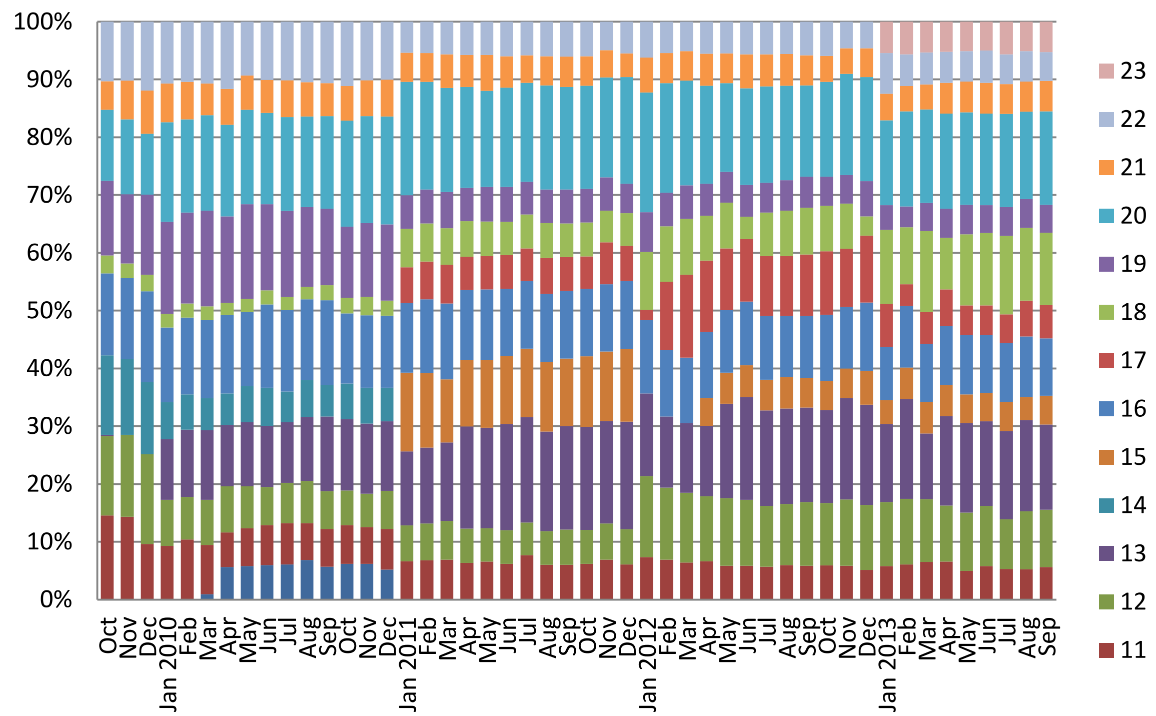
For these segments, a simple way to carry out the analysis would be to relate the total numbers of passengers choosing to fly on this segment at a particular time of day to the level of passport inspection wait times that prevailed in the past at that time of day. If wait time at a particular time of day was unusually high in a given month for a flight segment, one would expect that passengers who know this and are committed to flying on this segment in future might choose to fly at a different time of day in order to avoid an expected long wait. However, this simple approach would yield misleading results, because passengers might be committed or have a preference to arriving at a certain time of day. This preference, which is likely to be driven by reasons unrelated to wait time, may already be taking into account the possibility that wait time (and perhaps price) is higher than during other time blocks. Thus, relating levels of passengers to levels of wait time would likely show a positive relationship driven by congestion caused by time of day preferences, not a negative one driven by a preference for shorter wait times. We thus must analyze the relationship of deviations in passenger counts for a particular segment in a particular hour block of the day from its “steady stage” level to lagged deviations of wait time in that hour block of the day from its “steady state” level.[30]

The number of passengers arriving at a particular time of day on a flight segment might be influenced by variables other than expected passport inspection wait time. One important factor that we must control for is change in the scheduled number of flights arriving at a particular time of day, which results from airline decisions about their optimal flight schedule. Change in an hour block’s flight share might induce a change in passenger share that might then cause wait time to change, and this would induce a spurious correlation between deviations in passenger share and wait time. In order to control for change in the number of flights, for each

[30] By controlling for the prior period’s passenger share and the prior period’s expected wait time, we control for expected congestion due to preferences and other factors not related to wait time.

of the 74 segments included in our analysis, we identify blocks of hours for which the share of flights was stable. For each segment, we examine the percentages of flights arriving in given hours of the day in each month during FY 2010-2013 and identify hour blocks during which flight shares are reasonably stable. For example, for the London Heathrow-to-JFK flight segment, we identify stable hour-block shares in total monthly flights through inspection of figure 4-2, which suggests that the hour blocks 10 am-12 noon, 1-4 pm, 5-7 pm, and 8-11 pm accounted for stable shares in total monthly flights over the entire time period. We carried out this exercise for the other 73 flight segments and identified stable hour-block flight shares.[31]

Figure 4-2
Shares of Hours in Total Daily Number of Flights:
LHRJFK Flight Segment



[31] In some instances, a small change in a flight's arrival time caused the flight to move from one hour to another. In these cases, we grouped the hours together in order to avoid redefining our choice set and losing observations. If flight schedules went for a segment underwent a truly fundamental shift such that there is no continuity between the pre- and post-shift time periods, we treat the two periods as separate series. If consistent hour blocks could not be identified for the segment, it was dropped from the analysis. If a segment contains a highly unstable period, this period was dropped from the analysis. Such corrections occurred rarely, and for most segments, it was straightforward to identify stable flight-share hour blocks. We finally note that we dropped the earliest hour block for each segment from our analysis, because of concern over the interrelatedness of hour block outcomes for a segment. For example, if a segment has three identified hour blocks, and the flight share of one block rose by 5% and the share of a second block fell by 3%, then the share of the third hour block would have to fall by 2%. To recognize this restriction, the earliest hour block from each segment is dropped so as to more accurately represent the degrees of freedom in the model.

We relate the deviation of passenger share in the current month from the prior month's share for a particular hour block and given segment to lagged deviations in expected wait times. We decided upon a two-month lag based on a review of the "2012 Profile of Overseas Travelers" published by the Department of Commerce's Office of Travel and Tourism Industries.[32]We also estimate a model specification that includes a measure of the lagged change in average wait time for all other hour blocks of the same flight segment. The sign of the estimated coefficient on the hour block's own wait time deviation is expected to be negative, and the sign on the coefficient of the other hour blocks' wait time deviation is expected to be positive.

Table 4-2 presents statistical estimation results. For both specifications of the model, estimated coefficients for own hour-block expected wait time are neither statistically nor economically significant, and the overall explanatory value of the model as measured by the R-squared value is negligible. Change in expected wait times thus did not have a measurable impact on passenger demand as we have defined it here.

Table 4-2

Dependent Variable: First Difference of Deviation in Hour-Block Passenger Share		
Explanatory Variable	Model 1	Model 2
First Difference of Deviation in Own Expected Wait Time	0.0001142 (0.00029)	0.0001424 (0.00031)
First Difference of Deviation in Other Expected Wait Time		-0.0000930 (0.00034)
R-Squared	0.0000	0.0001
N	4,330	4,330

Note: standard errors are in parentheses.

If passenger demand and/or wait time changes are defined differently, statistical analysis might yield different results. One promising research avenue is to evaluate change in the total number of passengers at airports that have undergone major renovations and/or implemented programs to speed the passport inspection process. Airports that have introduced the Express Connection, One-Stop, and Global Entry programs may have experienced an increase in passenger volumes due to the processing benefits of these programs. Introduction of these programs corresponds to a natural experiment that significantly lowers wait time for participating passengers from normal levels, and study of the demand impacts of these natural experiments is an obvious future research activity. A difference-in-differences analysis could be performed to extract out the effects of macroeconomic influences over time. Such analysis would need to carefully select a control group of airports to mitigate the effects of self-selection into the program and other possible confounding variables. If properly done, however, this analysis could yield important insights into how mitigation of passport inspection wait times affects demand for international air trips through U.S. airports.

[32] This report shows that the median and average numbers of days before a trip for which U.S. travelers made their airline reservation were 45 and 66 days respectively, and the median and average number of days for overseas travelers was 40 and 65.6 respectively. A two-month lag in wait time thus seems the most appropriate as it reflects the most up-to-date information available at the time of purchase for most international travelers.

4.5. Evidence From the Survey of International Air Travelers on Deterrence of Trips to the U.S.

In 2012, the SIAT survey asked foreign residents if they expected to visit the U.S. again, and if not, the reason for this expectation. Table 4-3 summarizes responses to this question. The vast majority of respondents (96.4%) indicated that they do expect to visit the U.S. again. Of the 1,585 that said that they do not, 92 indicated that the reason is due to a complaint regarding DHS, or 6% of the 1,585. It should be noted, however, that one-half of these 1,585 did not specify a reason. If only those who gave a reason are counted, the percentage of those who responded negatively due to a complaint regarding DHS is 12%. The true percentage is thus between 6% and 12% of those not intending to return to the U.S. in future, which represents between 0.2% and 0.4% of all survey respondents.[33]

Table 4-4 gives average values for satisfaction with wait time and officer courtesy and also recalled total clearance time for those who said that they did not intend to visit the U.S. again. Those whose reason is a complaint about DHS reported much lower satisfaction with passport inspection wait time, and much higher recalled total clearance time, than those who gave other reasons. They also reported lower satisfaction with passport inspection officer courtesy and custom inspection outcomes, but differentials with values for the other groups are smaller. This suggests that dissatisfaction with long passport inspection waits is the primary concern of the respondents who say they will not return to the U.S. in future due to a complaint about DHS.[34]

Table 4-3

SIAT 2012 Responses to Question "Do you expect to visit the United States again?"	Number of responses	Percentage Breakdowns		
Total responses	***43,708***	***100.0%***		
Will visit U.S. again	**42,123**	**96.4%**		
Will not visit U.S. again	**1,585**	**3.6%**	**100%**	
Did not give reason	*787*	*1.8%*	*50%*	
Did give reason	*798*	*1.8%*	*50%*	*100%*
Complaints regarding DHS	92	0.2%	6%	12%
Too expensive	51	0.1%	3%	6%
Not enough time/too far away	32	0.1%	2%	4%
Age/too old	17	0.0%	1%	2%
Other reason	606	1.4%	38%	76%

[33] This approach implicitly assumes that the distribution of those not giving a reason would be the same as those giving a reason across reason categories.

[34] The distribution of these respondents is not unusual with respect to country of residence. The largest group was resident in the United Kingdom (23), followed by Japan (11), Taiwan (9). Germany (5), Singapore, South Korea and Switzerland (4), Mexico (3), Brazil, Sweden, China, Hong Kong, and Australia (2), and 19 countries with one respondent each.

Table 4-4

Reason for not visiting again	Passport inspection wait time	Passport officer courtesy	Customs inspection wait time	Customs officer courtesy	Recalled total clearance time
Complaints regarding DHS	1.80	2.20	2.66	2.52	93.6
Too expensive	3.16	3.38	2.98	2.76	49.8
Not enough time/too far away	3.26	3.93	3.72	3.83	44.6
Age/too old	3.44	3.88	3.56	3.57	43.4
Other reason	2.91	3.11	3.14	3.11	49.5
No reason given	3.00	3.17	3.18	3.16	48.1

4.6. An Opportunity Cost Approach to Assessing the Travel Deterrence Impacts of Passport Inspection Waits

Results from analysis of passenger counts and wait time for individual international flights and analysis of survey data suggest that wait time has a very small impact on travel decisions. The approach that we take in this study to quantify the impact of change in wait time on the number of international air trips is based on an opportunity cost approach. When considering whether or not to travel to or from the United States by air, a potential traveler will evaluate the opportunity cost of making a trip. This cost includes all monetary expenditures that the potential traveler would make on the trip, because this money could have been spent on other things. It also includes the monetized value of the time involved in making the trip, because this time could have been used for other purposes.

Table 4-5 shows all potential stages involved in an international air trip of a foreign resident to the U.S. and whether the expenditure of time and/or money potentially takes place in these stages. For some stages, there is a possibility that the potential traveler will have an additional experience that will increase the time and/or monetary cost of the trip. Two important conditional branches are connecting to another flight, which increases the time that the trip requires and creates the risk of missing a connecting flight, and undergoing secondary inspection, which increases the time that the trip requires and creates the risk of being denied entry. A potential traveler will know with certainty if they must take connecting flights. They will also evaluate the risk that they will have a mis-connect and/or undergo secondary inspection, multiply this risk by the monetary value of the consequences of that risk materializing, and incorporate this expected value into the total opportunity cost of the trip. A particularly important risk for this study is the conditional branch of the traveler making a connection to a U.S. domestic flight at the arrival international airport. The chance of experiencing a mis-connect at this stage might be increased by a high CBP-OFO passport inspection wait time. Chapter 5 reviews this issue in depth.

A table similar to table 4-5 could be developed for a U.S. resident who is considering making an international air trip to a foreign destination. Given the expected opportunity cost of an international air trip to or from the U.S., a potential traveler will evaluate their best choice in light of other activity possibilities and their expected opportunity costs, and they may or may not decide to make the trip to or from the U.S. If the expected opportunity cost of an international air trip to or from the U.S. rises, there will be some fall in demand for these trips. Ideally, we would like to estimate the demand response using changes in the total opportunity cost of a trip. Although values could be obtained or plausibly assumed for most components of table 4-5, data on how those values change over time are not available for many components. How demand for international air travel changes with price is instead evaluated by estimating how trip demand changes with respect to one component of table 4-5, the cost of a round-trip ticket (airfare). Many studies have estimated price elasticities of demand for air travel.[35]

[35]See InterVISTAS Consulting Inc. (2007) and Gillen et al. (2002) for literature reviews and discussion of issues involved in estimating these elasticities.

Table 4-5

Opportunity Cost Components: Foreign Resident Traveling to the U.S.

Stages of Potential Trip	Time Expenditure	Monetary Expenditure	Conditional Branches
Prepare for trip (planning, ticket purchase, lodging arrangements, etc.)	Yes	Maybe	
Get visa, comply with U.S. entry rules	Yes	Maybe	
Purchase air travel ticket	Yes	Airfare paid	
Get to departure airport	Yes	Maybe	
Check in at departure airport	Yes	No	
Airport security screening	Yes	No	
Get to departure gate	Yes	No	
Wait at departure gate	Yes	Maybe	
Time on plane	Yes	Maybe	
Plane lands at U.S. airport, taxis to gate	Yes	No	**Connecting flight in foreign country**
Stand in passport inspection queue	Total clearance time	No	
Passport inspection		No	**Secondary inspection**
Wait for luggage		No	
Customs inspection		Maybe	**Secondary inspection**
Exit airport		No	**Connecting flight in U.S.**
Get to hotel/home	Yes	Maybe	
Experience trip in U.S.	Yes	Hotel, food, shopping, entertainment, etc.	
Get to departure airport	Yes	Maybe	
Check in at departure airport	Yes	No	
Airport security screening	Yes	No	
Get to departure gate	Yes	No	
Wait at departure gate	Yes	Maybe	
Time on plane	Yes	Maybe	
Plane arrives at home airport, taxis to gate	Yes	No	**Connecting flight in U.S.**
Stand in passport inspection queue	Total clearance time	No	
Passport inspection		No	
Wait for luggage		No	
Customs inspection		Maybe	
Exit airport			**Connecting flight in foreign country**
Get to home	Yes	Maybe	

Table 4-6

Own-Price Elasticity of Demand Values

	Low	Point	High
Long-haul international business air travel	-0.20	-0.27	-0.48
Long-haul international leisure air travel	-0.56	-1.04	-1.70

We use the results of a meta-study by Gillen et al. (2002), who recommend the low, point, and high elasticity values for long-haul international business and leisure that are given in table 4-6.[36]

4.7. Wait Time Outcomes at Four International U.S. Airports

As in Roberts et al. (2013), we will quantify outcomes for 4 U.S. international airports: Chicago O'Hare International Airport (ORD), John F. Kennedy International Airport (JFK), Los Angeles International Airport (LAX), and Miami International Airport (MIA). Roberts et al. (2013) quantified how wait time changed at 14 inspection sites at these airports with the addition of an extra passport inspection officer using data on passengers processed and wait time outcomes for FY 2012. They then estimated how the value of time spent in passport inspection queues by existing traffic changed after the addition of an officer, and found that wait time savings ranged from $1.3 million (LAX) to $3.3 million (ORD), with an average value of $1.5 million.[37] Table 4-7 presents these impacts for each inspection site.

These results do not take into account the baggage delivery issue and whether redistribution of waiting in a passport inspection line to waiting in the baggage delivery area has any impact on passenger welfare. Following the approach developed earlier in this chapter, if we assume that a standard baggage delivery time of 30 minutes holds across all flights and that the only variable that matters for passenger welfare is the total time required to clear an airport (and not its distribution to different waiting areas), then we can adjust the estimates of saved waiting time presented in Roberts et al. (2013) to the values given in table 4-7. As previously noted, we do not have any data on baggage delivery time, and if average baggage delivery is less than 30 minutes and/or is synchronized with the movement of international passenger arrivals through passport inspection queues, a 30-minute standard will be too conservative and cause us to underestimate the true welfare impact of passport inspection queues.

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[36] Most international air travel to the U.S. is long-haul, so we will use the long-haul estimates in Gillen et al. (2013).

[37] See chapter 3 of Roberts et al. (2013) for details on the methodologies and assumptions used to develop these results. The number of distinct inspection sites at the four airports are one (ORD), three (MIA), and five (JFK and LAX.) Roberts et al. (2013) identified what inspection site at an airport yielded the greatest gains in value of saved wait time from an extra officer and assume that the officer is deployed to that site.

Table 4-7

	+1 Officer Deployed to 8 Most Congested Hours of the Day						
	Change in Average Wait Time	Change in Value of Total Wait Time (million US dollars)					
		Original Results of Roberts et al. (2013)			Results Taking Into Account Baggage Delivery		
		USC and LPR	NIM	*All Passengers*	USC and LPR	NIM	*All Passengers*
ORD	**-4.7%**	**$1.7**	**$1.6**	***$3.3***	**$0.5**	**$0.7**	***$1.2***
JFK							
American	**-5.7%**	**$0.8**	**$1.1**	***$1.9***	**$0.2**	**$0.6**	***$0.9***
British	**-7.6%**	**$0.4**	**$0.9**	***$1.3***	**$0.1**	**$0.5**	***$0.6***
Delta	**-6.4%**	**$0.9**	**$0.7**	***$1.6***	**$0.3**	**$0.4**	***$0.7***
Terminal 1	**-4.9%**	**$0.6**	**$1.6**	***$2.2***	**$0.2**	**$0.9**	***$1.1***
Terminal 4	**-3.5%**	**$1.2**	**$1.1**	***$2.3***	**$0.4**	**$0.6**	***$1.0***
LAX							
Satellite 2	**-6.6%**	**$0.5**	**$0.9**	***$1.3***	**$0.1**	**$0.4**	***$0.5***
Satellite 5	**-9.4%**	**$0.3**	**$0.5**	***$0.8***	**$0.1**	**$0.3**	***$0.3***
Satellite 7	**-9.2%**	**$0.5**	**$0.4**	***$0.9***	**$0.1**	**$0.2**	***$0.3***
Terminal 4	**-13.7%**	**$0.2**	**$0.1**	***$0.3***	**$0.0**	**$0.0**	***$0.1***
Tom Bradley	**-3.1%**	**$0.5**	**$0.8**	***$1.3***	**$0.1**	**$0.3**	***$0.4***
MIA							
Central Terminal	**-2.7%**	**$0.9**	**$1.1**	***$1.9***	**$0.2**	**$0.5**	***$0.8***
South Terminal	**-5.7%**	**$0.4**	**$1.2**	***$1.6***	**$0.1**	**$0.6**	***$0.7***
North Terminal	**-2.4%**	**$0.1**	**$0.2**	***$0.3***	**$0.0**	**$0.1**	***$0.1***

Wait time savings impacts under this assumption range from $0.5 million (LAX) to $1.2 million (ORD), with an average value of $0.6 million. These impacts are smaller but still significant. They are also more highly concentrated on NIM passengers, because non-U.S.-resident passengers experience a higher incidence of passport inspection waits longer than 30 minutes.

4.8. Change in Travel Demand at the Four Airports

Roberts et al. (2013) assume that the demand response to passport inspection wait times is zero. We now relax that assumption and assume that that demand will vary with wait time according to how change in the monetized value of wait time changes the opportunity cost of a trip and the price elasticity of demand. We assume that average wait time changes at an inspection site according to the values developed in Roberts et al. (2013), which are reproduced in table 4-7. For each terminal inspection site, we take the total number of passengers of different types (USC, LPR, and NIM) in FY 2013 and break these values down into business and leisure travelers.[38] We value the average wait time in passport inspection queues for these passenger groups using values of time for air travelers spent in border crossing queues that are developed in Roberts et al. (2013), chapter 3.[39] We then determine the value of the change in wait time brought about by addition of an extra officer. This is added to the average airfare paid by the passenger group to get a change in airfare price, and a percentage change in airfare price is then calculated.[40] The price elasticity of demand is then multiplied by the percentage change in airfare price to get a percentage change in number of trips, and this is applied to the number of passengers in the relevant group in FY 2013. A range of values are determined according to what price elasticity of demand value is used (low, point, or high) and what value of time is used (low, point, or high.)[41]

We also quantify the change in number of passengers if the average passport inspection wait time is reduced by 50%, and reduced by 100%. The latter scenario is an upper bound to how much trips to or from the U.S. will increase if passport inspection waits are eliminated completely. We do not evaluate how many extra CBP-OFO inspection officers would be required to achieve 50% and 100% reductions at each inspection site, but assume that enough officers have been deployed to achieve this.

Finally, we estimate change in the number of passengers for the +1 officer, 50% wait time reduction, and 100% reduction scenarios assuming that only passengers experiencing passport inspection waits of 30 minutes or more will be affected by the wait time reduction due to the baggage delivery issue.

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[38] We follow the approach described earlier in this chapter that is based on information in Office of Travel and Tourism Industries (2013a) and (2013b).

[39]One change made to the value of time estimates in Roberts et al. (2013) affects the value of time of non-U.S.-resident travelers. The previous study adjusted time value for U.S. residents by a per capita GDP ratio to get time value for non-U.S. residents. We use here the ratio of the median annual household income of foreign residents traveling to the U.S. by air to that of U.S. households traveling abroad by air survey (conversion factors are 86% for leisure travelers and 80% for business travelers.) These values are obtained from Office of Travel and Tourism Industries (2013a) and (2013b). This is a more appropriate conversion factor than the per capita GDP ratio capita (71%).

[40] Average airfare paid by U.S.-resident business and leisure travelers in 2012 is obtained from Office of Travel and Tourism Industries (2013a) and equals $4,149 and $2,668 respectively. Average airfare paid by foreign-resident business and leisure travelers is obtained from Office of Travel and Tourism Industries (2013b) and equals $4,767 and $3,511 respectively.

[41] In addition to developing estimates using only the value of airfare to represent the opportunity cost of a trip, we developed estimates based on establishing values for other trip opportunity cost components as outlined in table 4-5, and evaluating the impact of wait time change in the context of a more complete depiction of opportunity cost. However, this made no material difference to results, because the only price elasticity of demand that is available is for airfare, not for any broader measure of trip cost.

Results are presented in the tables below. The numbers of new passengers resulting from the +1 officer scenario are very small. Although a few hundred new passengers at an inspection site might seem significant, in the context of annual passenger flows that number in the hundreds of thousands or millions for these sites, these increases are barely above zero. Even in the 50% and 100% wait time change scenarios, increases in passengers of several thousand or a few tens of thousands represent relatively small percentage changes in the context of current passenger flows. This is consistent with the other evidence on the impact of wait time on travel decisions presented earlier in this chapter. We thus regard the changes in passenger volumes in response to change in passport inspection waits quantified here as being reasonably conservative.

+1 OFFICER : ALL WAIT TIME COUNTS													
		U.S.-Resident Passengers						**Foreign-Resident Passengers**					
		Leisure			***Business***			***Leisure***			***Business***		
		Value of Wait Time:			Value of Wait Time:			Value of Wait Time:			Value of Wait Time:		
Airpor	***Terminal***	Low	Point	High	Low	Point	High	Low	Point	High	Low	Point	High
Low Elasticity Value													
ORD		358	446	535	27	34	41	221	276	331	56	70	84
JFK	American	208	260	312	11	14	17	253	316	378	22	27	33
	British	105	131	156	6	7	8	176	220	263	15	19	23
	Delta	247	308	369	13	16	20	171	214	256	15	18	22
	Terminal 1	191	238	286	10	13	15	334	416	499	29	36	43
	Terminal 4	366	457	548	19	24	29	287	358	429	25	31	37
LAX	Satellite 2	113	141	169	9	11	13	185	231	277	22	27	33
	Satellite 5	75	93	112	6	7	9	134	168	201	16	20	24
	Satellite 7	83	104	125	6	8	10	79	98	118	9	12	14
	Terminal 4	49	61	73	4	5	6	34	43	51	4	5	6
	Tom Bradley	149	186	223	12	14	17	188	234	281	22	28	33
MIA	Central	339	424	508	23	29	35	169	211	253	12	16	19
	South	123	153	184	8	10	13	368	459	551	27	34	41
	North	32	40	48	2	3	3	51	64	76	4	5	6
Point Elasticity Value													
ORD		664	829	994	37	46	55	410	512	614	75	94	113
JFK	American	387	483	579	15	18	22	470	586	703	29	36	44
	British	194	242	291	7	9	11	327	408	489	20	25	30
	Delta	458	571	685	17	22	26	318	397	476	20	25	30
	Terminal 1	355	443	531	14	17	20	619	773	927	38	48	58
	Terminal 4	680	849	1,018	26	32	39	533	665	797	33	41	49
LAX	Satellite 2	210	262	314	12	15	18	344	429	514	29	37	44
	Satellite 5	139	173	207	8	10	12	249	311	373	21	27	32
	Satellite 7	155	193	231	9	11	13	146	182	218	12	16	19
	Terminal 4	91	114	136	5	6	8	64	80	96	5	7	8
	Tom Bradley	277	346	415	16	19	23	349	435	522	30	37	45
MIA	Central	630	787	943	31	39	46	314	392	470	17	21	25
	South	228	285	342	11	14	17	683	853	1,023	36	45	54
	North	59	74	88	3	4	4	95	118	142	5	6	8
High Elasticity Value													
ORD		1,085	1,355	1,624	66	82	98	671	837	1,004	135	169	202
JFK	American	633	790	947	26	33	40	768	958	1,149	52	65	78
	British	317	396	475	13	17	20	535	667	800	36	45	54
	Delta	748	934	1,120	31	39	47	520	649	778	35	44	53
	Terminal 1	580	724	868	24	30	36	1,012	1,264	1,515	69	86	103
	Terminal 4	1,112	1,388	1,664	46	58	70	871	1,087	1,303	59	74	89
LAX	Satellite 2	343	428	513	21	26	32	562	701	840	53	66	79
	Satellite 5	226	283	339	14	17	21	408	509	610	38	48	57
	Satellite 7	253	315	378	16	19	23	239	298	357	22	28	34
	Terminal 4	149	186	223	9	11	14	104	130	156	10	12	15
	Tom Bradley	453	566	678	28	35	42	570	712	853	53	67	80
MIA	Central	1,030	1,286	1,542	55	69	83	513	641	768	30	37	45
	South	373	466	558	20	25	30	1,117	1,394	1,672	65	81	97
	North	96	120	144	5	6	8	155	193	232	9	11	14

-50% WAIT TIME CHANGE FOR ALL FLIGHTS: ALL WAIT TIME COUNTS													
		U.S.-Resident Passengers						Foreign-Resident Passengers					
		Leisure			*Business*			*Leisure*			*Business*		
		ue of Average Wait Tin			ue of Average Wait Tin			ue of Average Wait Tin			ue of Average Wait Tin		
Airpor	***Terminal***	Low	Point	High	Low	Point	High	Low	Point	High	Low	Point	High
Low Elasticity Value													
ORD		5,273	6,582	7,891	403	504	604	3,428	4,279	5,130	872	1,090	1,308
JFK	American	2,597	3,242	3,887	137	172	206	3,287	4,103	4,919	283	353	424
	British	1,029	1,285	1,540	54	68	82	1,988	2,481	2,975	171	214	256
	Delta	2,206	2,753	3,301	117	146	175	1,551	1,936	2,321	133	167	200
	Terminal 1	3,250	4,056	4,863	172	215	257	4,789	5,977	7,166	412	515	617
	Terminal 4	10,404	12,985	15,567	550	687	824	7,466	9,319	11,171	642	802	962
LAX	Satellite 2	1,544	1,927	2,311	120	150	180	2,024	2,527	3,029	240	300	360
	Satellite 5	401	500	599	31	39	47	724	903	1,083	86	107	129
	Satellite 7	609	760	911	47	59	71	495	618	740	59	73	88
	Terminal 4	179	224	268	14	17	21	126	157	188	15	19	22
	Tom Bradley	4,962	6,193	7,424	385	482	578	5,460	6,815	8,170	647	809	970
MIA	Central	9,196	11,478	13,761	625	781	937	5,278	6,588	7,898	389	486	583
	South	1,896	2,367	2,837	129	161	193	5,887	7,348	8,809	434	542	650
	North	1,156	1,442	1,729	79	98	118	1,757	2,193	2,629	129	162	194
Point Elasticity Value													
ORD		9,793	12,224	14,654	540	674	809	6,367	7,947	9,527	1,168	1,459	1,750
JFK	American	4,824	6,021	7,218	184	230	275	6,105	7,620	9,135	378	473	567
	British	1,912	2,386	2,860	73	91	109	3,692	4,608	5,525	229	286	343
	Delta	4,097	5,114	6,130	156	195	234	2,881	3,596	4,310	179	223	268
	Terminal 1	6,035	7,533	9,030	230	287	345	8,894	11,101	13,308	551	689	826
	Terminal 4	19,321	24,116	28,911	736	920	1,103	13,865	17,306	20,747	859	1,074	1,288
LAX	Satellite 2	2,868	3,580	4,291	161	201	241	3,760	4,693	5,626	321	401	481
	Satellite 5	744	928	1,113	42	52	62	1,344	1,677	2,011	115	143	172
	Satellite 7	1,130	1,411	1,691	63	79	95	919	1,147	1,375	78	98	118
	Terminal 4	333	415	498	19	23	28	233	291	349	20	25	30
	Tom Bradley	9,215	11,501	13,788	516	644	773	10,140	12,656	15,173	866	1,082	1,298
MIA	Central	17,079	21,317	25,555	836	1,045	1,254	9,803	12,235	14,668	520	650	780
	South	3,521	4,395	5,269	172	215	259	10,933	13,646	16,359	580	725	870
	North	2,146	2,679	3,211	105	131	158	3,262	4,072	4,882	173	216	260
High Elasticity Value													
ORD		16,008	19,981	23,954	967	1,209	1,450	10,408	12,991	15,574	2,093	2,615	3,138
JFK	American	7,885	9,842	11,799	329	412	494	9,979	12,456	14,932	678	847	1,017
	British	3,125	3,900	4,676	131	163	196	6,035	7,533	9,031	410	512	615
	Delta	6,697	8,359	10,021	280	350	419	4,709	5,877	7,046	320	400	480
	Terminal 1	9,865	12,313	14,761	412	515	618	14,537	18,145	21,753	988	1,234	1,481
	Terminal 4	31,582	39,420	47,258	1,319	1,648	1,978	22,664	28,288	33,913	1,540	1,924	2,309
LAX	Satellite 2	4,688	5,851	7,015	288	360	431	6,146	7,671	9,196	576	719	863
	Satellite 5	1,216	1,518	1,819	75	93	112	2,197	2,742	3,287	206	257	308
	Satellite 7	1,847	2,306	2,764	113	142	170	1,502	1,875	2,248	141	176	211
	Terminal 4	544	679	814	33	42	50	381	476	570	36	45	54
	Tom Bradley	15,062	18,801	22,539	925	1,155	1,386	16,575	20,688	24,802	1,552	1,940	2,327
MIA	Central	27,917	34,845	41,773	1,499	1,873	2,247	16,024	20,000	23,977	932	1,165	1,398
	South	5,756	7,184	8,613	309	386	463	17,871	22,306	26,741	1,040	1,299	1,559
	North	3,508	4,379	5,249	188	235	282	5,333	6,656	7,980	310	388	465

-100% WAIT TIME CHANGE FOR ALL FLIGHTS: ALL WAIT TIME COUNTS													
		U.S.-Resident Passengers						Foreign-Resident Passengers					
		Leisure			*Business*			*Leisure*			*Business*		
		ue of Average Wait Ti			ue of Average Wait Ti			ue of Average Wait Ti			ue of Average Wait Ti		
Airpor	***Terminal***	Low	Point	High	Low	Point	High	Low	Point	High	Low	Point	High
Low Elasticity Value													
ORD		10,547	13,164	15,781	806	1,008	1,209	6,857	8,559	10,260	1,745	2,180	2,616
JFK	American	5,195	6,484	7,773	275	343	412	6,574	8,206	9,838	565	706	847
	British	2,059	2,570	3,080	109	136	163	3,976	4,963	5,950	342	427	513
	Delta	4,412	5,507	6,602	233	291	350	3,102	3,872	4,642	267	333	400
	Terminal 1	6,499	8,112	9,725	344	429	515	9,578	11,955	14,331	824	1,029	1,235
	Terminal 4	20,807	25,971	31,135	1,100	1,374	1,649	14,931	18,637	22,343	1,284	1,604	1,925
LAX	Satellite 2	3,088	3,855	4,621	240	300	360	4,049	5,054	6,058	480	600	719
	Satellite 5	801	1,000	1,199	62	78	93	1,447	1,806	2,166	172	214	257
	Satellite 7	1,217	1,519	1,821	95	118	142	990	1,235	1,481	117	147	176
	Terminal 4	358	447	536	28	35	42	251	313	376	30	37	45
	Tom Bradley	9,923	12,386	14,849	771	963	1,155	10,920	13,630	16,340	1,294	1,617	1,940
MIA	Central	18,392	22,957	27,521	1,250	1,562	1,874	10,557	13,177	15,797	777	971	1,165
	South	3,792	4,733	5,674	258	322	386	11,774	14,696	17,618	867	1,083	1,300
	North	2,311	2,885	3,458	157	196	235	3,513	4,385	5,257	259	323	388
Point Elasticity Value													
ORD		19,586	24,447	29,308	1,079	1,348	1,618	12,734	15,895	19,055	2,335	2,918	3,501
JFK	American	9,648	12,042	14,436	368	459	551	12,210	15,240	18,270	757	945	1,134
	British	3,823	4,772	5,721	146	182	218	7,384	9,217	11,049	458	572	686
	Delta	8,194	10,227	12,261	312	390	468	5,761	7,191	8,621	357	446	535
	Terminal 1	12,070	15,066	18,061	460	575	689	17,787	22,201	26,616	1,102	1,377	1,652
	Terminal 4	38,642	48,232	57,822	1,472	1,839	2,207	27,730	34,612	41,494	1,718	2,147	2,576
LAX	Satellite 2	5,736	7,159	8,583	321	401	481	7,519	9,385	11,251	642	802	963
	Satellite 5	1,488	1,857	2,226	83	104	125	2,688	3,355	4,022	230	287	344
	Satellite 7	2,260	2,821	3,382	127	158	190	1,838	2,294	2,750	157	196	235
	Terminal 4	665	830	995	37	47	56	466	582	698	40	50	60
	Tom Bradley	18,429	23,003	27,577	1,032	1,289	1,546	20,280	25,313	30,346	1,732	2,164	2,597
MIA	Central	34,157	42,634	51,111	1,673	2,090	2,508	19,605	24,471	29,336	1,040	1,300	1,560
	South	7,043	8,790	10,538	345	431	517	21,865	27,292	32,718	1,160	1,450	1,739
	North	4,292	5,357	6,423	210	263	315	6,525	8,144	9,763	346	433	519
High Elasticity Value													
ORD		32,016	39,962	47,908	1,934	2,417	2,900	20,816	25,981	31,147	4,186	5,231	6,275
JFK	American	15,770	19,684	23,598	659	823	987	19,958	24,911	29,864	1,356	1,695	2,033
	British	6,249	7,800	9,351	261	326	391	12,070	15,066	18,061	820	1,025	1,230
	Delta	13,394	16,717	20,041	559	699	839	9,417	11,755	14,092	640	800	959
	Terminal 1	19,730	24,626	29,523	824	1,030	1,235	29,075	36,291	43,506	1,976	2,469	2,962
	Terminal 4	63,165	78,840	94,516	2,638	3,297	3,955	45,328	56,577	67,826	3,080	3,849	4,617
LAX	Satellite 2	9,376	11,702	14,029	575	719	863	12,291	15,341	18,392	1,151	1,438	1,726
	Satellite 5	2,432	3,035	3,639	149	187	224	4,393	5,484	6,574	412	514	617
	Satellite 7	3,695	4,612	5,529	227	283	340	3,004	3,750	4,496	281	352	422
	Terminal 4	1,087	1,357	1,627	67	83	100	762	952	1,141	71	89	107
	Tom Bradley	30,125	37,601	45,077	1,849	2,310	2,772	33,150	41,377	49,604	3,105	3,880	4,654
MIA	Central	55,834	69,690	83,547	2,999	3,747	4,495	32,047	40,000	47,954	1,865	2,330	2,796
	South	11,512	14,369	17,226	618	773	927	35,742	44,612	53,482	2,080	2,599	3,118
	North	7,016	8,757	10,498	377	471	565	10,666	13,313	15,960	621	776	930

+1 OFFICER: ONLY WAIT TIME ABOVE 30 MINUTES COUNTS													
		U.S.-Resident Passengers						**Foreign-Resident Passengers**					
		Leisure			***Business***			***Leisure***			***Business***		
		Value of Wait Time:			Value of Wait Time:			Value of Wait Time:			Value of Wait Time:		
Airpoi	***Terminal***	Low	Point	High	Low	Point	High	Low	Point	High	Low	Point	High
Low Elasticity Value													
ORD		88	110	132	9	11	13	92	115	137	25	32	38
JFK	American	43	54	65	3	4	5	106	132	158	10	12	15
	British	21	26	31	2	2	2	59	74	89	6	7	9
	Delta	67	84	100	4	6	7	68	85	102	6	8	10
	Terminal 1	41	51	61	3	4	4	156	195	234	14	18	22
	Terminal 4	99	124	149	7	8	10	119	149	178	11	14	17
LAX	Satellite 2	20	25	30	2	3	3	47	59	70	7	8	10
	Satellite 5	14	18	21	2	2	2	38	48	57	5	7	8
	Satellite 7	16	20	24	2	2	3	23	28	34	3	4	5
	Terminal 4	8	10	12	1	1	1	8	11	13	1	1	2
	Tom Bradley	27	34	40	3	4	5	43	53	64	6	8	9
MIA	Central	75	93	112	7	9	10	59	74	89	5	6	7
	South	25	31	37	2	3	4	127	158	190	10	13	16
	North	7	9	10	1	1	1	17	21	25	1	2	2
Point Elasticity Value													
ORD		164	204	245	12	15	18	170	213	255	34	42	51
JFK	American	81	101	121	4	5	6	197	246	294	13	17	20
	British	39	49	58	2	3	3	110	137	165	8	10	11
	Delta	125	156	186	6	8	9	127	159	190	9	11	13
	Terminal 1	76	95	114	4	5	6	291	363	435	19	24	29
	Terminal 4	185	230	276	9	11	13	221	276	331	15	19	22
LAX	Satellite 2	37	47	56	3	4	5	87	109	131	9	11	13
	Satellite 5	27	33	40	2	3	3	71	88	106	7	9	10
	Satellite 7	30	37	44	2	3	4	42	53	63	4	5	6
	Terminal 4	14	18	21	1	2	2	16	20	23	2	2	2
	Tom Bradley	50	63	75	4	5	6	80	99	119	8	10	12
MIA	Central	139	174	208	9	12	14	110	138	165	7	8	10
	South	46	57	68	3	4	5	236	294	353	14	17	21
	North	13	16	19	1	1	1	31	39	47	2	2	3
High Elasticity Value													
ORD		268	334	401	21	26	32	279	348	417	61	76	91
JFK	American	132	165	197	8	9	11	322	401	481	24	30	36
	British	64	79	95	4	5	6	180	225	269	14	17	21
	Delta	204	254	305	11	13	16	208	259	311	15	19	23
	Terminal 1	125	156	187	7	9	11	475	593	711	35	43	52
	Terminal 4	302	377	452	16	20	24	362	452	541	27	33	40
LAX	Satellite 2	61	76	91	5	7	8	143	178	213	16	20	24
	Satellite 5	44	54	65	4	5	6	116	145	173	13	16	19
	Satellite 7	48	60	72	4	5	6	69	86	104	7	9	11
	Terminal 4	23	29	35	2	3	3	26	32	38	3	4	4
	Tom Bradley	82	102	122	7	9	11	130	162	195	15	18	22
MIA	Central	227	284	340	17	21	25	180	225	270	12	15	18
	South	75	93	112	6	7	8	385	481	576	25	31	37
	North	21	26	31	2	2	2	51	64	76	3	4	5

-50% WAIT TIME CHANGE : ONLY WAIT TIME ABOVE 30 MINUTES COUNTS													
		U.S.-Resident Passengers						Foreign-Resident Passengers					
		Leisure			***Business***			***Leisure***			***Business***		
		Value of Wait Time:			Value of Wait Time:			Value of Wait Time:			Value of Wait Time:		
Airpo	***Terminal***	Low	Point	High	Low	Point	High	Low	Point	High	Low	Point	High
Low Elasticity Value													
ORD		1,304	1,628	1,951	130	162	195	1,424	1,778	2,131	394	492	590
JFK	American	545	681	816	40	50	59	1,377	1,718	2,060	128	160	192
	British	206	257	308	15	19	23	670	836	1,002	64	81	97
	Delta	603	752	902	40	50	60	620	774	928	58	73	87
	Terminal 1	694	867	1,039	50	63	75	2,247	2,805	3,362	207	258	310
	Terminal 4	2,845	3,551	4,256	190	238	285	3,102	3,872	4,642	290	362	434
LAX	Satellite 2	276	344	412	31	39	47	514	642	769	72	90	108
	Satellite 5	77	96	115	8	11	13	205	256	307	28	35	42
	Satellite 7	116	145	174	13	16	19	144	179	215	20	24	29
	Terminal 4	28	35	42	3	4	5	31	38	46	4	5	7
	Tom Bradley	895	1,117	1,339	101	126	151	1,245	1,554	1,863	178	222	267
MIA	Central	2,034	2,539	3,044	187	233	280	1,856	2,316	2,777	152	190	228
	South	379	474	568	36	45	54	2,030	2,533	3,037	167	208	250
	North	249	311	373	23	29	35	578	721	865	48	60	72
Point Elasticity Value													
ORD		2,422	3,023	3,624	174	217	261	2,645	3,301	3,958	527	658	789
JFK	American	1,013	1,264	1,516	53	66	80	2,556	3,191	3,825	172	215	258
	British	382	477	572	20	25	31	1,244	1,552	1,861	86	108	129
	Delta	1,119	1,397	1,675	54	67	81	1,152	1,437	1,723	78	97	117
	Terminal 1	1,289	1,609	1,929	67	84	101	4,173	5,209	6,244	276	345	414
	Terminal 4	5,283	6,594	7,905	255	318	382	5,761	7,190	8,620	388	484	581
LAX	Satellite 2	512	639	766	42	52	63	955	1,192	1,429	96	120	144
	Satellite 5	143	179	214	11	14	17	382	476	571	38	47	56
	Satellite 7	216	270	323	17	21	26	267	333	399	26	33	39
	Terminal 4	52	65	78	4	6	7	57	71	86	6	7	9
	Tom Bradley	1,662	2,074	2,487	135	169	203	2,312	2,886	3,459	238	298	357
MIA	Central	3,778	4,715	5,653	250	312	375	3,446	4,301	5,157	203	254	305
	South	705	879	1,054	48	60	72	3,769	4,705	5,640	223	279	335
	North	463	578	693	31	39	46	1,073	1,339	1,606	64	80	96
High Elasticity Value													
ORD		3,959	4,942	5,924	312	390	468	4,323	5,396	6,469	944	1,180	1,415
JFK	American	1,656	2,067	2,478	95	119	143	4,179	5,216	6,253	308	385	462
	British	625	780	935	37	46	55	2,033	2,537	3,042	155	193	232
	Delta	1,829	2,283	2,738	97	121	145	1,882	2,350	2,817	140	174	209
	Terminal 1	2,108	2,631	3,154	120	150	180	6,821	8,514	10,207	495	619	743
	Terminal 4	8,635	10,778	12,921	456	570	684	9,417	11,754	14,090	695	868	1,041
LAX	Satellite 2	837	1,044	1,252	75	94	112	1,561	1,948	2,336	172	215	258
	Satellite 5	234	292	350	20	25	31	624	778	933	67	84	101
	Satellite 7	353	441	528	31	39	46	436	544	653	47	59	70
	Terminal 4	85	106	128	8	10	12	94	117	140	10	13	16
	Tom Bradley	2,717	3,391	4,065	242	303	363	3,779	4,717	5,655	427	534	640
MIA	Central	6,175	7,708	9,240	448	560	672	5,633	7,031	8,429	365	456	547
	South	1,152	1,437	1,723	87	108	130	6,161	7,690	9,219	400	500	600
	North	757	945	1,133	55	69	83	1,754	2,189	2,625	115	143	172

-100% WAIT TIME CHANGE : ONLY WAIT TIME ABOVE 30 MINUTES COUNTS													
		U.S.-Resident Passengers						**Foreign-Resident Passengers**					
		Leisure			***Business***			***Leisure***			***Business***		
		Value of Wait Time:			Value of Wait Time:			Value of Wait Time:			Value of Wait Time:		
Airpor	***Terminal***	Low	Point	High	Low	Point	High	Low	Point	High	Low	Point	High
Low Elasticity Value													
ORD		2,608	3,256	3,903	260	325	390	2,848	3,555	4,262	787	983	1,180
JFK	American	1,091	1,362	1,632	79	99	119	2,753	3,436	4,120	257	321	385
	British	412	514	616	30	38	46	1,339	1,672	2,004	129	161	193
	Delta	1,205	1,504	1,804	81	101	121	1,240	1,548	1,856	116	145	174
	Terminal 1	1,389	1,733	2,078	100	125	150	4,494	5,609	6,725	413	516	619
	Terminal 4	5,689	7,101	8,513	381	475	570	6,204	7,743	9,283	579	724	868
LAX	Satellite 2	551	688	825	62	78	94	1,028	1,284	1,539	144	180	215
	Satellite 5	154	192	231	17	21	25	411	513	615	56	70	84
	Satellite 7	233	290	348	26	32	39	287	359	430	39	49	59
	Terminal 4	56	70	84	7	8	10	62	77	92	9	11	13
	Tom Bradley	1,790	2,234	2,678	202	253	303	2,490	3,108	3,726	356	445	534
MIA	Central	4,068	5,078	6,088	374	467	560	3,711	4,632	5,553	304	380	456
	South	759	947	1,135	72	90	108	4,059	5,066	6,074	334	417	500
	North	499	623	747	46	58	69	1,156	1,442	1,729	96	120	143
Point Elasticity Value													
ORD		4,844	6,046	7,248	348	435	522	5,290	6,602	7,915	1,053	1,316	1,579
JFK	American	2,026	2,529	3,032	106	133	159	5,113	6,382	7,651	344	429	515
	British	765	954	1,144	41	51	61	2,487	3,104	3,722	173	216	259
	Delta	2,238	2,794	3,349	108	135	162	2,303	2,875	3,446	156	195	234
	Terminal 1	2,579	3,219	3,859	134	168	201	8,346	10,417	12,488	553	691	829
	Terminal 4	10,565	13,188	15,810	509	636	763	11,521	14,381	17,240	775	969	1,162
LAX	Satellite 2	1,024	1,278	1,532	84	105	125	1,910	2,384	2,858	192	240	288
	Satellite 5	286	357	428	23	28	34	763	952	1,142	75	94	113
	Satellite 7	432	539	646	34	43	52	534	666	798	52	65	79
	Terminal 4	104	130	156	9	11	13	115	143	171	12	15	17
	Tom Bradley	3,324	4,149	4,974	270	338	405	4,624	5,771	6,919	476	595	714
MIA	Central	7,555	9,430	11,306	500	625	750	6,892	8,603	10,313	407	508	610
	South	1,409	1,759	2,109	97	121	145	7,538	9,409	11,280	446	558	669
	North	927	1,156	1,386	62	77	93	2,146	2,679	3,211	128	160	192
High Elasticity Value													
ORD		7,918	9,883	11,848	624	779	935	8,647	10,792	12,938	1,888	2,359	2,830
JFK	American	3,312	4,134	4,956	190	238	285	8,358	10,432	12,506	616	770	923
	British	1,250	1,560	1,870	73	91	110	4,065	5,074	6,083	309	387	464
	Delta	3,659	4,567	5,475	193	242	290	3,765	4,699	5,634	279	349	419
	Terminal 1	4,215	5,262	6,308	241	301	361	13,642	17,028	20,414	991	1,238	1,486
	Terminal 4	17,271	21,557	25,843	913	1,141	1,368	18,833	23,507	28,181	1,390	1,736	2,083
LAX	Satellite 2	1,673	2,089	2,504	150	187	225	3,122	3,897	4,671	345	431	517
	Satellite 5	468	584	700	41	51	61	1,247	1,557	1,866	135	168	202
	Satellite 7	706	881	1,056	62	77	92	872	1,089	1,305	94	117	141
	Terminal 4	170	213	255	16	20	24	187	234	280	21	26	31
	Tom Bradley	5,433	6,782	8,130	485	606	727	7,558	9,434	11,310	854	1,067	1,280
MIA	Central	12,350	15,415	18,480	896	1,120	1,344	11,266	14,062	16,858	729	911	1,093
	South	2,303	2,875	3,447	173	216	259	12,322	15,380	18,438	800	1,000	1,199
	North	1,515	1,890	2,266	111	138	166	3,508	4,378	5,249	230	287	344

4.9. Limitations to the Opportunity Cost Approach

There are several important potential limitations to this approach:

- The value of a minute waited in a queue is the same regardless of how many minutes have been waited. However, the disutility of waiting in a queue may be nonlinear, and the disutility of an extra minute waited rises with the total amount of time waited. If disutility is nonlinear, then our methodology underestimates the value of time waited in queues; and the underestimation becomes more severe as the wait time increases.
- This approach makes some strong assumptions about potential air travelers. First, it requires them to be aware of what passport inspection wait times typically are. Second, it requires travelers to take the wait time into account when forming an estimate of the opportunity cost of a trip, which means that wait time is salient and plays an active role in their decision about where and when to travel. The assumption of full rationality has recently been shown to fail in some situations. Chetty (2007) shows that salience fails with respect to state sales tax rates. Finkelstein (2007) shows that drivers do not fully take into account EZ-Pass toll costs associated with driving on U.S. interstate highways. It might be the case that international air travelers do not take passport inspection waits into account when making travel decisions.
- We use the price elasticity of demand calculated on the basis of how travel demand varies with airfare. Ideally, we would like to estimate directly how change in passport and inspection wait time impacts travel demand. We are able to analyze passenger counts on international flights and how they respond to lagged wait time, but this only captures how passengers committed to flying to the U.S. might adjust their scheduled flight in response to wait time. It is generally not possible to use CBP-OFO flight data to estimate the fall in travel volume due to unusually high wait time. However, the introduction of programs at international airports such as Global Entry that significantly reduce wait time and were introduced at airports in a staggered fashion offer an important research opportunity. It may be possible to estimate change in travel demand resulting from these programs by taking advantage of the fact that the introduction of these programs effectively creates a treatment effect and the opportunity to evaluate travel levels before and after the treatment.
- Our lower-bound estimates are based on the assumption of a standard baggage delivery time of 30 minutes. To the extent that average baggage delivery time is less than this, and/or synchronized with the movement of passengers through passport inspection lines, our lower-bound estimates are too conservative. No data on actual baggage delivery time is available, as this data is kept by airlines and has not been made public.

4.10. Comparison of Demand Impact Results to Other Estimates

The first effort to quantify the impact of the passport and customs inspection process on international air travel to the U.S. is that of U.S. Travel Association (2013) (henceforth referred to as USTA.) USTA commissioned a survey of international travelers that focused on evaluation of experience with and/or perceptions of the passport and customs inspection process into the

U.S., and how this impacted respondents' travel plans. USTA then used survey results to estimate how many visits to the U.S. were deterred by the passport and customs inspection process, and the impacts associated with deterred travel on U.S. economic output and employment.

Key findings from the survey that USTA commissioned include:

- 24% of respondents reported that long lines and wait times at passport and customs inspection at U.S. airports is a reason that influenced their deciding to not travel to the U.S.;
- 43% of past visitors to the U.S. stated that they were somewhat or very likely to tell people to avoid travel to the U.S. if possible;
- 65% of respondents stated that they will not or are less likely to visit the U.S. in the next 5 years for business purposes based solely on their experience with or perceptions of the passport and customs inspection process at U.S. airports. 27% stated the same with respect to leisure purposes, and 46% for both leisure and business purposes;
- 14% of past visitors to the U.S. reported having missed a connecting flight due to a long wait time or delay during the passport and customs inspection process;
- The average visitor to the U.S. reported telling 8 people about their travel experience to the U.S. (whether they had a good or bad experience.)

Based on survey results and the number of international visitors coming to the U.S. in 2011, USTA then estimated that:

- 9.6 million potential overseas travelers did not come to the U.S. in 2011 because of experiencing or hearing about a negative passport and customs inspection entry process. (Overseas travelers are from foreign countries excluding Canada and Mexico);
- As a result, the U.S. economy lost $95 billion in total output, 288,300 jobs in the travel industry, and 518,900 jobs in the economy as a whole.[42]

These results suggest that the impacts of the passport and customs inspection process at U.S. airports on travel to the U.S. and the U.S. economy are strikingly large. The number of overseas visitors to the U.S. was 26% less than it would have been in 2011 because of passport and customs inspection outcomes, which is orders of magnitude larger than the deterrence impact developed in this chapter.[43]Indeed, the USTA impact estimates are material at the level of the U.S. national economy: an employment loss of 518,900 jobs equals 0.4% of the total nonfarm

[42] National output and employment impacts were calculated using the IMPLAN input-output model of the U.S. economy.

[43] 27.9 million overseas visitors came to the U.S. in 2011. If 9.6 million more had come, this would have been 37.5 million.

employment level in the U.S. national economy in 2011, and 4% of the number of those who were unemployed. Given the degree of difference between this study's results and those reported by the USTA, we review here the methodologies used by USTA in order to identify sources of difference.

We begin with a review of the survey that supports the USTA analysis.[44] This survey found a much greater impact of the passport and customs inspection process on travel plans of its respondents than the SIAT survey, whose results for 2012 are reviewed in detail in chapter 3. Only 0.2-0.4% of respondents to this survey indicated that they would not return to the U.S. because of complaints related to their interaction with DHS. In contrast, the USTA survey indicates that 43% of past visitors are likely to recommend avoiding travel to the United States based on their experience or perceptions with the immigration and customs process, and 24% of respondents who have decided not to travel to the United States indicated that long lines and wait times for immigration and customs processing were one of the reasons for deciding to not take this trip. This is a very large difference, with one survey suggesting that the passport and customs inspection experience has a fairly minimal impact but the other survey suggesting a very large impact. Factors that can explain this difference include the following:

- Regarding the USTA survey, it is difficult to assess the nature of its underlying population and sample. The survey was administered on-line. No information is provided on the mechanisms through which potential respondents were contacted, and how the sampling frame was developed. Respondents were limited to residents of six countries (the UK, France, Germany, Japan, China, and Brazil) who had traveled outside of their home country at least once in the past five years. No information is provided on how many of the survey's respondents actually visited the United States during the past 5 years;
- Although no copy of the USTA survey questionnaire itself has been made public, a summary of the survey's results includes text of the questions asked. The survey questions seem designed to elicit a predetermined set of responses. For example, lengthy descriptions of three potential problems with the entry process (long wait lines, bad CBP-OFO customer service, and difficulty in making travel connections) were listed as the first three possible reasons for deciding not to travel to the United States, followed by four other reasons that were more tersely phrased;
- All survey results are presented as percentages, making it impossible to determine whether the questions on which USTA findings are derived were asked to the entire survey sample, or only to respondents who had provided specific answers to previous questions;
- The USTA survey did not ask about traveler experiences during a specific time frame or for a specific number of visits. This is particularly relevant for the discussion of the

[44] Details on the survey, which was implemented by Consensus Research, are available at http://www.ustravel.org/sites/default/files/3.26.13_ExecSummaryFINAL2.pdf

impact of passport and customs lines and waiting time on missed connections. The survey asks respondents if they *ever* missed a connecting flight for this reason, rather than if they had missed a connecting flight on their last trip to the U.S. A misconnect rate based on the survey's question will overestimate the true misconnect rate;

- The USTA survey apparently asked travelers who had never visited the United States about the impact of long lines and long wait times for immigration and customs processing on their own travel decisions and on their recommendations to others, even though they had no previous experience with the actual U.S. entry process. The relevance of this information is not clear, since it is unlikely that overseas travelers considering a trip to the U.S. would solicit recommendations from someone who had never visited;
- Regarding the SIAT survey, it may underestimate the percentage of those not intending to visit the U.S. again due to a bad entry experience. The non-response rate to this survey may be systematically higher for those who had a poor entry experience than for those who did not. It is also possible that some of those who do respond do not give accurate answers to questions related to the entry process out of concerns such as reluctance to criticize a U.S. government agency. The fact that the SIAT survey is administered to passengers as they are leaving the U.S. may mitigate these potential problems, but they cannot be ruled out.

The USTA estimate of 9.6 million potential overseas travelers deterred by the entry process was calculated according to the following methodology. The survey found that 43% of all respondents who traveled to the U.S. were likely to tell others to avoid travel to the U.S. due to their experience or perception of the entry process. Assuming that this proportion is representative of the total population of overseas travelers, then 12 million overseas visitors who came to the U.S. in 2011 would tell others this.[45] Given that the survey also found that the average respondent told 8 people about their travel experience to the U.S., these 12 million would inform 96 million others about their negative entry process. USTA then assumes that 1 in 10 of those informed would decide to not come to the U.S., yielding 9.6 million lost visits.

This estimate is based on strong assumptions that go beyond the usual concerns such as the degree to which information collected in surveys about statements of intent reflect actual decisions in future. It is impossible to assess the validity of the estimates that 96 million potential travelers are informed, and that 1 in 10 of these decided to not travel.[46]

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[45] 43% times 27.9 million overseas visitors equals 12 million.

[46] It is not in fact obvious why a "grapevine" approach to estimating the number of deterred travelers was taken. The USTA survey asked respondents if they will not or are less likely to visit the U.S. because of the entry process, and using responses to this question to estimate the number of deterred travelers would require fewer arbitrary assumptions than the "grapevine" approach.

As a final methodological observation, we note that the USTA analysis does not factor in the impact of the passport and customs inspection process on American residents traveling abroad. If this process has a big deterrent impact on foreign residents, it will also have a deterrent impact on U.S. residents: the deterrent impact will be smaller, because U.S. residents are subject to smaller wait times, but it will exist. USTA has not developed estimates for the net impact of the entry process on the U.S. economy.

The evidence that we have developed in this chapter point to a small impact of passport and customs wait time on travel decisions. We believe that there are compelling reasons to expect *a priori* that this impact would be greater than zero but relatively small as compared to the impacts of factors such as traveler preferences, airfare cost, and other variables impacting travel decisions. To the degree that one regards the entry process as having much greater impacts on travel than what our findings suggest, our estimates should be regarded as a conservative lower bound.

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Chapter 5: Impact of Flight Delays and Passport Inspection Waits on the Risk of Missing Connecting Flights

Steve McGonegal and Timothy Beggs

5.1. Chapter Summary

Passenger delays from disrupted flights have a large and measurable economic impact. Varying estimates of this impact prompted the FAA's National Center of Excellence for Aviation Operations Research (NEXTOR) to sponsor a comprehensive study (ball et al., 2010). The NEXTOR report presented two models to estimate the total passenger time lost to flight delays, flight cancellations, and missed connections. The report estimated that missed connections accounted for 18 percent of the total time passengers lost to flight delays and disruptions in 2007.

Barnhart, Fearing, and Vaze (2010a) estimated that 4.5 percent of passengers on domestic routes with connections missed these flights in 2007. Missed connections were more frequent at six problem hub airports; the authors estimate that 6.1 percent of passengers missed their connecting flights at JFK during 2007.[47] Missed connections are a particular concern for arriving international travelers, because they have already spent more time in transit and, in the case of many foreign nationals, may be less familiar with U.S. airlines and other transportation options than U.S. travelers.

The 2013 USTA report has argued that excessive passport inspection waiting times account for a substantial number of missed connections from international arrivals. The USTA-sponsored survey asked respondents if they had ever missed a connecting flight, with 15 percent reporting that they had done so at least once (USTA/Consensus Research, 2013). Presumably, arriving passengers who miss connections after waiting in a passport waiting line for an extended period of time would be likely to identify this waiting time as one reason for missing their connecting flights.

The research presented in this chapter was conducted to determine on preliminary basis the extent to which extended waiting times at passport inspection stations (booths) could potentially contribute to the aggregate time lost from delayed arrivals and the proportion of arriving passengers who miss connecting flights. To address this issue, we develop a measure of the total delay from two sources—late arriving flights and above-average passport waiting times—and evaluate the impact of increases in total delay on the risk of passengers missing

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[47] About half of all arriving passengers at JFK are deplaning from international flights, and about 20 percent of these passengers are connecting to another flight (PANYNJ, 2013).

connecting flights. We also examine the role of airline booking practices in increasing or mitigating this risk.

The model is populated with 2012 flight arrival and airport waiting time (AWT) data from all five JFK airport terminals. These data are used to develop a preliminary assessment of the relative contributions of late arrivals, extended passport waits, and airline scheduling practices toward the total number of passengers arriving at JFK in 2012 from abroad who were at risk of missing their connecting flights.

Important preliminary results from this research include:

- Most passengers (75 percent) on international flights arrived at JFK and cleared primary passport inspection within an hour of the scheduled arrival time. However, nearly 3 million passengers (25 percent of total arrivals) experienced a delay of more than 1 hour, putting them at risk of missing a connecting flight, with the 11 percent who had a total delay of more than 2 hours presumably missing connections at a higher rate.
- Arriving passengers experienced more than 2.3 million hours of excess delays (combined waiting time in excess of 1 hour).
- The overwhelming majority (87 percent) of passengers with excess delays were on flights that arrived more than 15 minutes after the scheduled arrival time:
    - In the majority of these cases (46 percent of all delayed passengers), the passport inspection process did not add any extra time to this delay.
    - However, in 41 percent of the excess delay cases, passengers experienced extended passport inspection waits after deplaning from late arriving flights.
- Extended passport inspection waits were the sole source of missed connection risk for the remaining 13 percent of passengers who experienced extended delays.

Overall, flight delays contributed to an elevated risk of missed connections for 87 percent of all passengers (2.6 million people) who experienced extended entry delays and were solely responsible for the extended delays encountered by 1.4 million of these passengers. Extended passport waits were contributed to the excess delays experienced by 1.6 million passengers and were solely responsible for the delays encountered by 0.4 million people.

The preliminary analysis presented in this chapter for JFK in 2012 suggests that relatively few passengers on flights that arrive on time are at risk of missing connections because of extended passport waiting time. A substantially larger number of passengers are at risk of missing connections because of flight delays. However, extended passport waiting times contribute to the excess delays experienced by about half of the passengers who deplane from late arriving flights.

5.2. Selection of JFK International Airport for Preliminary Analysis of Missed Connection Risk

Studies of flight delays and disruptions have often focused attention on the New York metro area and its three hub airports (JFK, LaGuardia, and Newark), which collectively occupy the center of the most congested airspace in the United States and handle the largest share of domestic air traffic (*See, for example,* Ferguson et al., 2009). A 2007 FAA report attributed three-quarters of that summer's flight delays to airspace congestion round New York, taking into account the system-wide disruptive impacts caused by the delays originating at these airports propagating across airline networks.

International arrivals to JFK represent a particularly worthwhile sample of flights to use in studying the risk of missed connections and the potential role of extended passport inspection waits for several reasons:

1. JFK has five terminals which handle incoming international flights, which provides a larger pool of flight delay and airport wait time data for each day and arrival hour block.
2. Just over half of all passengers departing and arriving at JFK are boarding or deplaning from international flights (PANY&NJ, 2013, Table 2.2.1).
3. The majority of passengers making connecting flights (54.5 percent) at JFK are transferring to or from international flights (PANY&NJ, 2013, Table 2.6.1).
4. As noted previously, JFK has higher-than-average rates of delayed flights and missed connections, relative to the overall rates for the 29 large hub airports in the United States.

5.3. Delayed Flight Arrivals for Connecting Passengers

Arrival delays are an endemic feature of both domestic and international flight schedules, but passengers on international flights may face more frequent and/or longer arrival delays. International flights between individual origin-departure pairs are typically less frequent, so airlines are less likely to cancel flights experiencing pre-departure delays.[48] In addition, a higher percentage of international flights arrive at congested large hub airports, including JFK.

For this analysis we calculated the pre-arrival delay experienced by each international flight arriving at JFK in 2012 by comparing the actual arrival time for the flight recorded in the CBP data set described in Chapter 3 with the scheduled arrival time for the same flight obtained from another industry data source.[49] Individual flight delays were cumulated into a distribution of delays by 15-minute interval (e.g., 15-30, 30-45, 45-60 minutes late and so forth) for each terminal/day/hour block.[50] A summary of the flight delay distribution developed using these data is provided in Table 5-1.

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[48] The Department of Transportation (DOT) has recognized the differences in the extent of potential disruption from flight cancellations faced by passengers on domestic and international routes in its tarmac delay rules, which limit taxi-out delays to no more than 3 hours on domestic flights and no more than 4 hours on international flights.

[49] Planet data [will provide citation].

[50] Scheduled arrival times were not available for about 10 percent of the 2012 JFK international arrivals included in the CBP AWT data set. The distribution of delays for these flights were assumed to follow the distributions of delays for flights that arrived during the same terminal/day/hour block, where data for one or more such flights

Table 5-1

Flight Delays Encountered by Arriving International Flights at JFK in 2012

Terminal/ Carrier	Total Flights	Early	0-15 Minutes	15-60 Minutes	> 60 Minutes
American	10,288	54%	16%	20%	10%
British	5,326	50%	19%	20%	11%
Delta	5,907	64%	14%	15%	8%
Terminal 1	10,369	43%	20%	28%	9%
Terminal 4	25,746	52%	15%	20%	13%
JFK Total	**57,636**	**52%**	**16%**	**21%**	**11%**

About half of international flights arrive before the scheduled arrival time, and approximately 20 percent arrive more than 30 minutes early—an indicator of the pervasiveness and magnitude of the buffer that airlines build into published schedules to minimize disruptions to their networks. However, about one-third of international flights arrive more than 15 minutes later than scheduled, and one out of every nine of these flights are delayed more than an hour past the scheduled arrival time.[51] Passengers arriving on flights that have experienced lengthy delays face higher risks of missing their connections irrespective of the amount of time it will take them to clear the primary passport inspection.

5.4. Passport Waiting Times for Passengers Arriving on International Flights

After deplaning, arriving passengers are segregated into two lines—one for U.S. citizens (USCs) and legal permanent residents (LPRs) and another for non-immigrant (NIM) foreign nationals and other entrants (OTH). The distribution of passport wait times for these two groups of JFK arrivals in 2012 is shown in table 5-2.[52]

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were available, and for the same terminal/weekday/hour block where no data for other flights during the same terminal/date/hour block were available.

[51] DOT on-time performance standards treat flights that arrive within 15 minutes of the scheduled arrival time as not being delayed.

[52] CBP data provide waiting times for the first 97 percent of arriving passengers on each flight to clear passport inspection. This procedure is designed to insulate the wait time statistics from counting additional time spent by deplaning passengers whose arrival in the passport inspection lines is delayed for reasons, which could include attending to children's needs or obtaining assistance required by persons with various types of disabilities.

Table 5-2
Passport Wait Times for Passengers on Arriving International Flights at JFK in 2012

Minutes waited	USC+LPR	Share	NIM+OTH	Share	All Arriving Passengers	Share
0-15	2,716,529	*44.1%*	1,034,767	*18.6%*	3,751,296	*32.0%*
16-30	2,184,128	*35.5%*	1,629,129	*29.3%*	3,813,257	*32.5%*
31-45	820,041	*13.3%*	1,128,872	*20.3%*	1,948,913	*16.6%*
46-60	282,717	*4.6%*	730,493	*13.1%*	1,013,210	*8.6%*
61-75	99,753	*1.6%*	455,594	*8.2%*	555,347	*4.7%*
76-90	35,646	*0.6%*	262,220	*4.7%*	297,866	*2.5%*
91-105	12,868	*0.2%*	149,471	*2.7%*	162,339	*1.4%*
106-120	4,390	*0.1%*	81,671	*1.5%*	86,061	*0.7%*
121-180	3,180	*0.1%*	82,592	*1.5%*	85,772	*0.7%*
> 180	158	*0.0%*	5,489	*0.1%*	5,647	*0.0%*
Total	**6,159,410**		**5,560,298**		**11,719,708**	

Nearly 80 percent of USCs and LPRs cleared primary passport inspection in 30 minutes or less, and two-thirds of the remaining arrivals in this group had to wait no more than 45 minutes. However, higher percentages of NIMs and OTHs encountered extended passport inspection waits: 52 percent waited more than 30 minutes; 32 percent waited more than 45 minutes; and one out of every six NIM or OTH arrivals had to wait more than an hour. Overall, it took one out of every six arriving passengers more than 45 minutes to clear primary passport inspection. Extended passport inspection waits increase the risk of missed connections for all passengers.

5.5. Post-Primary Passport Inspection Sources of Delay for Connecting Passengers

After clearing the primary passport inspection station, passengers connecting from international flights must complete several additional activities within the time available before the next flight in their itinerary departs:[53]

- Retrieve baggage and clearing customs
- Re-check baggage after clearing customs.
- Walk, and possibly take bus or rail transit, to reach the departing flight gate, which could be located in a different terminal.
- Board the connecting flight.

Flight-specific data on the average amount of time required to complete each of these functions are not available. On a preliminary basis we assumed that completing these activities would require at least 30 minutes for passengers connecting in the same terminal and closer to an hour for those who need to board flights departing from other JFK terminals.

[53] Arriving passengers could also be referred for secondary passport inspection or immigration control interviews. Presumably, these functions should not be bypassed or abbreviated simply to reduce the risk of the detained passengers missing their connecting flights.

5.6. Carrier Response to Minimize the Impact of Flight and Passenger Delays

Airlines operate complex flight schedules that depend on the availability of aircraft, crews, and passengers at specified locations and times throughout the day. Events that delay or cancel the availability of any of these elements can generate ("propagate") delays in later flights and increases in the numbers of disrupted passengers that have to be rebooked or otherwise accommodated.

Carriers attempt to reduce the exposure of their networks to these disruptions by widening the time interval between the scheduled departure and arrival time to provide a buffer against delayed departures, and less frequently, delays in the taxi-in and gate arrival phase of the flight. When no such delays occur, the flight may arrive before its scheduled arrival time. This unused schedule buffer provides a bank of time that can reduce the risk of missed connections for passengers that encounter delays in one or more of the required post-arrival, pre-boarding activities.

Passengers booking multiple flight segments are provided additional protection against missing connection to the extent that airlines and travel agencies refuse to book connecting flights that depart too soon after the arriving international flight is scheduled to land. These minimum connect times (MCTs) may be based on airport-wide rules of thumb or specifically tailored to the specific arrival and departure terminals and gates. However, if the required MCT is insufficient, passengers may be facing an elevated risk of missing a connection, even if they do not encounter any extended delays in flight arrival, passport inspection, or other post-passport inspection activities.

However, airlines do not attempt to eliminate missed connections entirely. Passengers who do not encounter delays experience extended waits if connecting flights depart later, and the aircraft, crew, and gates may not be available at later times or may be required at another airport by a certain time. There is also some evidence that airlines compete by scheduling more frequent flights between destination pairs than is optimal from a system-wide perspective that takes into account the impact of additional flights on airport gate, runway, and airspace congestion (*See* Vaze and Barnhart, 2013).

It is therefore reasonable to characterize airlines as attempting to schedule flights so that optimal numbers of passengers miss their connections. To be optimal, these scheduling decisions would necessarily have to take into account the available data on flight delays and passport waiting times. In contrast, unexpected delays from sources that cannot be reasonably anticipated by airlines can be expected to increase the rate of missing a connecting flight above the optimal level.

5.7. Evaluating the Impact of Passport Inspection Waits on the Risk of Missed Connections

A missed connection occurs when an arriving passenger on an international flight is not able to complete the series of required airport-based tasks in the time available between the actual flight arrival time and the final call to board the connecting flight. The time available consists of two components:

- **Schedule buffer**. The previous discussion shows that this time interval may be longer than indicated by the scheduled arrival time if the international flight arrives early, which occurs frequently because of the buffer most airlines build into their flight schedules. We assume for this analysis that passengers do not have information on the length of the schedule buffer for their flight. Conversely, the time interval available to complete the required set of airport-based tasks may be shorter than anticipated if there is a flight delay, assuming that passengers do not have information in advance of booking on the probability of experiencing flight delays of varying lengths.[54]
- **Connect time**. Available time to make a connection includes the minimum connect time (MCT), which is usually set by the airline, and any additional time available before the next available flight to the final destination. Presumably, the MCT for passengers connecting from international flights takes into account the minimum time (however defined) to clear primary passport inspection, collect baggage, clear customs, re-check baggage, and arrive at the gate (which may possibly be in a different terminal) from which the connecting flight departs. The remaining time, including any contribution from unused schedule buffer in the case of early-arriving flights, provides a “connection buffer” to absorb possible delays in completing the required airport-based tasks, including clearing primary passport inspection.

Airlines do not typically report MCTs for various arrival-connecting flight pairs, which could potentially take into account the gate locations of the two flights and possibly the time of day. It is therefore necessary to make some assumptions about how airlines take expected passport waiting times into account when setting MCTs.[55]

This available time is absorbed by arrival delays, unexpected waits at passport inspection, and/or longer-than-expected time to complete each of the post-passport activities. One critical point is that lengthy arrival delays put more pressure on the passport inspection function and increase the likelihood that passengers will attribute missed connections to passport waits *of any length*:

- Without arrival delay, the entire buffer is available to offset above-average passport waiting time.
- With a sufficiently extended flight delay, even a lower than -average wait time to clear passport inspection could cause the available time limit to be exceeded.
- Perceptions may not match actual reason for delay, because the passport wait comes after flight delay, and the disutility of waiting time is nonlinear.

Some passengers who miss connections will encounter only one of these elements of the total delay, and attributing the cause of the missed connection is straightforward. For example,

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[54] Note that we assumed in the previous chapter that some passengers may take into account previous experience with passport waits when planning future flights. It is possible that some passengers also attempt to minimize their exposure to potential disruptions from flight delays by increasing the minimum connect time they will accept when booking a connecting flight.

[55] The Flyer Guide Wiki (http://www.flyerguide.com/wiki/index.php/Minimum_Connecting_Times_%28AA%29), reports that American Airlines has a MCT of 75 minutes for connecting from international to domestic flights at JFK.

passengers on flights that are delayed by two hours or more are likely to miss connections even if passport inspection is instantaneous.[56] Similarly, passengers on flights that arrive on time or early will be likely to miss connections if they subsequently encounter passport waits of two hours or more.

However, the more interesting case to investigate is the one in which smaller increments of flight delay and higher-than-expected passport waiting time combine to increase the risk of missed connections. The model presented below provides an approach to estimate number of passengers in this category and assess the relative contributions of flight delays and extended passport inspection waits to the overall risk of missing a connection flight.

5.8. Missed Connection Risk from Flight Delays and Extended Passport Waits

The risk of a missed connection for an arriving passenger on an international flight can be characterized as follows:

P (missed connect) = f (total excess delay, schedule buffer, scheduled connect time interval)

As noted above, we do not have data on the rate of missed connections for international arrivals generally, nor is there sufficient information available to develop estimates of schedule buffer and the distribution of connect times for arriving international flights. However, it is possible to estimate the *risk* of a missed connection as a function of the total excess delay encountered from flight delay and extended passport wait time.

Airlines may take into account the possibility of flight delays and above-average passport wait times when determining minimum connect times to optimize the rate of misconnects. For this analysis we assumed that connections are scheduled to accommodate passengers on international flights that arrive within 15 minutes of the scheduled time and a passport wait time of 45 minutes:

- Airlines are required to report on-time performance for domestic flights on their websites as the percentage of flights that arrive within 15 minutes of the scheduled time.
- A passport wait time cut off of 45 minutes includes all of those who clear the passport inspection within 15 minutes of the average 2012 AWT for TDH blocks at JFK.

5.9. Excess Delays Experienced by International Arrivals to JFK in 2012

The passport data presented in Tables 3-1 and 3-2 of Chapter 3 indicate that 2012 JFK average wait time (AWT) varied among terminals and the hour block of flight arrival. Additional tabulations of the same data indicated that average AWT also varied by month (October had the largest average AWT) and day of the week (with the largest average AWTs on Fridays and Saturdays. Consequently, we matched the data on flight delays and passport wait times

[56] According to the CBP wait time data summarized in Table 5-2, a few passengers clear inspection in less than one minute.

available for each terminal, date, and hour (TDH) block of arrival to calculate the total delay from these two sources experienced by passengers on each flight. The wait time distributions for primary passport inspection from CBP site (http://awt.cbp.gov/).[57]

The CBP AWT site provides terminal/date/hour block wait time statistics that cover 61,789 international flights that arrived at JFK in 2012. As Table 5-3 shows, we were able to identify 57,634 flights with valid data on scheduled arrival time.

Table 5-3

Matching Flight Delay and Wait Time Data for Arriving International Flights at JFK in 2012

Group	TDH Blocks*	Flights in CBP Data	Flights with Delay Data	Delayed Arrivals**	Percent Delayed	AWT***	MWT***
Delay data for all flights	18,755	43,038	43,038	12,943	30%	26.6	56.5
Delay data for some flights	4,707	17,908	14,326	5,265	37%	30.5	68.6
No delay data	721	843	0	0	n/a	21.2	40.8
JFK 2012 Total	**24,183**	**61,789**	**57,364**	**18,208**	**32%**	**27.2**	**58.4**

*TDH = time/date/hour block.

**Arrived more than 15 minutes after scheduled arrival time.

***Average minutes for individual TDH cells.

About 75 percent of international flights arrived during TDH blocks for which the flight delay could be calculated for each arriving flight. Arrival delays could also be calculated for about 80 percent (14,326 of 17, 908) of the flights arriving in TDH blocks for which scheduled arrival information was available for some but not all flights. As Table 5-3 shows, it is important to include these "partial data" blocks in the analysis, because average AWT and MWT for flights in TDH blocks with partial flight delay data were 12 and 18 percent larger, respectively, than the averages for all 2012 JFK international arrivals. Accordingly, flight delays for the arrivals without valid scheduled arrival time information were assumed to match the overall distribution of flight delays for the flights in the same TDH block for which arrival delays could be calculated.

These matched data were used to estimate the number of passengers with aggregate flight delay and passport wait times in each 15 minute time interval. For example, the number of passengers who experienced an aggregate wait of 45-60 minutes was calculated as the sum of those with flight delays of 45-60 minutes and passport waits of 0-15 minutes (taking both at the midpoints of their respective ranges), those with flight delays of 30-45 minutes and passport waits of 15-30 minutes, and so forth.[58]

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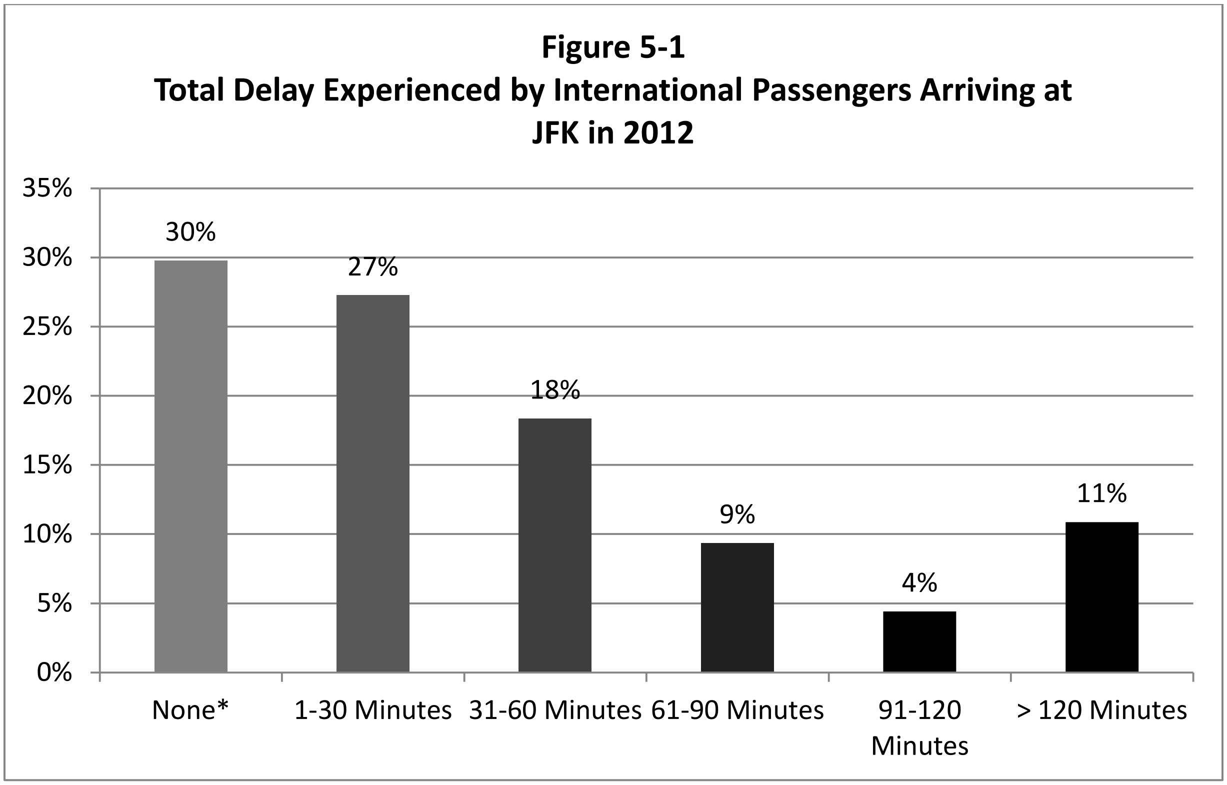
[57] The data on this site are provided for all arriving passengers, rather than separately for USCs, LPRs, and NIMs.

[58] As noted in Table 5-1, many flights arrive before their scheduled times. Thus, some of the passengers in the 45-60 minute aggregate delay interval may have experienced passport waits of more than 60 minutes after deplaning from flights that arrived early. These early arrivals are included in the results presented in the remainder of this section. However, a small number of passengers who arrived early subsequently experienced passport waiting

Figure 5-1 shows the distribution of passenger delays calculated using this procedure.



*Passengers on flights that arrived early and cleared primary passport inspection before the scheduled arrival time.

As Figure 5-1 shows, most passengers (75 percent) on international flights arrived at JFK and cleared primary passport inspection within an hour of the scheduled arrival time. However, 25 percent of arriving passengers (about 3 million people) experienced a delay of more than 1 hour, potentially putting them at risk of missing a connecting flight, with the 11 percent who had a total delay of more than 2 hours presumably missing connections at a higher rate.

Figure 5-2 shows that the proportion of arriving passengers who experienced total delays of more than 1 hour varied significantly among the five international terminals.

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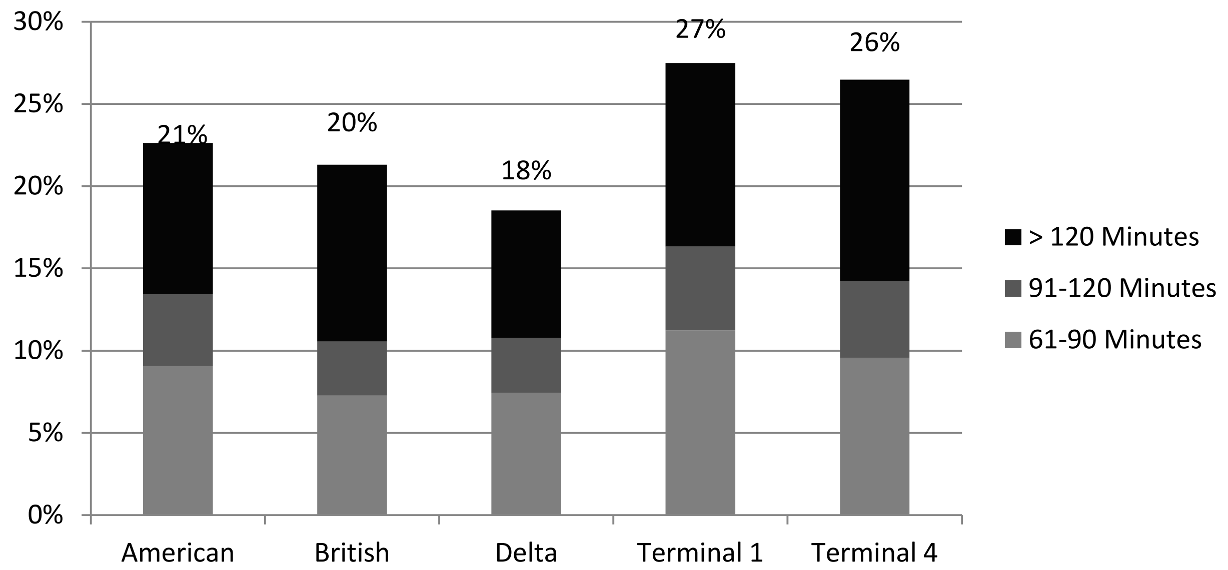
times in excess of 2 hours. These passengers could not be assigned to a 15-minute time interval block and were therefore excluded from the analysis.

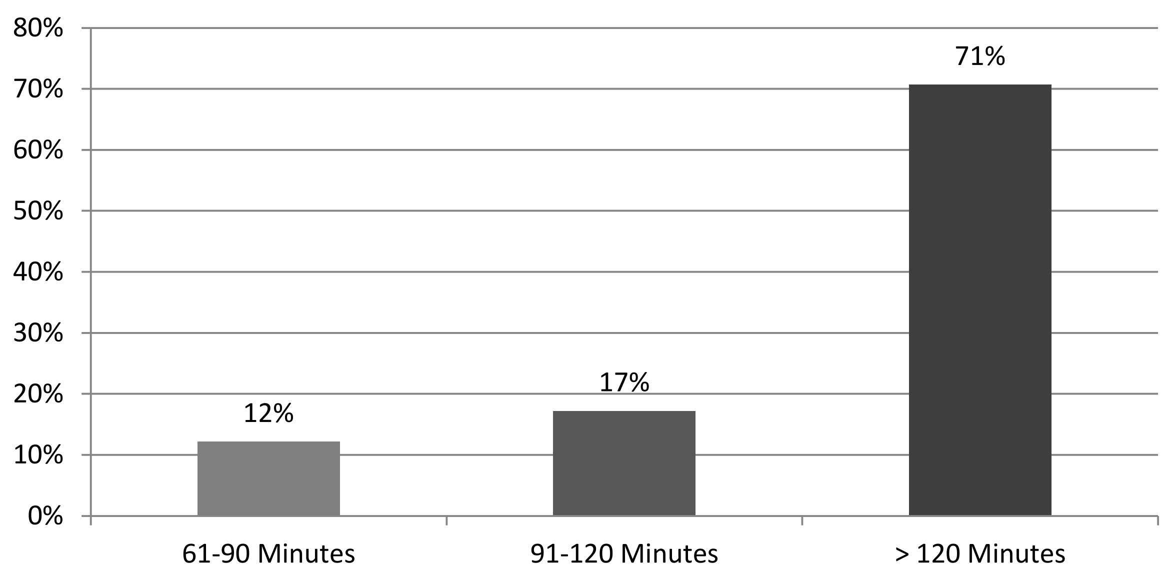
Figure 5-2
Share of International Passengers with Total Delay of More than 60 Minutes



The higher shares of delayed passengers in Terminals 1 and 4 may be partially attributable to arriving flights with higher proportions of NIMs requiring passport inspections.

Arriving passengers experienced more than 2.3 million hours of excess delays (combined waiting time in excess of 1 hour). Figure 5-3 shows that passengers with total waits of more than 2 hours incurred the bulk of this excess waiting time.

Figure 5-3
Excess Delay Hours for International Passengers Arriving at JFK in 2012



5.10. Contributions of Flight Delays and Extended Passport Waits to Excess Delays

International passengers can incur an increased the risk of a missed connection from one of three scenarios for extended delays:

- The flight arrived late, but the passport inspection wait was within the normal range.
- The flight arrived late, and there was also an extended passport inspection wait.
- The flight arrived early or on time but there was an extended passport inspection wait,

The linked data set was queried to determine the numbers of passengers falling into each of these three groups and the total excess delay hours incurred. These results are presented in Table 5-4.

Table 5-4
Time Data for Arriving International Flights at JFK in 2012

	Millions of Passengers	Percent of Passengers	Millions of Excess Delay Hours	Percent of Hours
Total delay > 60 minutes	2.98		2.33	
Flight delay > 15 minutes	2.59	87%	2.17	93%
with passport wait <= 45 minutes	1.37	46%	1.00	43%
with passport wait > 45 minutes	1.22	41%	1.17	50%
Flight delay <= 15 minutes	0.39	13%	0.16	7%

*All of these cases involved passport wait times of more than 45 minutes.

As Table 5-4 indicates, the overwhelming majority (87 percent) of passengers with excess delays were on flights that arrived more than 15 minutes after the scheduled arrival time:

- In the majority of these cases (46 percent of all delayed passengers), the passport inspection process did not add any extra time to this delay.
- However, in 41 percent of the excess delay cases, passengers also experienced extended passport inspection waits after deplaning from late arriving flights.

Extended passport inspection waits were the sole source of missed connection risk for the remaining 13 percent of passengers who experienced extended delays.

Overall, flight delays contributed to an elevated risk of missed connections for 87 percent of all passengers (2.6 million people) who experienced extended entry delays and were solely responsible for the extended delays encountered by 1.4 million of these passengers. Extended passport waits were contributed to the excess delays experienced by 1.6 million passengers and were solely responsible for the delays encountered by 0.4 million people.

Finally, it is important to note that early arriving flights "saved" about 0.8 million passengers who experienced extended passport waiting times from incurring excess delays that would have increased the risk of missing connections. Conversely, an additional 1.6 million passengers on flights that arrived 15 to 45 minutes late cleared passport inspection in sufficient time to avoid incurring excess delays. These estimates illustrate the connection risk-mitigating characteristics of airline schedule buffer and adequate minimum connect times: the same time provides insurance against missed connections for passengers who incur excess delays from either flight delays or extended passport waiting times.

5.11. Discussion of Results

Most passengers (75 percent) arriving on international flights at JFK in 2012 cleared primary passport inspection within an hour of the scheduled arrival time. However, 25 percent incurred delays in excess of an hour, and 11 percent experience delays of more than 2 hours.

The preliminary analysis presented in this chapter for JFK in 2012 suggests that relatively few passengers on flights that arrive on time are at risk of missing connections because of extended passport waiting time. A substantially larger number of passengers are at risk of missing connections because of flight delays. However, extended passport waiting times contribute to the excess delays experienced by about half of the passengers who deplane from late arriving flights.

5.12. Implications for USTA Analysis

These results indicate that flight delays, not extended passport wait times, are the most significant contributor to the risk of missed connections for passengers arriving on international flights. They also provide an explanation of the seemingly contradictory results from the USTA/Consensus Research survey that was extensively discussed in chapter 4 relating to missed connections:

- Because the survey did not ask about other reasons for missing a connecting flight, passengers who experienced a flight delay followed by an extended passport wait (41 percent of all passengers with excess delays) would be likely to attribute the missed connection to the extended passport wait.
- Moreover, delayed passengers who did not experience an extended passport wait time (and may actually have experienced a lower than average waiting time) may still have attributed missed connections to the passport inspection process, since the survey did not provide other reasons for the missed connection.

Finally, it is worth considering that the literature on valuing the time lost to transportation delays generally indicates that the disutility of waiting an additional increment of time increases with the amount of time previously waited. In this context, a passenger who has to wait in a passport inspection line after arriving late is more likely to be dissatisfied with a wait of any length of time than a passenger who arrived early or on time.[59]

[59] One implication is that passengers who are pre-cleared before boarding are likely to be more satisfied with a wait of any given length of time than those who clear passport inspection after the flight.

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Chapter 6: Travel Expenditure Analysis

Dan Wei

6.1. Introduction

In this chapter we translate changes in the number of airline travelers in response to wait time reduction of CBP inspection at the selected international airports into changes in their expenditures. Since wait time reduction affects both the number of incoming foreign visitors and U.S. residents who return from their international trips, the tourist expenditure changes are analyzed for both groups. The changes in international travel expenditures by U.S. residents are used to evaluate how increased international travel would affect their expenditures within the U.S., thereby offsetting somewhat the gains from an increase in foreign travelers visiting the U.S.

We utilize a well-established methodology used in the literature on the economic impacts of tourism. The methodology was recently refined and applied by the CREATE research team in studies for TSA (Rose et al., 2013) and CBP (Roberts et al., 2013).

6.2. Change in Spending by Foreign Visitors to the U.S.

6.2.1. Average Expenditure Per Foreign Visitor

Table 6-1 presents the average per visitor expenditure data by spending category for both leisure and business visitors from overseas. The data are from the Department of Commerce report on the profile of inbound overseas travelers to the United States in 2012 (U.S. DOC, 2013a). On average, each foreign leisure visitor spent $3,061 per trip in 2012. Among the total

Table 6-1. Average Per Visitor Expenditures by Foreign Travelers to U.S. by Category, 2012

Expenditure Category	All Overseas Visitors	Leisure Visitors	Business Visitors
Lodging	$459	$406	$711
Shopping, Gifts & Other Purchases	$449	$486	$350
Food, Beverages	$315	$327	$289
Entertainment	$198	$230	$124
Ground Transportation	$94	$91	$132
Air Transportation	$80	$80	$96
Other	$50	$51	$27
Medical Services	$5	$4	$3
International Airfare	$1,578	$1,386	$2,376
Total	**$3,228**	**$3,061**	**$4,108**

Source: U.S. Department of Commerce(2013a).

expenditures, international airfare accounts for about 45%. The second largest portion of expenditure is related to shopping, gifts and other purchases. For foreign business travelers, the average per person expenditure in 2012 was $4,108, of which nearly 60% was spent on international airfare. The second largest expenditure for business travelers was lodging.

To further disaggregate some of the spending categories in Table 6-1 to match the sectoring classification of our USCGE economic model, we use two sets of weights. The first is BEA (2011) data on tourist expenditures by type of traveler presented in Table 6-2. We use the expenditure vector presented in the “Nonresidents” column to compute the weights for disaggregating some of the spending categories, such as “Entertainment”, “Ground Transportation”, and “Other”, in Table 6-1 for both foreign leisure and business visitors. Since the original BEA table includes an aggregate category of “Nondurable PCE commodities other than gasoline,” we further break down this category into the following three subcategories using the data from Armah and Teensma (2012).

- Food and beverages purchased for off-premises consumption
- Clothing and footwear
- Miscellaneous expenditures (retail purchases not included in other expenditure categories).

Table 6-3 shows the bridging scheme between the commodity types in Table 6-2 and the expenditure categories in Table 6-1, as well as the mapping to the USCGE sectors.

Table 6-4 presents the average expenditure per visitor by BEA commodity type for both foreign business and leisure travelers. The total per visitor expenditures shown in the last row of Table 6-4 are the same as those presented in the last row of Table 6-1.

Table 6-2. Expenditures in the U.S. by Type of Traveler
(in millions of 2011 dollars)

Commodity	Resident Households	Business	Government	Non-Resident Spending
Traveler accommodations	65,833	54,287	8,992	33,207
Food services and drinking places	54,044	40,150	7,500	25,573
Domestic passenger air transportation services	40,042	17,289	7,871	9,109
Passenger rail transportation services	647	408	279	147
Interurban bus transportation	9,293	0	0	185
Interurban charter bus transportation	813	108	411	332
Urban transit systems and other transportation services	1,460	0	0	266
Taxi service	2,703	312	54	156
Scenic and sightseeing transportation services	1,216	2,095	363	666
Automotive rental	7,413	23,501	1,563	542
Other vehicle rental	199	487	2	129
Automotive repair services	6,094	2,146	154	1,138
Parking lots and garages	1,360	397	270	144
Highway tolls	472	78	27	98
Travel arrangement and reservation services	16,216	21,213	743	1,741
Motion pictures and performing arts	9,424	3,696	0	1,309
Spectator sports	1,511	5,270	0	422
Participant sports	6,632	2,441	0	715
Gambling	27,529	0	0	9,210
All other recreation and entertainment	14,332	1,556	0	1,309
Gasoline	69,832	24,591	1,763	2,986
Food and beverages purchased for off-premises consumption	28,577	7,685	909	10,328
Clothing and footwear	12,758	3,431	406	4,611
Miscellaneous expenditures	32,405	8,714	1,031	11,712

Source: BEA (2011).

Table 6-3. BEA-DOC-USCGE Commodity/Sector Mapping Scheme

BEA Commodity Type	DOC Expenditure Type	USCGE Sectors	
		Code	Description
Traveler accommodations	Lodging	HOTR	Hotels and Restaurants
Food services and drinking places	Food, Beverages	HOTR	Hotels and Restaurants
Domestic passenger air transportation services	Air Transportation	TAIR	Air Transport
Passenger rail transportation services	Ground Transportation	TRAL	Rail Transport
Interurban bus transportation	Ground Transportation	TLTP	Private Transit
Interurban charter bus transportation	Ground Transportation	TLTP	Private Transit
Urban transit systems and other transportation services	Ground Transportation	TLTP	Private Transit
Taxi service	Ground Transportation	TLTP	Private Transit
Scenic & sightseeing transportation services	Ground Transportation	TOTH	Other Transport
Automotive rental	Ground Transportation	OBSV	Other Business Services
Other vehicle rental	Ground Transportation	OBSV	Other Business Services
Automotive repair services	Ground Transportation	OBSV	Other Business Services
Parking lots and garages	Ground Transportation	PSRV	Personal Services
Highway tolls	Ground Transportation	TOTH	Other Transport
Travel arrangement and reservation services	Other	OBSV	Other Business Services
Motion pictures and performing arts	Entertainment	ENTR	Entertainment
Spectator sports	Entertainment	ENTR	Entertainment
Participant sports	Entertainment	ENTR	Entertainment
Gambling	Entertainment	ENTR	Entertainment
All other recreation and entertainment	Entertainment	ENTR	Entertainment
Gasoline	Other	MPET	Petroleum Refining
Food and beverages purchased for off-premises consumption	Food, Beverages	MOFD	Other Food Mftg
Clothing and footwear	Shopping, Gifts & Other Purchases	MOND	Other Non-Durables Mftg
Miscellaneous expenditures	Shopping, Gifts & Other Purchases	MOND	Other Non-Durables Mftg
Medical Services	Medical Services	MEDC	Medical Services
International Airfare	International Airfare	TAIR	Air Transport

Table 6-4. Average Per Visitor Expenditures by BEA Commodity Category (in 2012$)

	Foreign Leisure Visitors	Foreign Business Visitors
Traveler accommodations	$406	$711
Food services and drinking places	$233	$206
Domestic passenger air transportation services	$80	$96
Passenger rail transportation services	$4	$5
Interurban bus transportation	$4	$6
Interurban charter bus transportation	$8	$12
Urban transit systems and other transportation services	$6	$9
Taxi service	$4	$5
Scenic and sightseeing transportation services	$16	$23
Automotive rental	$13	$19
Other vehicle rental	$3	$4
Automotive repair services	$27	$39
Parking lots and garages	$3	$5
Highway tolls	$2	$3
Travel arrangement and reservation services	$19	$10
Motion pictures and performing arts	$23	$13
Spectator sports	$7	$4
Participant sports	$13	$7
Gambling	$163	$88
All other recreation and entertainment	$23	$13
Gasoline	$32	$17
Food and beverages for off-premises consumption	$94	$83
Clothing and footwear	$137	$99
Miscellaneous expenditures	$349	$251
Medical Services	$4	$3
International Airfare	$1,386	$2,376
Total	**$3,061**	**$4,108**

6.2.2. Total Expenditure Changes by Foreign Visitors due to Airport Wait Time Change

Tables 6-5 and 6-6 present the results from previous chapters of the estimated increase in foreign visitors and returning U.S. residents for three wait time reduction scenarios: 1) adding one CBP officer; 2) 50% reduction in wait time; 3) 100% reduction in wait time. Table 6-5 presents the results without taking baggage wait time into account, while Table 6-6 presents the results with consideration of baggage wait time. The two sets of results can be viewed as the upper-bound and lower-bound estimates, respectively, of changes in total number of air travelers in response to CBP passport inspection wait time reductions.

Table 6-5. Increased Foreign Visitors and Returning U.S. Residents in Response to Wait Time Changes: Upper-bound Estimates -- without Considering Baggage Wait Time

Airport/Terminal		+1 Officer				Wait Time Falls by 50%				Wait Time Falls by 100%			
		U.S.-Resident Passengers		Foreign-Resident Passengers		U.S.-Resident Passengers		Foreign-Resident Passengers		U.S.-Resident Passengers		Foreign-Resident Passengers	
		Leisure	Business	Leisure	Business	Leisure	Business	Leisure	Business	Leisure	Business	Leisure	Business
ORD		823	45	508	93	12,134	669	7,884	1,447	24,269	1,339	15,768	2,894
JFK	American	483	18	586	36	6,014	229	7,610	472	12,028	459	15,220	944
	British	242	9	408	25	2,383	91	4,602	285	4,766	182	9,204	571
	Delta	571	22	397	25	5,108	195	3,591	223	10,215	390	7,182	445
	Terminal 1	442	17	772	48	7,524	287	11,086	688	15,048	574	22,172	1,375
	Terminal 4	848	32	664	41	24,087	919	17,283	1,072	48,175	1,837	34,566	2,144
LAX	Satellite 2	260	15	425	36	3,553	199	4,657	398	7,106	398	9,313	796
	Satellite 5	172	10	309	26	922	52	1,664	142	1,843	103	3,329	285
	Satellite 7	191	11	181	15	1,400	78	1,138	97	2,801	157	2,277	195
	Terminal 4	113	6	79	7	412	23	289	25	824	46	578	49
	Tom Bradley	344	19	432	37	11,417	640	12,559	1,073	22,834	1,279	25,118	2,147
MIA	Central Terminal	797	39	397	21	21,589	1,059	12,401	659	43,178	2,117	24,802	1,319
	South Terminal	289	14	865	46	4,451	218	13,831	735	8,903	437	27,661	1,471
	North Terminal	75	4	120	6	2,713	133	4,127	219	5,426	266	8,254	439
Total		**5,648**	**261**	**6,142**	**464**	**103,707**	**4,791**	**102,722**	**7,537**	**207,414**	**9,583**	**205,444**	**15,073**

Table 6-6. Increased Foreign Visitors and Returning U.S. Residents in Response to Wait Time Changes: Lower-bound Estimates -- with Consideration of Baggage Wait Time

Airport/Terminal		+1 Officer				Wait Time Falls by 50%				Wait Time Falls by 100%			
		U.S.-Resident Passengers		Foreign-Resident Passengers		U.S.-Resident Passengers		Foreign-Resident Passengers		U.S.-Resident Passengers		Foreign-Resident Passengers	
		Leisure	Business	Leisure	Business	Leisure	Business	Leisure	Business	Leisure	Business	Leisure	Business
ORD		203	15	211	42	3,001	216	3,275	653	6,002	432	6,550	1,305
JFK	American	101	5	245	16	1,263	66	3,187	214	2,526	133	6,373	429
	British	48	3	137	10	477	25	1,550	108	953	51	3,100	215
	Delta	155	8	159	11	1,395	67	1,436	97	2,791	135	2,871	194
	Terminal 1	95	5	362	24	1,608	84	5,202	345	3,215	168	10,403	690
	Terminal 4	230	11	276	19	6,586	318	7,181	484	13,172	636	14,362	967
LAX	Satellite 2	46	4	108	11	634	52	1,183	119	1,268	104	2,365	238
	Satellite 5	33	3	88	9	177	14	473	47	354	28	945	93
	Satellite 7	37	3	53	5	268	21	330	32	535	43	661	65
	Terminal 4	18	2	19	2	65	6	71	7	129	11	142	14
	Tom Bradley	62	5	99	10	2,059	168	2,863	295	4,118	335	5,727	590
MIA	Central Terminal	176	12	140	8	4,775	316	4,360	258	9,551	633	8,719	516
	South Terminal	58	4	298	18	891	61	4,768	283	1,781	122	9,536	566
	North Terminal	16	1	39	2	586	39	1,357	81	1,171	78	2,715	162
Total		**1,278**	**79**	**2,234**	**187**	**23,784**	**1,454**	**37,235**	**3,023**	**47,567**	**2,908**	**74,470**	**6,046**

Below we compute the vector of tourist expenditure changes due to the changes in total number of foreign visitors in the four airports combined. Appendix A to the end of Volume 1 presents the results for each of the 14 individual terminals included in this study. By multiplying the per visitor expenditures calculated in Table 6-4 by the total number of increased foreign (NIM) visitors shown in the last row of Tables 6-5 and 6-6, we obtain the vector of changes in spending by foreign visitors for the upper-bound and lower-bound scenarios, respectively.

For international airfare expenditures, we take into consideration the percentage of service provided by the U.S. air carriers. We computed the market shares of U.S. and foreign carriers using international airport arrival data provided by CBP for calendar-year 2012. The information for individual arrival flights includes airline carrier, and number of passengers broken down by US citizens (USC), lawful permanent residents (LPR), and foreign visitors. Using the airline carrier codes designated by the International Air Transport Association (IATA) obtained from the IATA Airline Coding Directory, the CBP dataset was divided into groups of passengers flying on US and foreign carriers. Table 6-7 presents the number of passengers by type of passenger and type of carrier. The U.S. and foreign carrier shares are computed for both U.S. citizens/residents and foreign visitors.

Based on the total counts for the four airports, in 2012, 50.6% of the U.S. international air travelers and 34.3% of the foreign visitors chose U.S. airline services. Large variations exist across the four airports. The lowest U.S. airline shares for both U.S. travelers and foreign travelers were observed at LAX (31.3% for the former and 18.1% for the latter). The largest U.S. airline shares among the four airports were observed in MIA airport (70.7% for U.S. resident travelers and 48.3% for foreign visitors). These percentages are applied to the total international airfare expenditures by visitor type to estimate the portions of expenditures that go to the U.S. airlines.

Tables 6-8 and 6-9 present the upper-bound and lower-bound estimates of changes in tourist expenditures by foreign visitors in terms of BEA commodity categories for the four airport total. Tables 6-10 and 6-11 present the results in terms of USCGE model sectors. The upper-bound results indicate that when one additional officer is added in each of the 14 terminals, the total foreign visitor expenditures will increase by about $13 million and $1.2 million for leisure visitors and business travelers, respectively. For the 50% wait time reduction scenario, the total increased expenditures are expected to be $221 million for foreign leisure visitors and $19 million for foreign business visitors. The expenditure change estimates are doubled in the 100% wait time reduction scenario compared with the 50% reduction scenario. For the lower-bound case, the expenditure change estimates are about 37% of the corresponding estimates in the upper-bound case.

Table 6-7.Market Shares of U.S. and Foreign Airline Carriers

Airport	Type of Carrier	USC + LPR (Count and Share)	NIM (Count and Share)
JFK	US Carrier	2,883,744 (46.6%)	1,673,952 (29.9%)
	Foreign Carrier	3,310,732 (53.4%)	3,915,219 (70.1%)
LAX	US Carrier	1,145,928 (31.3%)	701,683 (18.1%)
	Foreign Carrier	2,514,227 (68.7%)	3,181,332 (81.9%)
MIA	US Carrier	2,662,110 (70.7%)	2,441,500 (48.3%)
	Foreign Carrier	1,105,287 (29.3%)	2,617,727 (51.7%)
ORD	US Carrier	1,437,716 (59.0%)	716,791 (45.2%)
	Foreign Carrier	999,429 (41.0%)	869,558 (54.8%)
Total	US Carrier	8,129,498 (50.6%)	5,533,926 (34.3%)
	Foreign Carrier	7,929,675 (49.4%)	10,583,836 (65.7%)

Table 6-8. Increased Expenditure by Foreign Visitors due to Wait Time Reduction by BEA Commodity Category: Upper-bound Estimates (in millions of 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	**Business**	**Leisure**	**Business**	**Leisure**	**Business**
Traveler accommodations	$2.5	$0.3	$41.7	$5.4	$83.4	$10.7
Food services and drinking places	$1.4	$0.1	$23.9	$1.6	$47.9	$3.1
Domestic passenger air transportation services	$0.5	$0.0	$8.2	$0.7	$16.4	$1.4
Passenger rail transportation services	$0.0	$0.0	$0.4	$0.0	$0.7	$0.1
Interurban bus transportation	$0.0	$0.0	$0.5	$0.0	$0.9	$0.1
Interurban charter bus transportation	$0.0	$0.0	$0.8	$0.1	$1.6	$0.2
Urban transit systems and other transportation services	$0.0	$0.0	$0.7	$0.1	$1.3	$0.1
Taxi service	$0.0	$0.0	$0.4	$0.0	$0.8	$0.1
Scenic and sightseeing transportation services	$0.1	$0.0	$1.6	$0.2	$3.3	$0.3
Automotive rental	$0.1	$0.0	$1.3	$0.1	$2.7	$0.3
Other vehicle rental	$0.0	$0.0	$0.3	$0.0	$0.6	$0.1
Automotive repair services	$0.2	$0.0	$2.8	$0.3	$5.6	$0.6
Parking lots and garages	$0.0	$0.0	$0.4	$0.0	$0.7	$0.1
Highway tolls	$0.0	$0.0	$0.2	$0.0	$0.5	$0.1
Travel arrangement and reservation services	$0.1	$0.0	$1.9	$0.1	$3.9	$0.1
Motion pictures and performing arts	$0.1	$0.0	$2.4	$0.1	$4.8	$0.2
Spectator sports	$0.0	$0.0	$0.8	$0.0	$1.5	$0.1
Participant sports	$0.1	$0.0	$1.3	$0.1	$2.6	$0.1
Gambling	$1.0	$0.0	$16.8	$0.7	$33.6	$1.3
All other recreation and entertainment	$0.1	$0.0	$2.4	$0.1	$4.8	$0.2
Gasoline	$0.2	$0.0	$3.3	$0.1	$6.6	$0.3
Food & beverages purchased for off-premises consumption	$0.6	$0.0	$9.7	$0.6	$19.3	$1.3
Clothing and footwear	$0.8	$0.0	$14.1	$0.7	$28.2	$1.5
Miscellaneous expenditures	$2.1	$0.1	$35.8	$1.9	$71.6	$3.8
Medical Services	$0.0	$0.0	$0.4	$0.0	$0.8	$0.0
International Airfare	$2.8	$0.4	$48.7	$6.1	$97.3	$12.2
Total	**$13.1**	**$1.2**	**$220.7**	**$19.2**	**$441.4**	**$38.3**

Table 6-9. Increased Expenditure by Foreign Visitors due to Wait Time Reduction by BEA Commodity Category: Lower-bound Estimates (in millions of 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
Commodity	**Leisure**	**Business**	**Leisure**	**Business**	**Leisure**	**Business**
Traveler accommodations	$0.9	$0.1	$15.1	$2.1	$30.2	$4.3
Food services and drinking places	$0.5	$0.0	$8.7	$0.6	$17.3	$1.2
Domestic passenger air transportation services	$0.2	$0.0	$3.0	$0.3	$6.0	$0.6
Passenger rail transportation services	$0.0	$0.0	$0.1	$0.0	$0.3	$0.0
Interurban bus transportation	$0.0	$0.0	$0.2	$0.0	$0.3	$0.0
Interurban charter bus transportation	$0.0	$0.0	$0.3	$0.0	$0.6	$0.1
Urban transit systems and other transportation services	$0.0	$0.0	$0.2	$0.0	$0.5	$0.1
Taxi service	$0.0	$0.0	$0.1	$0.0	$0.3	$0.0
Scenic and sightseeing transportation services	$0.0	$0.0	$0.6	$0.1	$1.2	$0.1
Automotive rental	$0.0	$0.0	$0.5	$0.1	$1.0	$0.1
Other vehicle rental	$0.0	$0.0	$0.1	$0.0	$0.2	$0.0
Automotive repair services	$0.1	$0.0	$1.0	$0.1	$2.0	$0.2
Parking lots and garages	$0.0	$0.0	$0.1	$0.0	$0.3	$0.0
Highway tolls	$0.0	$0.0	$0.1	$0.0	$0.2	$0.0
Travel arrangement and reservation services	$0.0	$0.0	$0.7	$0.0	$1.4	$0.1
Motion pictures and performing arts	$0.1	$0.0	$0.9	$0.0	$1.7	$0.1
Spectator sports	$0.0	$0.0	$0.3	$0.0	$0.6	$0.0
Participant sports	$0.0	$0.0	$0.5	$0.0	$0.9	$0.0
Gambling	$0.4	$0.0	$6.1	$0.3	$12.2	$0.5
All other recreation and entertainment	$0.1	$0.0	$0.9	$0.0	$1.7	$0.1
Gasoline	$0.1	$0.0	$1.2	$0.1	$2.4	$0.1
Food & beverages purchased for off-premises consumption	$0.2	$0.0	$3.5	$0.3	$7.0	$0.5
Clothing and footwear	$0.3	$0.0	$5.1	$0.3	$10.2	$0.6
Miscellaneous expenditures	$0.8	$0.0	$13.0	$0.8	$26.0	$1.5
Medical Services	$0.0	$0.0	$0.1	$0.0	$0.3	$0.0
International Airfare	$1.0	$0.1	$18.0	$2.5	$36.0	$5.0
Total	**$4.8**	**$0.5**	**$80.4**	**$7.8**	**$160.7**	**$15.5**

Table 6-10. Increased Expenditure by Foreign Visitors due to Wait Time Reduction by USCGE Sector: Upper-bound Estimates (in millions of 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$0.6	$0.0	$9.7	$0.6	$19.3	$1.3
MPET	Petroleum Refining	$0.2	$0.0	$3.3	$0.1	$6.6	$0.3
MOND	Other Non-Durables Mftg	$3.0	$0.2	$49.9	$2.6	$99.8	$5.3
TAIR	Air Transport	$3.3	$0.4	$56.9	$6.8	$113.8	$13.6
TRAL	Rail Transport	$0.0	$0.0	$0.4	$0.0	$0.7	$0.1
TOTH	Other Transport	$0.1	$0.0	$1.9	$0.2	$3.8	$0.4
TLTP	Private Transit	$0.1	$0.0	$2.3	$0.2	$4.6	$0.5
HOTR	Hotels and Restaurants	$3.9	$0.4	$65.6	$6.9	$131.3	$13.8
PSRV	Personal Services	$0.0	$0.0	$0.4	$0.0	$0.7	$0.1
OBSV	Other Business Services	$0.4	$0.0	$6.4	$0.5	$12.8	$1.1
ENTR	Entertainment	$1.4	$0.1	$23.6	$0.9	$47.3	$1.9
MEDC	Medical Services	$0.0	$0.0	$0.4	$0.0	$0.8	$0.0
Total		**$13.1**	**$1.2**	**$220.7**	**$19.2**	**$441.4**	**$38.3**

Table 6-11. Increased Expenditure by Foreign Visitors due to Wait Time Reduction by USCGE Sector: Lower-bound Estimates (in millions of 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$0.2	$0.0	$3.5	$0.3	$7.0	$0.5
MPET	Petroleum Refining	$0.1	$0.0	$1.2	$0.1	$2.4	$0.1
MOND	Other Non-Durables Mftg	$1.1	$0.1	$18.1	$1.1	$36.2	$2.1
TAIR	Air Transport	$1.2	$0.2	$21.0	$2.8	$42.0	$5.6
TRAL	Rail Transport	$0.0	$0.0	$0.1	$0.0	$0.3	$0.0
TOTH	Other Transport	$0.0	$0.0	$0.7	$0.1	$1.4	$0.2
TLTP	Private Transit	$0.1	$0.0	$0.8	$0.1	$1.7	$0.2
HOTR	Hotels and Restaurants	$1.4	$0.2	$23.8	$2.8	$47.6	$5.5
PSRV	Personal Services	$0.0	$0.0	$0.1	$0.0	$0.3	$0.0
OBSV	Other Business Services	$0.1	$0.0	$2.3	$0.2	$4.6	$0.4
ENTR	Entertainment	$0.5	$0.0	$8.6	$0.4	$17.1	$0.7
MEDC	Medical Services	$0.0	$0.0	$0.1	$0.0	$0.3	$0.0
Total		**$4.8**	**$0.5**	**$80.4**	**$7.8**	**$160.7**	**$15.5**

6.3. Change in Domestic Expenditures by American Visitors Overseas

6.3.1. Average Expenditures Per U.S. Traveler

Reduction in wait time of CBP inspection also results in increased international leisure and business travels by U.S. residents. In this study, we assume that the increased travel expenditures abroad by the U.S. residents will result in reduced domestic spending of the same amount. Table 6-12 presents the average per person expenditure on international air transportation and the spending outside the U.S. by U.S. residents traveling abroad. The data are gathered from the Department of Commerce report on the profile of U.S. resident travelers visiting overseas destinations in 2012 (U.S. DOC, 2013b). On average, each American leisure travelers spent $2,612 per trip in 2012. The average per person spending of business trips was $4,538.

6.3.2. Total Change in Domestic Spending by U.S. Visitors Overseas

We compute the total change of expenditures on foreign travel by U.S. residents by multiplying the per visitor expenditures shown in Table 6-12 by the total number of increased returning U.S. residents presented in the last row of Tables 6-5 and 6-6 (for upper-bound and lower-bound estimates, respectively). The results are presented in Table 6-13 for the upper-bound estimates and in Table 6-14 for the lower-bound estimates. The first row of Tables 6-13 and 6-14 presents the total amount of reduced domestic spending by the U.S. resident travelers who increase their international travels. The second row of Tables 6-13 and 6-14 presents the increased revenue to the U.S. airline industry due to the increased international travel by the U.S. residents. These numbers are computed by applying the U.S. carrier shares for the U.S. air travelers presented in Table 6-7 to the total increased amount of international travel airfare expenditures by the U.S. residents.

For the +1 officer scenario, the decreased domestic spending by U.S. resident leisure and business travelers are estimated to be $14.8 million and $1.2 million, respectively, for the upper-bound estimates. The increased spending on U.S. airlines by U.S. travelers is estimated to be $3.3 million and $0.3 million for leisure and business travelers, respectively. For the 50% wait time reduction scenario, the decreased domestic spending is estimated to be $271 million and $22 million for U.S. resident leisure and business travelers, respectively, for the upper-bound estimates. The increased demand on U.S. airline services is $63 million and $6.2 million for leisure and business visitors, respectively. The estimates for the 100% wait time reduction scenario are two times of those in the 50% wait time reduction scenario. For all of the three wait time reduction scenarios, the lower-bound estimates are about 23% and 30% of the upper-bound estimates for leisure travelers and business travelers, respectively.

In the CGE modeling in the following chapter, we assume that the U.S. resident leisure travelers will reduce their domestic spending proportionally across *all* spending categories to offset their increased international travel expenditures. As for U.S. residents traveling abroad for business purposes, we assume that they will reduce *only* their domestic business travel expenditures as an offset. The total reduced domestic business travel expenditures by U.S. residents are first disaggregated among BEA travel-related commodity categories presented in Table 6-2 (using the data presented in the "Business" and "Government" columns combined). Then the expenditure changes are mapped to USCGE sectors, and are presented in Tables 6-14 and 6-15 for upper-bound and lower-bound estimates, respectively.

Table 6-12. Average Per Visitor Expenditures by U.S. Residents Traveling Abroad (in 2012$)

Expenditure Category	Leisure	Business
Airfare	$1,170	$2,155
Expenditures outside of U.S.	$1,442	$2,080
Total	**$2,612**	**$4,538**

Source: U.S. Department of Commerce (2013b).

Table 6-13. Changes in Expenditure by U.S. Residents Upper-bound Estimates (in millions of 2012$)

	+1 Officer		**Wait Time Falls by 50%**		**Wait Time Falls by 100%**	
Spending Change	**Leisure**	**Business**	**Leisure**	**Business**	**Leisure**	**Business**
Total Reduced Domestic Spending	-$14.8	-$1.2	-$270.9	-$21.7	-$541.8	-$43.5
Increased Spending on U.S. Airlines to Travel Abroad	$3.3	$0.3	$63.2	$6.2	$126.4	$12.3

Table 6-14. Changes in Expenditure by U.S. Residents: Lower-bound Estimates (in millions of 2012$)

	+1 Officer		**Wait Time Falls by 50%**		**Wait Time Falls by 100%**	
Spending Change	**Leisure**	**Business**	**Leisure**	**Business**	**Leisure**	**Business**
Total Reduced Domestic Spending	-$3.3	-$0.4	-$62.1	-$6.6	-$124.2	-$13.2
Increased Spending on U.S. Airlines to Travel Abroad	$0.8	$0.1	$14.6	$1.9	$29.2	$3.8

Table 6-15. Offsets in Domestic Expenditures by U.S. Residents Traveling on Traveling on International Business: Upper-bound Estimates (in millions of 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	$0.0	-$0.7	-$1.5
MPET	Petroleum Refining	-$0.1	-$2.3	-$4.5
MOND	Other Non-Durables Mftg	-$0.1	-$1.2	-$2.3
TAIR	Air Transport	-$0.1	-$2.2	-$4.3
TRAL	Rail Transport	$0.0	-$0.1	-$0.1
TOTH	Other Transport	$0.0	$0.0	$0.0
TLTP	Private Transit	$0.0	-$0.3	-$0.6
HOTR	Hotels and Restaurants	-$0.5	-$9.6	-$19.1
PSRV	Personal Services	$0.0	-$0.1	-$0.1
OBSV	Other Business Services	-$0.2	-$4.3	-$8.6
ENTR	Entertainment	-$0.1	-$1.1	-$2.2
Total		**-$1.2**	**-$21.7**	**-$43.5**

Table 6-16. Offsets in Domestic Expenditures by U.S. Residents Traveling on Traveling on International Business: Lower-bound Estimates (in millions of 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	$0.0	-$0.2	-$0.4
MPET	Petroleum Refining	$0.0	-$0.7	-$1.4
MOND	Other Non-Durables Mftg	$0.0	-$0.4	-$0.7
TAIR	Air Transport	$0.0	-$0.7	-$1.3
TRAL	Rail Transport	$0.0	$0.0	$0.0
TOTH	Other Transport	$0.0	$0.0	$0.0
TLTP	Private Transit	$0.0	-$0.1	-$0.2
HOTR	Hotels and Restaurants	-$0.2	-$2.9	-$5.8
PSRV	Personal Services	$0.0	$0.0	$0.0
OBSV	Other Business Services	-$0.1	-$1.3	-$2.6
ENTR	Entertainment	$0.0	-$0.3	-$0.7
Total		**-$0.4**	**-$6.6**	**-$13.2**

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Chapter 7: CGE Modeling Approach and Results

Fynn Prager and Adam Rose

7.1. Introduction

7.1.1. Macroeconomic Impacts

In this chapter, we estimate the macroeconomic impacts of reduced wait times at four major US airports. Previous chapters focused on direct impacts. Chapter 3 estimated the reduction in wait times from adding one CBP officer at each international terminal in these airports, as well as from a 50% wait time reduction scenario. It converted these estimates into the opportunity cost time savings to airline travellers. The chapter also estimated changes in the number of visitors to the US that reduced wait times would stimulate. In addition, it noted the likelihood that reduced weight times will also spur more travel by Americans for both leisure and business abroad, because it would reduce delays upon their return to the US.

Chapter 6, building on the estimates of changes in air passenger volume, computed the increase in direct expenditures by foreign airline travellers to the US for both the +1 and 50% wait time decrease scenarios. It also estimated the decreased expenditures for purchases of goods and services in the US due to increased airline travel abroad by Americans. Both sets of expenditure estimates were adjusted to account for spending on airline tickets from American carriers.

In this chapter, we take the estimates from Chapter 6 as an input into an economic model to estimate the indirect and total impacts from the +1 staffing change and the 50% wait time reduction scenarios. Indirect effects stem from several sources. First, direct changes in travel expenditures stimulate additional economic activity "upstream" through an increase in the demand along the supply chain. For example, increased spending in American restaurants stimulates the demand for beef, which in turn stimulates the demand for corn as feed, which in turn stimulates the demand for fertilizer, and so on. In addition restaurant employees receive additional wages (or new employees are hired), which induces spending on various consumer goods and services, which, in turn have further upstream ripple, or multiplier, effects.

Additional indirect impacts stem from price changes, both increasing and decreasing, for various products in our example. Increased demand for restaurants and hotels will raise their prices, not just for foreign tourists but for *everyone*. Moreover, these price increases have ripple effects of their own for goods and services downstream. For example, increased food prices affect not only restaurants but school lunches and meals at home. These price increases have an offsetting effect on the "quantity" stimulus described in the previous paragraph.

The combination of price and quantity effects is referred to as "general equilibrium" effects and can only be traced through a sophisticated economic model. In our analysis below, we perform our estimates from the ground up. That is, we separately estimate the implications of positive stimuli from increased international visitors and negative stimuli from increased American business and leisure travel abroad. We present total economic impacts in terms of two major economic indicators— Gross Domestic Product (GDP) and employment for each of the two scenarios, including the presence and absence of baggage delays.

7.1.2. The Computable General Equilibrium Modelling Approach

Several types of models are typically used to perform macroeconomic impact analyses. We chose a modelling approach for this project that we considered most appropriate given criteria such as accuracy, transparency and cost.

The three major macroeconomic impact modelling approaches are input-output analysis (I-O), macroeconometric (ME) and computable general equilibrium (CGE) (Rose, 2004; Rose, 2014). I-O is based on a double-entry bookkeeping set of transactions among economic sectors. It is a widely used tool because empirical versions are inexpensive and readily available for the US, its states and even its counties. I-O has several positive attributes, including its low cost, its accounting of all production inputs, and its focus on interdependence between economic sectors to trace out quantity multiplier effects. However, I-O is a linear model, which means it does not readily allow for substitution between production inputs and consumer commodity purchases, lacks behavioral content, and treats prices as of secondary importance (Rose and Miernyk, 1989).

ME models are typically based on long time series of data for multiple variables and formal statistical estimation. They divide the economy into distinct sectors and have a forecasting ability the other two approaches lack (but that is not needed for the case at hand). ME models are expensive and lack the transparency of the other two approaches (REMI, 2013; Rose et al., 2009).

CGE is a model of the entire economy based on decisions by individual producers and consumers in response to price signals within limits of available capital, labor and natural resources. Thus, CGE models maintain the advantages of I-O but overcome its limitations—they are non-linear, allow for substitution among production inputs and among consumer commodity purchases, have behavioral content, focus on the workings of markets and prices, and include explicit constraints on resource availabilities. CGE models can be “shocked” to reflect direct policy changes in one area of the economy. Indirect impacts then ripple throughout the CGE model with respect to the mechanisms detailed above. CGE models are the state-of-the-art approach for simulation purposes, and are more transparent and typically less expensive to construct than ME models (Rose, 1995; Dixon and Rimmer, 2002)

We use CREATE‘s US CGE Model. This model and its regional variants, have successfully been used in more than a dozen studies, including the economic impacts of 9/11 (Rose et al., 2009), simulations of terrorist attacks on the electricity and water systems of Los Angeles (Rose et al., 2007), a national foot and mouth disease epidemic (Oladosu et al., 2013), and trade-offs between urban security and commerce (Rose et al., 2014), as well as applications in other areas such as climate change policy (see, e.g., Oladosu and Rose, 2007; Prager, 2013).

The US CGE Model consists of 57 producing sectors. Institutions in the model are households, government, and external accounts. There are nine household income groups and two categories each of government (State/Local and Federal) and external accounts (Rest of the U.S. and Rest of the world). It is programmed and solved with the General Algebraic Modeling Software (GAMS). A detailed description of the Model is presented in Appendix 7-A.

7.2. Impact Analysis Overview

TABLE 7-1. IMPACT ANALYSIS OVERVIEW

	Positive Stimulus **Increase in Foreign Visitors to the US**	**Negative Stimulus (Offset Effect)** **Increase in US Residents Traveling Abroad**
Opportunity Cost Measurement (Chapters 2 and 3)	**Total estimates** of increase in foreign visitors to the US based on opportunity cost estimate model.	**Total estimates** of increase in US residents traveling abroad based on opportunity cost estimate model.
Expenditure Vector Measurement (Chapter 4)	**Direct Economic Impacts:** Change in spending by foreign visitors, distinguished by business (including government) and non-business (leisure), on US goods and services while in the country. Change in spending on international air transportation provided by U.S. carriers, also distinguished by business and leisure.	**Direct Economic Impacts:** Spending by US residents traveling abroad (for both business and leisure travel). This includes the total amount spent while abroad and the spending on international air transportation provided by U.S. airlines.
CGE Modeling (Chapter 5)	**Total Economic Impacts:** Two elements: 1. Increased spending by foreign visitors to the US (Simulation A). *Method*: Increase in exports -- according to the Direct Economic Impact levels estimated in Chapter 4 for the domestic sectors in which foreign visitors spend, 2. Increased spending by US residents and business travelers on US airlines to travel abroad (Simulation D). *Method*: Increase in sales to US	**Total Economic Impacts:** Two elements: 1. Decreased spending in the US due to increased US resident leisure travel abroad (Simulation B). *Method*: Reduction in household income to suppress household spending at the Direct Economic Impact levels determined in Chapter 4. The consumption function distributes these spending changes across sectors with respect to relevant variables, such as price changes. 2. Decreased spending in the US due to

	households and businesses from Air Transport sector for levels determined in Chapter 4.	increased US business travel abroad (Simulation C). *Method*: Reduction in business demand - according to Direct Economic Impact levels determined in Ch. 4– for sectors in which business travelers spend

Direct Economic Impact levels for these four Simulations are presented in Table 7-2. These levels are taken from the analysis presented in Chapters 4 and 6. For example, in the 50% Wait Time Reduction scenario, the Direct Economic Impact levels for the four Simulations outlined in Table 7-1 are:

- (Simulation A) Increased spending by foreign visitors to the US (Leisure $220.7m and Business $19.2m; Total $239.9m),
- (Simulation B) Decreased spending in the US due to increased US resident leisure travel abroad(-$270.9 m),
- (Simulation C) Decreased spending in the US due to increased US business travel abroad (-$21.7m),
- (Simulation D) Increased spending by US residents and business travelers on US airlines to travel abroad (Leisure $63.2 m and Business $6.2 m; Total $69.4 m).

TABLE 7-2. DIRECT IMPACT LEVELS OF INCREASED AIRLINE TRAVELERS (in millions of 2012 dollars)

	+1 Officer		50% Wait Time Reduction		100% Wait Time Reduction	
Direct Impact Category	**Leisure**	**Business**	**Leisure**	**Business**	**Leisure**	**Business**
A. Increase in expenditure by foreign visitors to the US	$13.1	$1.2	$220.7	$19.2	$441.4	$38.1
D. Increase in US residents spending on US airlines to travel abroad	$3.3	$0.3	$63.2	$6.2	$126.4	$12.3
B and C. Increase in US residents travelling abroad (reduced domestic spending)	-$14.8	-$1.2	-$270.9	-$21.7	-$541.8	-$43.5

Source: Computed by authors in Chapters 3 and 4.

7.3. Methodology and Basic Calculations

<u>Simulation A:</u> **Positive Stimulus, part 1**

Increased spending by foreign visitors to the US; Direct Economic Impact:

- **+1 Officer**: Leisure $13.1m and Business $1.2m; **Total $14.3m**.
- **50% Wait Time Reduction**: Leisure $220.7m and Business $19.2m; **Total $239.9m**

Method:

- An increase in exports - according to the Direct Economic Impact levels determined for the domestic sectors in which foreign visitors spend:
  - Petroleum
  - Other Non-Durable Manufacturing
  - Air Transport
  - Rail Transport
  - Other Transport
  - Private Transit
  - Hotels and Restaurants
  - Personal Services
  - Other Business Services
  - Entertainment
  - Medical Services

The following calculation steps were undertaken:

- These sectors are "shocked" in the model by the percentage levels presented in Table 7-3. When foreign visitors spend money in the US, they are effectively exporting goods to their country of residence. This is an external stimulus to the US economy. As such, exports are increased in the USCGE Model by the values presented in "Percent of Exports" column. For example, in the 50% Wait Time Reduction Scenario, Foreign Travelers increase spending on Air Transport by $63.7m, which accounts for 0.213% of exports by that sector.
- All else equal, we expect increases in exports to stimulate increases in domestic production, which in turn reduce prices and hence stimulate domestic demand. Total Economic Impacts are therefore expected to be increases to output and employment.
- Simulations for 50% Wait Time Reduction simulations are scaled down (divided) by 10, to enable the model to solve feasibly. CGE results are then scaled up (multiplied) by 10. No scaling is performed for the +1 Officer scenario.[60][61]

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[60] Aggregate results exclude the Construction sector impacts because of unreliable results for this sector in the model.

[61] When a previously endogenous variable like Exports of Air Transport is made endogenous, it is necessary to balance the number of equations and unknowns by making a previously exogenous variable endogenous. Therefore, the zero profit condition is relaxed for the Air Transport sector to enable the model to solve feasibly.

TABLE 7-3. BASELINE EXPORT AND GROSS OUTPUT USCGE DATA FOR SECTORS TO BE SHOCKED IN SIMULATION A, EXPORT STIMULUS

				Direct Export Stimulus					
		Baseline Exports		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
Sector	Baseline Output ($m)	Level ($m)	Percent of Gross Output (%)	Level ($m)	Percent of Exports	Level ($m)	Percent of Exports	Level ($m)	Percent of Exports
Other Food Mftg	356,718	22,942	6.43%	0.6	0.003%	10.3	0.045%	20.6	0.090%
Petroleum Refining	595,522	24,563	4.12%	0.2	0.001%	3.4	0.014%	6.9	0.028%
Other Non-Durables Mftg	828,824	71,900	8.67%	3.1	0.004%	52.6	0.073%	105.1	0.146%
Air Transport	114,869	29,943	26.07%	3.7	0.012%	63.7	0.213%	127.4	0.426%
Rail Transport	54,354	4,500	8.28%	0.0	0.001%	0.4	0.009%	0.8	0.018%
Other Transport	284,306	8,375	2.95%	0.1	0.001%	2.1	0.025%	4.2	0.050%
Private Transit	32,260	0	0.00%	0.2	0.000%	2.6	0.000%	5.1	0.000%
Hotels and Restaurants	674,819	270	0.04%	4.3	1.614%	72.5	26.910%	145.1	53.819%
Personal Services	151,098	0	0.00%	0.0	0.000%	0.4	0.000%	0.8	0.000%
Other Business Services	3,188,311	81,520	2.56%	0.4	0.001%	6.9	0.008%	13.8	0.017%
Entertainment	200,366	102	0.05%	1.5	1.440%	24.6	24.062%	49.1	48.124%
Medical Services	1,297,633	13	0.00%	0.0	0.199%	0.4	3.319%	0.9	6.638%
Total (all sectors)	24,826,107	1,237,883	4.99%	14.2	0.001%	239.9	0.019%	479.8	0.039%

__Simulation B:__ **Negative Stimulus, Offset Effect, part 1**

Decreased spending in the US due to increased US resident leisure travel abroad. Direct Economic Impact:

- **+1 Officer: -$14.8m**
- **50% Wait Time Reduction: -$270.9 m**.

__Method:__

A reduction in household income to suppress household spending at the Direct Economic Impact levels determined in Chapter 4. The CGE model consumption function distributes these spending changes across sectors with respect to relevant variables, such as price changes.

Since CGE models are based on equilibrium concepts, it is difficult to impose constraints on them, especially with respect to domestic spending by US households. A device that is typically used in CGE analysis is that of a "phantom tax", which effectively raises the price of a good to conform to a spending constraint. It is called a "phantom tax" because it is not actually collected and spent by government, and does not change the basic price of the good to the consumer (see Dixon and Rimmer, 2002). For Simulation B, we impose this device to dampen total US household demand on the household income function. For example, in the 50% Wait Time Reduction case, US household demand is constrained by $271m.

The calculation steps are shown in Table 7-6. The first column ("pre-policy") shows household demand in the base data. The second and third columns show the change in total household demand for the two scenarios. For example, in the 50% Wait Time reduction scenario, when household demand is dampened by $271m, this translates to a -0.002922% change. Hence we impose the aforementioned calculation procedure, and iterated towards the change in household income which suppresses household demand by the desired percentage.

TABLE 7-4. HOUSEHOLD DEMAND IMPACTS RESULTING FROM SIMULATION B (Changes in Household Demand)

Pre-Policy Household Demand Level ($bn)	+1 Officer, Desired Household Demand Level ($bn)	50% Wait Time Reduction, Desired Household Demand Level ($bn)
9,269.084	9,269.069	9,268.813
Level Change	-0.015	-0.271
% Change	-0.000159%	-0.002922%

<u>Simulation C:</u> Negative Stimulus, Offset Effect, part 1

Decreased spending in the US due to increased US business travel abroad; Direct Economic Impact**:**

- **+1 Officer: -$1.2m**
- **50% Wait Time Reduction: -$21.7m.**

<u>Method</u>:

A reduction in business demand - according to Direct Economic Impact levels determined in Chapter 5 – for sectors which business travelers spend in:

- Air Transport
- Rail Transport
- Other Transport, Private Transit
- Retail Trade

- Hotels and Restaurants
- Personal Services
- Other Business Services
- Entertainment
- Medical Services

The following calculation steps were undertaken:

- As with Simulation B, we used a "phantom tax" approach. We constrained business travel demand by increasing the price of sectors which business travelers spend in. Also like Simulation B, we iterated towards the desired demand change by first estimating the shock level.
- However, for Simulation C numerous sectors are constrained at once. It is therefore not always possible to achieve the desired demand changes precisely for each sector. As shown in Table 7-5, we were able to estimate the desired demand changes to within less than $0.4 million for most sectors.[62]

TABLE 7-5: SIMULATION C SHOCK TO DEMAND PRICE (50% Wait Time Reduction Scenario).

Sectors	Desired Demand Change ($m)	Closest CGE Result Demand Change ($m)	Difference ($m)	Demand Price Change Used in Shock
TAIR	-2.169	-2.163	0.006	1.00007892
TRAL	-0.059	0.152	0.211	1.00000174
TWAT	0.000	0.000	0.000	1.00000000
TOTH	-0.009	-0.247	-0.238	1.00000004
TLTP	-0.288	-0.286	0.002	1.00003022
RTRD	-4.184	-4.573	-0.389	1.00000100
HOTR	-9.564	-9.504	0.060	1.00001802
PSRV	-0.058	-0.321	-0.263	1.00000556
OBSV	-4.294	-5.247	-0.953	1.00000001
ENTR	-1.118	-1.113	0.005	1.00000488
Total	-21.744	-23.302	-1.559	

[62] The exception here is Other Business Services (OBSV), which is $0.95 million different from the desired demand level. It is not possible to be more precise with this sector because it is usually large. Other Business Services is the largest sector in the model, with an output of $3.2 trillion, or 13 percent of total gross output.

<u>Simulation D:</u> Positive Stimulus, part 2

Increased spending by US residents and business travelers on US airlines to travel abroad; Direct Economic Impact:

- **+1 Officer:** Leisure $3.3m and Business $0.3m; **Total $3.7m**
- **50% Wait Time Reduction:** Leisure $63.2m and Business $6.2m; **Total $69.4m.**

Method:

An increase in sales to US households and businesses from Air Transport sector for levels determined in Chapter 5. Here we used a "phantom subsidy" approach, this time stimulating demand for Air Transport by reducing the indirect tax on that sector. An iterative approach was used to identify the change to indirect tax that would stimulate demand to the desired levels. For the +1 Officer Scenario, the change to indirect tax was 0.00569, while for the 50% Wait Time Reduction, the change to indirect tax was 0.1079

7.4. Results

7.4.1. +1 CBP Officer at each POE Case

TABLE 7-6. ECONOMIC IMPACTS OF DECREASES IN WAIT TIMES AT SELECTED U.S. AIR PORTS OF ENTRY (+1 CBP Officer at each POE)

Simulation	Direct Impact	GDP (million 2012$)		Employment (Jobs)	
		Lower bound	Upper bound	Lower bound	Upper bound
A	Increased spending by foreign visitors to the US	$4.1	$11.1	49	132
B	Decreased spending in the US due to increased US leisure travel abroad	-$0.8	-$3.6	-14	-63
C	Decreased spending in the US due to increased US business travel abroad	-$0.4	-$1.4	-7	-24
D	Increased spend by US leisure and business travelers on US airlines to travel abroad	$1.3	$5.7	9	37
	Total	**$4.2**	**$11.8**	**37**	**82**

7.4.2. 50% Wait Time Reduction Case

TABLE 7-7. ECONOMIC IMPACTS OF DECREASES IN WAIT TIMES AT SELECTED U.S. AIR PORTS OF ENTRY (50% Wait Time Reduction)

		GDP (million 2012$)		Employment (Jobs)	
Simulation	Direct Impact	Lower bound	Upper bound	Lower bound	Upper bound
A	Increased spending by foreign visitors to the US	$45.5	$123.8	614	1673
B	Decreased spending in the US due to increased US leisure travel abroad	-$14.2	-$61.8	-299	-1303
C	Decreased spending in the US due to increased US business travel abroad	-$8.0	-$26.3	-134	-440
D	Increased spend by US leisure and business travelers on US airlines to travel abroad	$14.2	$59.7	145	610
	Total	**$37.5**	**$95.4**	**326**	**540**

7.5. Sectoral Results

Table 7-8 presents the 5 sectors most positively impacted in each Simulation. Comprehensive sector-by-sector results are presented in Appendix 7-B. Simulations A is the positive stimulus impacts from foreign visitors purchasing goods and services in the U.S. The sectors in Table 7-8 are those stimulated by Simulation A; the exception, Wholesale Trade, is likely to be stimulated as an upstream client of many of these shocked sectors. Similarly, Simulation D is a focused positive stimulus to Air Transport. Air Transport is therefore the most positively impacted sector, and other sectors are clearly linked in terms of supply-chain relationships. Simulations B and C both feature negative direct impacts. As such, the positively impacted sectors are likely to be those benefitting from price decreases and substitution effects.

TABLE 7-8. TOP 5 SECTORS POSITIVELY IMPACTED BY DECREASES IN WAIT TIMES AT SELECTED U.S. AIR PORTS OF ENTRY (+1 CBP Officer at each POE, Upper Bound)

Simulation A				Simulation B			
Sectors	**% Δ**	**GDP**	**Jobs**	**Sectors**	**% Δ**	**GDP**	**Jobs**
Air Transport	0.00445%	2.2	16	Construction	0.00017%	1.3	21
Wholesale Trade	0.00073%	6.3	47	Other Mining	0.00016%	0.1	1
Hotels and Restaurants	0.00037%	1.4	40	Other Durable Mfg	0.00002%	0.2	2
Entertainment	0.00036%	0.4	11	Electronics Mfg	0.00002%	0.0	0
Other Food Mfg.	0.00031%	0.2	2	Real Estate	0.00001%	0.1	1
Simulation C				**Simulation D**			
Sectors	**% Δ**	**GDP**	**Jobs**	**Sectors**	**% Δ**	**GDP**	**Jobs**
Wholesale Trade	0.00003%	0.2	2	Air Transport	0.00318%	1.6	12
Water Transport	0.00002%	0.0	0	Wholesale Trade	0.00064%	5.5	41
Rail Transport	0.00000%	0.0	0	Other Transport	0.00016%	0.3	5
Fisheries	0.00000%	0.0	0	Personal Services	0.00015%	0.2	3
Dairy Farming	0.00000%	0.0	0	Petroleum Refineries	0.00008%	0.1	0

7.6. Overall Results and Conclusions

Tables 7-9 and 7-10 present Overall Results and Implicit multipliers. Multipliers represent total impacts on the economy divided by the direct impact for each of our two major economic indicators. The total impacts include all of the supply chain relationships. It is important to note that CGE multipliers tend to be lower than corresponding I-O multipliers primarily because of offsetting price effects.

In our simulations, Simulations A, C, and D are largely in the generally anticipated range of CGE multipliers; between 1 and 3. It is notable that the implicit multipliers for Simulation B are the smallest, and less than 1 in both cases, which means the total impact is smaller than the direct impact. In Simulation B, the dampening of household demand reduces prices for many sectors, which in turn stimulates demand from business purchasers, and hence offsets some of the direct impacts. Simulation B results also contribute to the overall implicit multiplier being significantly larger than the implicit multiplier for Simulations A-D. Simulations A and B, which drive the overall results because they are larger than Simulations C and D, have similar direct impact values, yet Simulation B total impacts are much smaller in magnitude. The combination of these factors means that the overall implicit multiplier is significantly larger in absolute value than the implicit multiplier for each Simulation.

TABLE 7-9. OVERALL RESULTS AND IMPLICIT MULTIPLIERS
(+1 CBP Officer at each POE, Upper-Bound)

Simulation	Direct Impact		Total (CGE)		Implicit Multiplier	
	GDP (2012 $m)	Jobs	GDP (2012 $m)	Jobs	GDP (2012 $m)	Jobs
A	$7.9	92	$11.1	132	1.41	1.44
B	-$8.2	-95	-$3.6	-63	0.44	0.67
C	-$0.7	-8	-$1.4	-24	2.18	3.14
D	$2.0	24	$5.7	37	2.80	1.57
Total	$1.1	13	$11.8	81	10.96	6.49

TABLE 7-10. OVERALL RESULTS AND IMPLICIT MULTIPLIERS
(50% Wait Time Reduction, Upper-Bound)

Simulation	Direct Impact		Total (CGE)		Implicit Multiplier	
	GDP (2012 $m)	Jobs	GDP (2012 $m)	Jobs	GDP (2012 $m)	Jobs
A	$132.9	1547	$123.8	1673	0.93	1.08
B	-$150.0	-1747	-$61.8	-1303	0.41	0.75
C	-$12.0	-140	-$26.3	-440	2.18	3.14
D	$38.4	447	$59.7	610	1.56	1.36
Total	$9.2	107	$95.4	539	10.37	5.03

Our major conclusions are:

- There is an overall stimulus to the U.S. economy (GDP and jobs) from reducing wait times. Each Simulation reflects a different component of the overall economic impact. When these impacts are combined, there is a net positive impact on the U.S. economy in terms of GDP and employment.
    - For the +1 CBP Officer at each POE upper-bound case, the result is a $11.8 million increase in GDP and 81 additional jobs.
    - For the 50% Wait Time Reduction at each POE upper-bound case, the result is a $95.4 million increase in GDP and 539 additional jobs.

- Direct impacts largely offset one another. As shown in Table 7-9, and detailed in Chapter 6, the direct impact benefits of increases in the numbers of incoming tourists only slightly outweigh the offset effect of U.S. residents traveling abroad, once the necessary adjustments for Air Transport expenditures are made. Therefore, while reduced wait times are beneficial to the global economy, the direct impacts are only marginally beneficial to the U.S. economy.

- However, total impacts identified in this Chapter are more positive than direct impacts because of the following factors:
    - Simulations A and B drive the overall results. The former is an increase in foreign visitors spending in the U.S., while the latter is the U.S. resident travel offset effect. These Simulations are significantly larger in terms of direct and total impacts than Simulation C and D, which are respectively the U.S. business travel offset effect and the positive stimulus to Air Transport.
    - While Simulations A and B have similar direct impacts, the positive total impacts for Simulation A are larger in magnitude than the negative total impacts for Simulation B.
    - This result is reflected in the implicit multiplier results in Tables 9 and 10.

- Results comparisons for the +1 CBP Officer and 50% Wait Time Reduction Scenarios follow intuition. The ratio of 50% Wait Time Reduction to +1 CBP Officer is 8.5:1 the size of total direct impacts, 8.1:1 for total GDP impacts, and 6.6:1 for total employment impacts. Comparative results for the two Scenarios are also similar for each Simulation. The one exception is Simulation A, which has a ratio of 17:1 for direct impacts and 11:1 for total GDP impacts. This result is reflected in Tables 9 and 10 by the fact that the implicit multiplier for the +1 CBP Officer Scenario (1.41) is greater than the 50% Wait Time Reduction Scenario implicit multiplier (0.93).

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Appendix 7-A: USCGE Model

This analysis adapts the USCGE model developed by Gbadebo Oladosu and Adam Rose (Rose et al., 2009; Oladosu and Rose, 2007; Rose and Oladosu, 2002; Oladosu, 2000) to analyze the economic impacts of environmental policy and disasters. The model consists of 65 producing sectors, along with mulitiple institutions: households (divided into nine household income groups), government (divided into two groups of state and local, and federal), and external agents (i.e. foreign producers). The model represents production activities as a series of nested constant elasticity of substitution (CES) functions. For international trade, the model employs Armington functions for imports and the constant elasticity of transformation function for exports. Armington functions separate out imported and domestically produced goods, ideally to reflect differential quality and consumer preferences, which allows for substitution between the two categories of goods. After governments collect taxes from labor and capital income, the remaining income goes to households and foreign entities according to fixed shares. Transfers also occur between institutions in the form of subsidies, social security payments, and income taxes.

A Linear Expenditure System of aggregate commodities (such as Food, Housing, and Gasoline) represents household consumption behavior, while a Leontief expenditure function characterizes government consumption. Household and government borrowing and saving functions are specified, and the consequent investments are allocated to finance capital goods. Equilibrium conditions include the balancing of supply and demand across sectoral product markets, while the labor market follows Keynesian assumptions to allow for an unemployment equilibrium. Data from government and the academic literature is used to formulate key aspects of this model: Social Accounting Matrices for national and selected states, as well as wage and employment data.[63]

Each sector is assumed to be model by a representative producer. “The aggregate profit obtained by each production unit maximizing profit separately taking prices as given is the same as that which would be obtained if they were to coordinate their decision” (Mas-Colell, Whinson, & Green, 1995). Aggregation issues are also relevant when considering substitution functions. “Separability” is assumed, meaning that the marginal rate of substitution between any two factors (see Figure A1 for the nesting structure) in a given group is independent from the marginal rates of substitution elsewhere in the nesting structure.

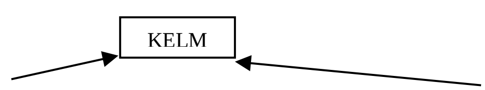
Producer behavior in CGE models is usually represented by the constant elasticity of substitution (CES) functional form. Examples of CES and CET (constant elasticity of transformation, the corollary function using a negative elasticity of substitution, in this case to represent shifts between domestic and foreign sales) functions are presented in equations 1) and 6) below. CES functions range from perfect to no substitution between factors. Perfect substitution means that two factors or goods can be substituted without a change to utility,

[63] These data are acquired from IMPLAN, a national and regional economic accounts data provider (IMPLAN, 2010) and government sources.

ceteris paribus. This implies that an increase in the price of one good or factor would increase demand for the other good or factor. Perfect substitution, also known as the Leontief or fixed input coefficient function, is represented by a straight-line isoquant with an elasticity of substitution value of 1(σ= 1). At the other extreme, no substitution is represented by the right-angled isoquant with the negative infinity elasticity of substitution value ($\sigma = -\infty$). In between is unit elasticity of substitution, which corresponds to the Cobb-Douglass function, and is represented by a curved isoquant with an elasticity of substitution of zero ($\sigma = 0$).

The cost functions used in the USCGE model are constant returns to scale form, non-separable, nested constant elasticity of substitution (NNCES), which is shown in equations 9 and 10 below. As shown in Figure A1, the nesting structure is divided into 6 levels. The top level ("KELM") represents substitution possibilities between sub-aggregates of Capital (K), Labor (L), Energy (E) and Materials inputs (M). Level 2 separates substitution possibilities into two groups – an aggregation of Capital, Energy, and Labor inputs (KEL), and a material input aggregate (M). Level 3 further separates the KEL nest into an aggregate of Capital and Energy inputs (KE) on one side, and Labor inputs on the other (L). In addition, the materials nest is separated into three further aggregates: 1) Services (S), which further disaggregates in Level 4 to Financial Services (FS)[64] and Other Services (OS);[65] 2) Manufactured Goods (M1), which disaggregates to Chemical Materials (CM)[66] and Other Materials (OM)[67]; and 3) Transport, which disaggregates to Transport Services (TR)[68] and Other Transport (OT).[69] Also in Level 4, Capital (K) and Energy (E) are separated.

Level 1



[64] The Financial Services nest is an aggregate of the intermediate good inputs of Finance Banking and Credit (BANK), Security Brokers (SECB), and Insurance (INSR).

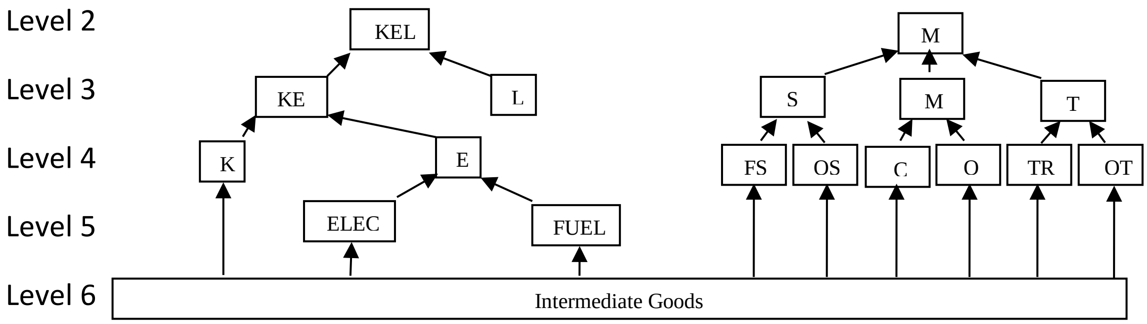
[65] The Other Services nest is an aggregate of the intermediate good inputs of Sanitary Services (SANT), Wholesale Trade (WTRD), Retail Trade (RTRD), Real Estate (REST), Owner-Occupied Dwellings (OODW), Hotel and Restaurants (HOTR), Personal Services (PSRV), Veterinary Services (VSRV), Waste Management and Remediation (WAST), Other Business Services (OBSV), Entertainment (ENTR), Education (EDUC), Medical Services (MEDC), Other Health and Social Services (OSOC), Federal Military (FGML), Other Government (OGOV), and State and Local Government (SGGV).

[66] The Chemical Materials nest is an aggregate of the intermediate good inputs from Chemicals Manufacturing (MCHM), Private Water Utilities (PWAT), and Government Utilities (GVUT).

[67] The Other Materials nest is an aggregate of the intermediate good inputs from Agriculture (ABEEF, ADARY, AOLVS, APOUL, AFISH, AOTH), Mining (CRUD, OMIN), Construction (CNSR), Food Manufacturing (MFML, MOML, MANM, MPTY, MFSH, MOFD), other Durable and Non-Durable Manufacturing (MOND, MPRM, MORD, MSEM, MODR), Communications (COMC, INFO) and Non-comparable Imports (NCMP).

[68] The Transport Services nest consists of Air Transport (TAIR), Truck Transport (TRUK), Water Transport (TWAT), and Rail Transport (TRAL).

[69] The Other Transport nest consists of Other Transport (TOTH), Private Transit (TLTP), and Local Public Transportation (TLTG).



L = Labor	T = Transport	FS = Finance
K = Capital	S = Services	CM = Chemicals
E = Energy	M = Materials	OM = Other Materials
FUEL= Fossil Fuels	M1 = Materials Sub	TR = Transport (Truck, Rail, Water and Air)
ELEC = Electricity Generation	OT = Other Transport Services	

FIGURE A1. USCGE NESTING STRUCTURE

International trade is represented by the Armington relationship for imports and the constant elasticity of transformation for exports below. A CES function allows for demand substitution between domestic goods and competitive imports. This represents the corollary for substitutions between exports and domestic markets to characterize the revenue-maximizing behavior of domestic firms. In line with the small country assumption, import and export prices are fixed as equivalent to world prices. The small country assumption is relaxed for individual sectors as part of the simulation modeling, which is discussed further in the following chapter.

Household consumption is divided across numerous aggregate commodities via a Linear Expenditure System. The cost of household services incorporates household demands along with the changes to prices of composite goods adjusted for household substitution elasticity values. These factors, along with the household consumption data, inform expenditure shares on household services and household disposable income, which is household labor and capital income less taxes and transfers, combine to determine household demand and total purchases across these aggregate commodity groups. Finally, the household utility function accounts for changes to household disposable income, commodity price changes, and household substitution effects. The household utility function also sums across households to represent total societal utility.

Government consumption is represented by a Leontief expenditure function. Household and government savings are fixed proportions of disposable income (i.e. income following adjustments for taxes and transfers) and are balanced by savings by foreign sources. Each of these institutions also undertakes capital borrowing. Investments are financed by net institutional savings plus depreciation charges and retained earnings (thus mirroring the deductions from household capital income).

Counter-factual (simulations) analyses first establish a base case simulation with no policy impacts. In this analysis, we employ a short-run closure rule is implemented for both the base case and policy impact simulations, which assumes that capital factor use remains constant – on the basis that capital investments are immobile in the short-run – and the labor wage rate also remains constant, following the intuition of short-run "sticky" wages (Oladosu and Rose, 2007, Dixon and Rimmer, 2002). The implication of these two constraints is that the short-run closure rule assumes that capital rates of return are flexible, and that employment levels will adjust to meet these aforementioned sticky wages with respect to economic pressures facing companies.

Appendix 7-B: Sectoral Results

TABLE B1.SECTORAL OUTPUT IMPACTS OF SIMULATIONS A & B, FOR +1 OFFICER SCENARIO.

	Simulation A				Simulation B			
	GDP		Employment		GDP		Employment	
Sector	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
ABEEF	0.003	0.008	0	0	-0.001	-0.005	0	0
ADARY	0.001	0.004	0	0	-0.002	-0.008	0	0
AOLVS	0.004	0.011	0	0	-0.003	-0.012	0	0
APOUL	0.002	0.004	0	0	-0.001	-0.005	0	0
AFISH	0.002	0.004	0	0	-0.001	-0.003	0	0
AOTH	0.017	0.046	0	1	-0.005	-0.021	0	0
COAL	0.004	0.010	0	0	-0.001	-0.005	0	0
CRUD	0.006	0.016	0	0	-0.002	-0.008	0	0
OMIN	-0.167	-0.453	-1	-2	0.030	0.131	0	1
CNSR	*	*	*	*	0.295	1.302	5	21
MFML	-0.002	-0.004	0	0	-0.001	-0.002	0	0
MOML	0.004	0.011	0	0	-0.001	-0.005	0	0
MANM	0.006	0.017	0	1	-0.002	-0.009	0	0
MPTY	0.003	0.009	0	0	-0.002	-0.009	0	0
MFSH	0.000	0.000	0	0	0.000	-0.001	0	0
MOFD	0.086	0.233	1	2	-0.011	-0.050	0	0
MCHM	0.036	0.099	0	0	-0.010	-0.043	0	0
MPET	-0.020	-0.053	0	0	0.000	-0.001	0	0
MOND	0.272	0.737	2	6	-0.023	-0.100	0	-1
MPRM	-0.007	-0.018	0	0	0.000	-0.001	0	0
MORD	0.000	0.001	0	0	0.000	0.000	0	0
MSEM	-0.151	-0.411	-1	-2	0.009	0.040	0	0
MODR	-0.430	-1.167	-4	-12	0.038	0.168	0	2
TAIR	0.807	2.188	6	16	-0.001	-0.002	0	0
TRUK	0.000	0.001	0	0	-0.013	-0.058	0	-1
TWAT	-0.014	-0.038	0	0	0.000	-0.001	0	0
TRAL	-0.004	-0.011	0	0	0.000	-0.001	0	0
TOTH	0.083	0.225	1	4	0.004	0.018	0	0
TLTP	0.002	0.006	0	0	0.000	-0.001	0	0
COMC	0.034	0.093	0	0	-0.032	-0.142	0	-1
INFO	-0.070	-0.191	0	-1	-0.015	-0.065	0	0
PELE	0.008	0.022	0	0	-0.007	-0.032	0	0
GASU	0.002	0.005	0	0	-0.002	-0.007	0	0
PWAT	0.000	0.000	0	0	0.000	0.000	0	0

SANT	0.001	0.001	0	0	0.000	0.000	0	0
WTRD	2.319	6.288	17	47	**	**	**	**
RTRD	-0.063	-0.170	-1	-3	-0.294	-1.298	-6	-26
REST	0.024	0.066	0	1	0.023	0.102	0	1
BANK	0.060	0.164	0	1	-0.068	-0.300	0	-2
SECB	0.016	0.044	0	1	-0.025	-0.110	0	-2
INSR	0.021	0.056	0	0	-0.119	-0.526	-1	-4
OODW	0.003	0.008	0	0	-0.002	-0.008	0	0
HOTR	0.507	1.374	15	40	-0.101	-0.445	-3	-13
PSRV	0.021	0.056	0	1	-0.012	-0.055	0	-1
VSRV	0.004	0.011	0	0	-0.010	-0.045	0	-1
WAST	0.001	0.002	0	0	-0.001	-0.006	0	0
OBSV	0.317	0.861	4	12	-0.020	-0.090	0	-1
ENTR	0.165	0.448	4	11	-0.046	-0.202	-1	-5
EDUC	0.025	0.067	0	1	-0.143	-0.630	-3	-11
MEDC	0.126	0.342	2	5	-0.156	-0.692	-2	-9
OSOC	0.021	0.057	1	2	-0.050	-0.220	-2	-7
GELE	0.001	0.003	0	0	-0.001	-0.006	0	0
TLTG	0.003	0.009	0	0	0.000	-0.001	0	0
GVUT	0.002	0.005	0	0	-0.001	-0.004	0	0
FGML	-0.004	-0.010	0	0	-0.002	-0.010	0	0
OGOV	0.009	0.025	0	0	-0.015	-0.067	0	0
SGGV	0.000	0.000	0	0	0.000	0.000	0	0
Total Impact	**4.097**	**11.108**	**49*** **	**132*** **	**-0.804**	**-3.556**	**-14*** **	**-63*** **
Direct Impact	**5.247**	**14.225**			**-3.337**	**-14.753**		

*Construction (CNSR) results are removed from the results for Simulation A.
** Wholesale Trade (WTRD) results are removed from the results for Simulation B.
*** Total Impact results for Employment may not match the sum of column values due to rounding.

TABLE B2: SECTORAL OUTPUT IMPACTS OF SIMULATIONS C & D, FOR +1 OFFICER SCENARIO.

	Simulation C				Simulation D			
	GDP		Employment		GDP		Employment	
Sector	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
ABEEF	0.000	0.000	0	0	0.000	0.001	0	0
ADARY	0.000	0.000	0	0	0.001	0.004	0	0
AOLVS	0.000	0.000	0	0	0.000	0.001	0	0
APOUL	0.000	0.000	0	0	0.000	0.001	0	0
AFISH	0.000	0.000	0	0	0.000	-0.001	0	0
AOTH	0.000	-0.001	0	0	-0.003	-0.013	0	0
COAL	0.000	0.000	0	0	0.001	0.004	0	0
CRUD	0.000	-0.002	0	0	0.011	0.047	0	0
OMIN	-0.006	-0.019	0	0	-0.051	-0.215	0	-1
CNSR	-0.056	-0.186	-1	-3	-0.500	-2.127	-8	-34
MFML	0.000	0.000	0	0	0.000	0.001	0	0
MOML	0.000	0.000	0	0	0.000	0.001	0	0
MANM	0.000	0.000	0	0	0.000	0.001	0	0
MPTY	0.000	0.000	0	0	0.000	0.002	0	0
MFSH	0.000	0.000	0	0	0.000	0.001	0	0
MOFD	-0.001	-0.003	0	0	0.001	0.004	0	0
MCHM	-0.004	-0.012	0	0	-0.009	-0.037	0	0
MPET	-0.001	-0.005	0	0	0.020	0.086	0	0
MOND	-0.006	-0.018	0	0	-0.005	-0.021	0	0
MPRM	-0.001	-0.003	0	0	-0.006	-0.026	0	0
MORD	0.000	0.000	0	0	0.000	0.000	0	0
MSEM	-0.013	-0.044	0	0	-0.089	-0.377	0	-2
MODR	-0.027	-0.091	0	-1	-0.170	-0.724	-2	-7
TAIR	-0.066	-0.220	0	-2	0.368	1.565	3	12
TRUK	-0.003	-0.009	0	0	-0.006	-0.026	0	0
TWAT	0.001	0.003	0	0	-0.007	-0.032	0	0
TRAL	0.000	0.001	0	0	-0.005	-0.020	0	0
TOTH	-0.005	-0.015	0	0	0.070	0.296	1	5
TLTP	-0.002	-0.007	0	0	0.001	0.003	0	0
COMC	-0.007	-0.024	0	0	0.023	0.099	0	0
INFO	-0.009	-0.030	0	0	-0.019	-0.080	0	-1
PELE	-0.001	-0.003	0	0	0.003	0.011	0	0
GASU	0.000	-0.001	0	0	0.001	0.002	0	0
PWAT	0.000	0.000	0	0	0.000	0.000	0	0
SANT	0.000	0.000	0	0	0.000	0.001	0	0
WTRD	0.065	0.217	0	2	1.296	5.513	10	41

RTRD	-0.054	-0.178	-1	-4	-0.035	-0.147	-1	-3
REST	-0.010	-0.033	0	0	0.023	0.097	0	1
BANK	-0.009	-0.031	0	0	0.037	0.158	0	1
SECB	-0.004	-0.013	0	0	0.010	0.042	0	1
INSR	-0.009	-0.031	0	0	0.026	0.112	0	1
OODW	-0.001	-0.002	0	0	0.002	0.007	0	0
HOTR	-0.086	-0.285	-2	-8	0.031	0.133	1	4
PSRV	-0.001	-0.002	0	0	0.036	0.153	1	3
VSRV	-0.001	-0.002	0	0	0.002	0.007	0	0
WAST	0.000	-0.002	0	0	-0.001	-0.002	0	0
OBSV	-0.057	-0.189	-1	-3	0.156	0.663	2	9
ENTR	-0.011	-0.037	0	-1	0.009	0.038	0	1
EDUC	-0.009	-0.031	0	-1	0.030	0.128	1	2
MEDC	-0.028	-0.093	0	-1	0.059	0.251	1	3
OSOC	-0.004	-0.015	0	0	0.012	0.052	0	2
GELE	0.000	-0.001	0	0	0.000	0.001	0	0
TLTG	-0.002	-0.005	0	0	-0.001	-0.002	0	0
GVUT	0.000	-0.001	0	0	0.000	0.002	0	0
FGML	0.000	-0.001	0	0	-0.002	-0.010	0	0
OGOV	-0.003	-0.009	0	0	0.008	0.032	0	0
SGGV	0.000	0.000	0	0	0.000	0.000	0	0
Total Impact	**-0.432**	**-1.434**	**-7*****	**-24*****	**1.331**	**5.660**	**9*****	**37*****
Direct Impact	**-0.357**	**-1.186**			**0.859**	**3.655**		

***Total Impact results for Employment may not match the sum of column values due to rounding.

Appendix A. Tourist Expenditure Change Vectors for Individual Terminals

In this appendix, we present the expenditure change vectors associated with wait time changes in each of the 14 airport terminals evaluated in this study.   The expenditure change vectors are presented for both foreign leisure and business travelers visiting the U.S., as well as the U.S. residents traveling abroad. For the latter, the focus is the reduction in domestic spending, which is assumed to be equivalent to the increased expenditures associated with increased international travels in response to CBP wait time reduction.

Table A1. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in ORD: Upper-bound Estimates (in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$47,797	$7,752	$741,683	$120,287	$1,483,366	$240,575
MPET	Petroleum Refining	$16,368	$1,590	$253,994	$24,676	$507,987	$49,351
MOND	Other Non-Durables Mftg	$246,928	$32,633	$3,831,640	$506,370	$7,663,280	$1,012,739
TAIR	Air Transport	$358,840	$109,049	$5,568,204	$1,692,135	$11,136,408	$3,384,270
TRAL	Rail Transport	$1,787	$476	$27,732	$7,382	$55,464	$14,764
TOTH	Other Transport	$9,288	$2,472	$144,131	$38,365	$288,262	$76,731
TLTP	Private Transit	$11,416	$3,039	$177,145	$47,153	$354,290	$94,307
HOTR	Hotels and Restaurants	$324,627	$85,484	$5,037,313	$1,326,483	$10,074,626	$2,652,967
PSRV	Personal Services	$1,751	$466	$27,166	$7,231	$54,332	$14,462
OBSV	Other Business Services	$31,537	$6,781	$489,365	$105,229	$978,730	$210,458
ENTR	Entertainment	$116,859	$11,561	$1,813,328	$179,400	$3,626,655	$358,799
MEDC	Medical Services	$2,032	$280	$31,536	$4,340	$63,072	$8,681
Total		**$1,169,230**	**$261,583**	**$18,143,236**	**$4,059,052**	**$36,286,473**	**$8,118,103**

Table A2. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in ORD: Lower-bound Estimates (in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$19,854	$3,496	$308,086	$54,253	$616,173	$108,505
MPET	Petroleum Refining	$6,799	$717	$105,506	$11,129	$211,012	$22,259
MOND	Other Non-Durables Mftg	$102,571	$14,718	$1,591,618	$228,386	$3,183,236	$456,772
TAIR	Air Transport	$149,058	$49,184	$2,312,966	$763,197	$4,625,932	$1,526,394
TRAL	Rail Transport	$742	$215	$11,520	$3,329	$23,039	$6,659
TOTH	Other Transport	$3,858	$1,115	$59,870	$17,304	$119,740	$34,608
TLTP	Private Transit	$4,742	$1,371	$73,584	$21,267	$147,168	$42,535
HOTR	Hotels and Restaurants	$134,846	$38,556	$2,092,440	$598,279	$4,184,880	$1,196,557
PSRV	Personal Services	$727	$210	$11,284	$3,261	$22,569	$6,523
OBSV	Other Business Services	$13,100	$3,059	$203,276	$47,461	$406,553	$94,922
ENTR	Entertainment	$48,542	$5,214	$753,235	$80,914	$1,506,470	$161,828
MEDC	Medical Services	$844	$126	$13,100	$1,958	$26,199	$3,915
Total		**$485,684**	**$117,981**	**$7,536,486**	**$1,830,738**	**$15,072,971**	**$3,661,476**

Table A3. Changes in Expenditure by U.S. Residents (upper-bound estimates for ORD; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$2,149,155	-$205,938	-$31,694,929	-$3,037,102	-$63,389,859	-$6,074,204
Increased Spending on U.S. Airlines to Travel Abroad	$567,900	$65,803	$8,375,181	$970,440	$16,750,363	$1,940,879

Table A4. Changes in Expenditure by U.S. Residents (lower-bound estimates for ORD; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$529,940	-$66,274	-$7,838,495	-$979,386	-$15,676,990	-$1,958,771
Increased Spending on U.S. Airlines to Travel Abroad	$140,033	$21,177	$2,071,272	$312,941	$4,142,544	$625,883

Table A5. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for ORD; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$7,018	-$103,498	-$206,995
MPET	Petroleum Refining	-$21,520	-$317,375	-$634,750
MOND	Other Non-Durables Mftg	-$11,091	-$163,563	-$327,126
TAIR	Air Transport	-$20,545	-$302,996	-$605,992
TRAL	Rail Transport	-$561	-$8,273	-$16,547
TOTH	Other Transport	-$86	-$1,264	-$2,529
TLTP	Private Transit	-$2,730	-$40,259	-$80,518
HOTR	Hotels and Restaurants	-$90,584	-$1,335,892	-$2,671,784
PSRV	Personal Services	-$545	-$8,033	-$16,065
OBSV	Other Business Services	-$40,674	-$599,838	-$1,199,676
ENTR	Entertainment	-$10,585	-$156,110	-$312,221
Total		**-$205,938**	**-$3,037,102**	**-$6,074,204**

Table A6. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for ORD; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$2,258	-$33,375	-$66,750
MPET	Petroleum Refining	-$6,926	-$102,345	-$204,690
MOND	Other Non-Durables Mftg	-$3,569	-$52,745	-$105,489
TAIR	Air Transport	-$6,612	-$97,708	-$195,417
TRAL	Rail Transport	-$181	-$2,668	-$5,336
TOTH	Other Transport	-$28	-$408	-$816
TLTP	Private Transit	-$879	-$12,982	-$25,965
HOTR	Hotels and Restaurants	-$29,151	-$430,790	-$861,580
PSRV	Personal Services	-$175	-$2,590	-$5,181
OBSV	Other Business Services	-$13,089	-$193,432	-$386,864
ENTR	Entertainment	-$3,407	-$50,342	-$100,683
Total		**-$66,274**	**-$979,386**	**-$1,958,771**

Table A7. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK American Terminal (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$55,085	$3,020	$715,891	$39,248	$1,431,783	$78,496
MPET	Petroleum Refining	$18,864	$620	$245,161	$8,051	$490,322	$16,103
MOND	Other Non-Durables Mftg	$284,576	$12,713	$3,698,396	$165,220	$7,396,793	$330,441
TAIR	Air Transport	$289,908	$29,335	$3,767,691	$381,239	$7,535,381	$762,478
TRAL	Rail Transport	$2,060	$185	$26,768	$2,409	$53,535	$4,817
TOTH	Other Transport	$10,705	$963	$139,119	$12,518	$278,237	$25,036
TLTP	Private Transit	$13,157	$1,184	$170,985	$15,385	$341,970	$30,771
HOTR	Hotels and Restaurants	$374,121	$33,303	$4,862,143	$432,810	$9,724,285	$865,621
PSRV	Personal Services	$2,018	$182	$26,221	$2,359	$52,443	$4,719
OBSV	Other Business Services	$36,345	$2,642	$472,348	$34,335	$944,695	$68,669
ENTR	Entertainment	$134,676	$4,504	$1,750,270	$58,535	$3,500,540	$117,070
MEDC	Medical Services	$2,342	$109	$30,439	$1,416	$60,879	$2,832
Total		**$1,223,855**	**$88,759**	**$15,905,432**	**$1,153,526**	**$31,810,863**	**$2,307,052**

Table A8. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK American Terminal (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$23,067	$1,372	$299,783	$17,826	$599,565	$35,652
MPET	Petroleum Refining	$7,899	$281	$102,662	$3,657	$205,324	$7,314
MOND	Other Non-Durables Mftg	$119,167	$5,774	$1,548,719	$75,041	$3,097,438	$150,082
TAIR	Air Transport	$121,400	$13,323	$1,577,736	$173,154	$3,155,472	$346,307
TRAL	Rail Transport	$862	$84	$11,209	$1,094	$22,418	$2,188
TOTH	Other Transport	$4,483	$437	$58,257	$5,686	$116,513	$11,371
TLTP	Private Transit	$5,509	$538	$71,601	$6,988	$143,201	$13,976
HOTR	Hotels and Restaurants	$156,665	$15,126	$2,036,042	$196,577	$4,072,085	$393,153
PSRV	Personal Services	$845	$82	$10,980	$1,072	$21,961	$2,143
OBSV	Other Business Services	$15,220	$1,200	$197,798	$15,594	$395,595	$31,189
ENTR	Entertainment	$56,396	$2,046	$732,933	$26,586	$1,465,865	$53,172
MEDC	Medical Services	$981	$49	$12,747	$643	$25,493	$1,286
Total		**$512,494**	**$40,313**	**$6,660,465**	**$523,916**	**$13,320,931**	**$1,047,833**

Table A9. Changes in Expenditure by U.S. Residents (upper-bound estimates for JFK American Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$1,260,748	-$83,526	-$15,708,097	-$1,040,682	-$31,416,194	-$2,081,363
Increased Spending on U.S. Airlines to Travel Abroad	$262,902	$21,062	$3,275,581	$262,414	$6,551,163	$524,828

Table A10. Changes in Expenditure by U.S. Residents (lower-bound estimates for JFK American Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$262,614	-$24,002	-$3,298,728	-$300,643	-$6,597,457	-$601,286
Increased Spending on U.S. Airlines to Travel Abroad	$54,763	$6,052	$687,878	$75,809	$1,375,756	$151,618

Table A11. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for JFK American Terminal; in 2012$)

USCGE Sector		**+1 Officer**	**Wait Time Falls by 50%**	**Wait Time Falls by 100%**
MOFD	Other Food Mftg	-$2,846	-$35,464	-$70,928
MPET	Petroleum Refining	-$8,728	-$108,751	-$217,501
MOND	Other Non-Durables Mftg	-$4,498	-$56,046	-$112,092
TAIR	Air Transport	-$8,333	-$103,823	-$207,647
TRAL	Rail Transport	-$228	-$2,835	-$5,670
TOTH	Other Transport	-$35	-$433	-$867
TLTP	Private Transit	-$1,107	-$13,795	-$27,590
HOTR	Hotels and Restaurants	-$36,740	-$457,752	-$915,503
PSRV	Personal Services	-$221	-$2,752	-$5,505
OBSV	Other Business Services	-$16,497	-$205,538	-$411,076
ENTR	Entertainment	-$4,293	-$53,492	-$106,984
Total		**-$83,526**	**-$1,040,682**	**-$2,081,363**

Table A12. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for JFK American Terminal; in 2012$)

USCGE Sector		**+1 Officer**	**Wait Time Falls by 50%**	**Wait Time Falls by 100%**
MOFD	Other Food Mftg	-$818	-$10,245	-$20,490
MPET	Petroleum Refining	-$2,508	-$31,417	-$62,834
MOND	Other Non-Durables Mftg	-$1,293	-$16,191	-$32,382
TAIR	Air Transport	-$2,395	-$29,994	-$59,987
TRAL	Rail Transport	-$65	-$819	-$1,638
TOTH	Other Transport	-$10	-$125	-$250
TLTP	Private Transit	-$318	-$3,985	-$7,970
HOTR	Hotels and Restaurants	-$10,557	-$132,240	-$264,480
PSRV	Personal Services	-$63	-$795	-$1,590
OBSV	Other Business Services	-$4,740	-$59,378	-$118,756
ENTR	Entertainment	-$1,234	-$15,453	-$30,907
Total		**-$24,002**	**-$300,643**	**-$601,286**

Table A13. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK British Terminal (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$38,345	$2,102	$432,952	$23,736	$865,904	$47,472
MPET	Petroleum Refining	$13,132	$431	$148,267	$4,869	$296,534	$9,738
MOND	Other Non-Durables Mftg	$198,097	$8,850	$2,236,691	$99,921	$4,473,382	$199,842
TAIR	Air Transport	$201,808	$20,420	$2,278,598	$230,563	$4,557,196	$461,126
TRAL	Rail Transport	$1,434	$129	$16,188	$1,457	$32,377	$2,913
TOTH	Other Transport	$7,452	$671	$84,135	$7,571	$168,271	$15,141
TLTP	Private Transit	$9,158	$824	$103,407	$9,305	$206,814	$18,609
HOTR	Hotels and Restaurants	$260,430	$23,183	$2,940,493	$261,752	$5,880,987	$523,504
PSRV	Personal Services	$1,404	$126	$15,858	$1,427	$31,716	$2,854
OBSV	Other Business Services	$25,300	$1,839	$285,663	$20,765	$571,326	$41,529
ENTR	Entertainment	$93,750	$3,135	$1,058,516	$35,401	$2,117,033	$70,801
MEDC	Medical Services	$1,630	$76	$18,409	$856	$36,818	$1,713
Total		**$851,941**	**$61,786**	**$9,619,178**	**$697,622**	**$19,238,357**	**$1,395,243**

Table A14. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK British Terminal (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$12,915	$793	$145,826	$8,954	$291,653	$17,909
MPET	Petroleum Refining	$4,423	$163	$49,939	$1,837	$99,878	$3,674
MOND	Other Non-Durables Mftg	$66,723	$3,339	$753,359	$37,695	$1,506,719	$75,389
TAIR	Air Transport	$67,973	$7,703	$767,475	$86,979	$1,534,949	$173,958
TRAL	Rail Transport	$483	$49	$5,453	$550	$10,905	$1,099
TOTH	Other Transport	$2,510	$253	$28,338	$2,856	$56,677	$5,712
TLTP	Private Transit	$3,085	$311	$34,829	$3,510	$69,659	$7,020
HOTR	Hotels and Restaurants	$87,718	$8,746	$990,413	$98,745	$1,980,826	$197,490
PSRV	Personal Services	$473	$48	$5,341	$538	$10,683	$1,077
OBSV	Other Business Services	$8,522	$694	$96,217	$7,833	$192,433	$15,667
ENTR	Entertainment	$31,577	$1,183	$356,528	$13,355	$713,056	$26,709
MEDC	Medical Services	$549	$29	$6,200	$323	$12,401	$646
Total		**$286,950**	**$23,309**	**$3,239,919**	**$263,175**	**$6,479,839**	**$526,350**

Table A15. Changes in Expenditure by U.S. Residents (upper-bound estimates for JFK British Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$632,382	-$41,896	-$6,224,785	-$412,400	-$12,449,570	-$824,800
Increased Spending on U.S. Airlines to Travel Abroad	$131,869	$10,564	$1,298,043	$103,989	$2,596,087	$207,978

Table A16. Changes in Expenditure by U.S. Residents (lower-bound estimates for JFK British Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$126,579	-$11,732	-$1,244,982	-$115,427	-$2,489,964	-$230,854
Increased Spending on U.S. Airlines to Travel Abroad	$26,395	$2,958	$259,614	$29,106	$519,228	$58,211

Table A17. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for JFK British Terminal; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$1,428	-$14,054	-$28,107
MPET	Petroleum Refining	-$4,378	-$43,096	-$86,191
MOND	Other Non-Durables Mftg	-$2,256	-$22,210	-$44,420
TAIR	Air Transport	-$4,180	-$41,143	-$82,286
TRAL	Rail Transport	-$114	-$1,123	-$2,247
TOTH	Other Transport	-$17	-$172	-$343
TLTP	Private Transit	-$555	-$5,467	-$10,933
HOTR	Hotels and Restaurants	-$18,428	-$181,397	-$362,795
PSRV	Personal Services	-$111	-$1,091	-$2,181
OBSV	Other Business Services	-$8,275	-$81,450	-$162,901
ENTR	Entertainment	-$2,154	-$21,198	-$42,396
Total		**-$41,896**	**-$412,400**	**-$824,800**

Table A18. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for JFK British Terminal; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$400	-$3,933	-$7,867
MPET	Petroleum Refining	-$1,226	-$12,062	-$24,124
MOND	Other Non-Durables Mftg	-$632	-$6,216	-$12,433
TAIR	Air Transport	-$1,170	-$11,516	-$23,031
TRAL	Rail Transport	-$32	-$314	-$629
TOTH	Other Transport	-$5	-$48	-$96
TLTP	Private Transit	-$156	-$1,530	-$3,060
HOTR	Hotels and Restaurants	-$5,161	-$50,771	-$101,543
PSRV	Personal Services	-$31	-$305	-$611
OBSV	Other Business Services	-$2,317	-$22,797	-$45,595
ENTR	Entertainment	-$603	-$5,933	-$11,866
Total		**-$11,732**	**-$115,427**	**-$230,854**

Table A19. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK Delta Terminal (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$37,305	$2,045	$337,799	$18,519	$675,597	$37,039
MPET	Petroleum Refining	$12,775	$420	$115,681	$3,799	$231,362	$7,598
MOND	Other Non-Durables Mftg	$192,721	$8,610	$1,745,115	$77,960	$3,490,230	$155,921
TAIR	Air Transport	$196,332	$19,866	$1,777,812	$179,890	$3,555,624	$359,781
TRAL	Rail Transport	$1,395	$126	$12,630	$1,137	$25,261	$2,273
TOTH	Other Transport	$7,249	$652	$65,644	$5,907	$131,288	$11,813
TLTP	Private Transit	$8,910	$802	$80,680	$7,260	$161,361	$14,519
HOTR	Hotels and Restaurants	$253,363	$22,553	$2,294,237	$204,225	$4,588,474	$408,449
PSRV	Personal Services	$1,366	$123	$12,373	$1,113	$24,745	$2,227
OBSV	Other Business Services	$24,614	$1,789	$222,881	$16,201	$445,761	$32,402
ENTR	Entertainment	$91,205	$3,050	$825,877	$27,620	$1,651,755	$55,241
MEDC	Medical Services	$1,586	$74	$14,363	$668	$28,726	$1,336
Total		**$828,821**	**$60,109**	**$7,505,092**	**$544,299**	**$15,010,185**	**$1,088,599**

Table A20. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK Delta Terminal (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$14,913	$892	$135,043	$8,081	$270,087	$16,162
MPET	Petroleum Refining	$5,107	$183	$46,246	$1,658	$92,493	$3,316
MOND	Other Non-Durables Mftg	$77,045	$3,757	$697,653	$34,019	$1,395,306	$68,038
TAIR	Air Transport	$78,489	$8,669	$710,725	$78,498	$1,421,449	$156,996
TRAL	Rail Transport	$558	$55	$5,049	$496	$10,099	$992
TOTH	Other Transport	$2,898	$285	$26,243	$2,577	$52,486	$5,155
TLTP	Private Transit	$3,562	$350	$32,254	$3,168	$64,508	$6,336
HOTR	Hotels and Restaurants	$101,288	$9,842	$917,178	$89,116	$1,834,357	$178,233
PSRV	Personal Services	$546	$54	$4,946	$486	$9,893	$972
OBSV	Other Business Services	$9,840	$781	$89,102	$7,070	$178,204	$14,139
ENTR	Entertainment	$36,462	$1,331	$330,165	$12,053	$660,330	$24,105
MEDC	Medical Services	$634	$32	$5,742	$292	$11,484	$583
Total		**$331,342**	**$26,230**	**$3,000,348**	**$237,513**	**$6,000,696**	**$475,026**

Table A21. Changes in Expenditure by U.S. Residents (upper-bound estimates for JFK Delta Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$1,490,745	-$98,764	-$13,340,881	-$883,850	-$26,681,762	-$1,767,701
Increased Spending on U.S. Airlines to Travel Abroad	$310,862	$24,904	$2,781,950	$222,868	$5,563,900	$445,737

Table A22. Changes in Expenditure by U.S. Residents (lower-bound estimates for JFK Delta Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$405,737	-$34,059	-$3,644,545	-$305,605	-$7,289,090	-$611,210
Increased Spending on U.S. Airlines to Travel Abroad	$84,608	$8,588	$759,990	$77,060	$1,519,981	$154,120

Table A23. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for JFK Delta Terminal; in 2012$)

USCGE Sector		**+1 Officer**	**Wait Time Falls by 50%**	**Wait Time Falls by 100%**
MOFD	Other Food Mftg	-$3,366	-$30,120	-$60,239
MPET	Petroleum Refining	-$10,321	-$92,362	-$184,724
MOND	Other Non-Durables Mftg	-$5,319	-$47,600	-$95,199
TAIR	Air Transport	-$9,853	-$88,177	-$176,354
TRAL	Rail Transport	-$269	-$2,408	-$4,815
TOTH	Other Transport	-$41	-$368	-$736
TLTP	Private Transit	-$1,309	-$11,716	-$23,432
HOTR	Hotels and Restaurants	-$43,442	-$388,768	-$777,537
PSRV	Personal Services	-$261	-$2,338	-$4,675
OBSV	Other Business Services	-$19,506	-$174,564	-$349,127
ENTR	Entertainment	-$5,077	-$45,431	-$90,862
Total		**-$98,764**	**-$883,850**	**-$1,767,701**

Table A24. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for JFK Delta Terminal; in 2012$)

USCGE Sector		**+1 Officer**	**Wait Time Falls by 50%**	**Wait Time Falls by 100%**
MOFD	Other Food Mftg	-$1,161	-$10,414	-$20,829
MPET	Petroleum Refining	-$3,559	-$31,936	-$63,871
MOND	Other Non-Durables Mftg	-$1,834	-$16,458	-$32,917
TAIR	Air Transport	-$3,398	-$30,489	-$60,977
TRAL	Rail Transport	-$93	-$832	-$1,665
TOTH	Other Transport	-$14	-$127	-$254
TLTP	Private Transit	-$451	-$4,051	-$8,102
HOTR	Hotels and Restaurants	-$14,981	-$134,423	-$268,845
PSRV	Personal Services	-$90	-$808	-$1,617
OBSV	Other Business Services	-$6,727	-$60,358	-$120,716
ENTR	Entertainment	-$1,751	-$15,708	-$31,417
Total		**-$34,059**	**-$305,605**	**-$611,210**

Table A25. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK Terminal 1 (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$72,631	$3,982	$1,042,907	$57,176	$2,085,815	$114,352
MPET	Petroleum Refining	$24,873	$817	$357,150	$11,729	$714,299	$23,458
MOND	Other Non-Durables Mftg	$375,222	$16,762	$5,387,806	$240,692	$10,775,613	$481,384
TAIR	Air Transport	$382,252	$38,679	$5,488,754	$555,387	$10,977,507	$1,110,774
TRAL	Rail Transport	$2,716	$244	$38,995	$3,509	$77,990	$7,018
TOTH	Other Transport	$14,114	$1,270	$202,668	$18,236	$405,335	$36,472
TLTP	Private Transit	$17,347	$1,561	$249,090	$22,413	$498,180	$44,827
HOTR	Hotels and Restaurants	$493,290	$43,911	$7,083,146	$630,516	$14,166,292	$1,261,032
PSRV	Personal Services	$2,660	$239	$38,199	$3,437	$76,398	$6,874
OBSV	Other Business Services	$47,922	$3,483	$688,114	$50,018	$1,376,228	$100,037
ENTR	Entertainment	$177,574	$5,939	$2,549,785	$85,274	$5,099,570	$170,548
MEDC	Medical Services	$3,088	$144	$44,344	$2,063	$88,688	$4,126
Total		**$1,613,689**	**$117,031**	**$23,170,957**	**$1,680,451**	**$46,341,915**	**$3,360,902**

Table A26. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK Terminal 1 (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$34,079	$1,997	$489,346	$28,678	$978,691	$57,356
MPET	Petroleum Refining	$11,671	$410	$167,579	$5,883	$335,158	$11,766
MOND	Other Non-Durables Mftg	$176,059	$8,408	$2,528,029	$120,724	$5,056,057	$241,448
TAIR	Air Transport	$179,358	$19,400	$2,575,394	$278,565	$5,150,789	$557,130
TRAL	Rail Transport	$1,274	$123	$18,297	$1,760	$36,594	$3,520
TOTH	Other Transport	$6,623	$637	$95,094	$9,147	$190,188	$18,293
TLTP	Private Transit	$8,140	$783	$116,876	$11,242	$233,753	$22,484
HOTR	Hotels and Restaurants	$231,458	$22,024	$3,323,504	$316,248	$6,647,008	$632,495
PSRV	Personal Services	$1,248	$120	$17,924	$1,724	$35,847	$3,448
OBSV	Other Business Services	$22,486	$1,747	$322,872	$25,088	$645,744	$50,175
ENTR	Entertainment	$83,320	$2,979	$1,196,392	$42,771	$2,392,784	$85,542
MEDC	Medical Services	$1,449	$72	$20,807	$1,035	$41,614	$2,070
Total		**$757,164**	**$58,699**	**$10,872,114**	**$842,863**	**$21,744,227**	**$1,685,727**

Table A27. Changes in Expenditure by U.S. Residents (upper-bound estimates for JFK Terminal 1; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$1,155,295	-$76,540	-$19,652,336	-$1,301,992	-$39,304,671	-$2,603,985
Increased Spending on U.S. Airlines to Travel Abroad	$240,912	$19,300	$4,098,066	$328,305	$8,196,133	$656,611

Table A28. Changes in Expenditure by U.S. Residents (lower-bound estimates for JFK Terminal 1; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$248,449	-$22,460	-$4,198,837	-$380,416	-$8,397,674	-$760,831
Increased Spending on U.S. Airlines to Travel Abroad	$51,809	$5,663	$875,576	$95,924	$1,751,152	$191,848

Table A29. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for JFK Terminal 1; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$2,608	-$44,369	-$88,738
MPET	Petroleum Refining	-$7,998	-$136,057	-$272,115
MOND	Other Non-Durables Mftg	-$4,122	-$70,119	-$140,237
TAIR	Air Transport	-$7,636	-$129,893	-$259,786
TRAL	Rail Transport	-$209	-$3,547	-$7,094
TOTH	Other Transport	-$32	-$542	-$1,084
TLTP	Private Transit	-$1,015	-$17,259	-$34,518
HOTR	Hotels and Restaurants	-$33,667	-$572,691	-$1,145,382
PSRV	Personal Services	-$202	-$3,444	-$6,887
OBSV	Other Business Services	-$15,117	-$257,148	-$514,296
ENTR	Entertainment	-$3,934	-$66,924	-$133,848
Total		**-$76,540**	**-$1,301,992**	**-$2,603,985**

Table A30. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for JFK Terminal 1; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$765	-$12,964	-$25,927
MPET	Petroleum Refining	-$2,347	-$39,753	-$79,506
MOND	Other Non-Durables Mftg	-$1,210	-$20,487	-$40,975
TAIR	Air Transport	-$2,241	-$37,952	-$75,904
TRAL	Rail Transport	-$61	-$1,036	-$2,073
TOTH	Other Transport	-$9	-$158	-$317
TLTP	Private Transit	-$298	-$5,043	-$10,085
HOTR	Hotels and Restaurants	-$9,879	-$167,329	-$334,657
PSRV	Personal Services	-$59	-$1,006	-$2,012
OBSV	Other Business Services	-$4,436	-$75,133	-$150,267
ENTR	Entertainment	-$1,154	-$19,554	-$39,108
Total		**-$22,460**	**-$380,416**	**-$760,831**

Table A31. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK Terminal 4 (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$62,478	$3,425	$1,625,886	$89,137	$3,251,773	$178,274
MPET	Petroleum Refining	$21,396	$703	$556,794	$18,285	$1,113,588	$36,571
MOND	Other Non-Durables Mftg	$322,770	$14,419	$8,399,559	$375,238	$16,799,117	$750,475
TAIR	Air Transport	$328,817	$33,272	$8,556,935	$865,845	$17,113,870	$1,731,690
TRAL	Rail Transport	$2,336	$210	$60,793	$5,470	$121,586	$10,940
TOTH	Other Transport	$12,141	$1,092	$315,957	$28,430	$631,915	$56,860
TLTP	Private Transit	$14,922	$1,343	$388,330	$34,942	$776,660	$69,885
HOTR	Hotels and Restaurants	$424,333	$37,773	$11,042,584	$982,971	$22,085,167	$1,965,941
PSRV	Personal Services	$2,288	$206	$59,552	$5,359	$119,104	$10,717
OBSV	Other Business Services	$41,223	$2,996	$1,072,766	$77,978	$2,145,531	$155,957
ENTR	Entertainment	$152,751	$5,109	$3,975,100	$132,941	$7,950,199	$265,883
MEDC	Medical Services	$2,657	$124	$69,132	$3,216	$138,264	$6,433
Total		**$1,388,113**	**$100,672**	**$36,123,388**	**$2,619,813**	**$72,246,775**	**$5,239,627**

Table A32. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in JFK Terminal 4 (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$25,959	$1,545	$675,538	$40,212	$1,351,075	$80,423
MPET	Petroleum Refining	$8,890	$317	$231,342	$8,249	$462,683	$16,498
MOND	Other Non-Durables Mftg	$134,107	$6,505	$3,489,923	$169,277	$6,979,846	$338,555
TAIR	Air Transport	$136,620	$15,010	$3,555,311	$390,600	$7,110,622	$781,201
TRAL	Rail Transport	$971	$95	$25,259	$2,468	$50,518	$4,935
TOTH	Other Transport	$5,045	$493	$131,277	$12,825	$262,554	$25,651
TLTP	Private Transit	$6,200	$606	$161,347	$15,763	$322,694	$31,526
HOTR	Hotels and Restaurants	$176,306	$17,040	$4,588,070	$443,438	$9,176,141	$886,877
PSRV	Personal Services	$951	$93	$24,743	$2,417	$49,487	$4,835
OBSV	Other Business Services	$17,128	$1,352	$445,722	$35,178	$891,444	$70,355
ENTR	Entertainment	$63,466	$2,305	$1,651,610	$59,973	$3,303,219	$119,945
MEDC	Medical Services	$1,104	$56	$28,724	$1,451	$57,447	$2,902
Total		**$576,746**	**$45,415**	**$15,008,865**	**$1,181,852**	**$30,017,729**	**$2,363,703**

Table A33. Changes in Expenditure by U.S. Residents (upper-bound estimates for JFK Terminal 4; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$2,215,523	-$146,781	-$62,916,405	-$4,168,292	-$125,832,810	-$8,336,585
Increased Spending on U.S. Airlines to Travel Abroad	$461,999	$37,012	$13,119,845	$1,051,060	$26,239,691	$2,102,121

Table A34. Changes in Expenditure by U.S. Residents (lower-bound estimates for JFK Terminal 4; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$601,099	-$50,504	-$17,202,654	-$1,442,131	-$34,405,307	-$2,884,263
Increased Spending on U.S. Airlines to Travel Abroad	$125,346	$12,735	$3,587,239	$363,642	$7,174,477	$727,284

Table A35. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for JFK Terminal 4; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$5,002	-$142,046	-$284,092
MPET	Petroleum Refining	-$15,339	-$435,584	-$871,168
MOND	Other Non-Durables Mftg	-$7,905	-$224,483	-$448,966
TAIR	Air Transport	-$14,644	-$415,849	-$831,698
TRAL	Rail Transport	-$400	-$11,355	-$22,710
TOTH	Other Transport	-$61	-$1,735	-$3,471
TLTP	Private Transit	-$1,946	-$55,254	-$110,507
HOTR	Hotels and Restaurants	-$64,563	-$1,833,455	-$3,666,910
PSRV	Personal Services	-$388	-$11,024	-$22,049
OBSV	Other Business Services	-$28,990	-$823,252	-$1,646,505
ENTR	Entertainment	-$7,545	-$214,255	-$428,510
Total		**-$146,781**	**-$4,168,292**	**-$8,336,585**

Table A36. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for JFK Terminal 4; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$1,721	-$49,145	-$98,289
MPET	Petroleum Refining	-$5,278	-$150,702	-$301,404
MOND	Other Non-Durables Mftg	-$2,720	-$77,666	-$155,332
TAIR	Air Transport	-$5,039	-$143,874	-$287,748
TRAL	Rail Transport	-$138	-$3,929	-$7,857
TOTH	Other Transport	-$21	-$600	-$1,201
TLTP	Private Transit	-$669	-$19,116	-$38,233
HOTR	Hotels and Restaurants	-$22,215	-$634,332	-$1,268,665
PSRV	Personal Services	-$134	-$3,814	-$7,628
OBSV	Other Business Services	-$9,975	-$284,826	-$569,652
ENTR	Entertainment	-$2,596	-$74,127	-$148,254
Total		**-$50,504**	**-$1,442,131**	**-$2,884,263**

Table A37. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Satellite 2 (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$40,027	$3,023	$438,058	$33,088	$876,115	$66,177
MPET	Petroleum Refining	$13,707	$620	$150,015	$6,788	$300,031	$13,575
MOND	Other Non-Durables Mftg	$206,785	$12,728	$2,263,067	$139,291	$4,526,135	$278,583
TAIR	Air Transport	$140,604	$19,104	$1,538,784	$209,079	$3,077,568	$418,158
TRAL	Rail Transport	$1,497	$186	$16,379	$2,031	$32,758	$4,061
TOTH	Other Transport	$7,778	$964	$85,127	$10,554	$170,255	$21,107
TLTP	Private Transit	$9,560	$1,185	$104,627	$12,971	$209,253	$25,942
HOTR	Hotels and Restaurants	$271,852	$33,341	$2,975,169	$364,887	$5,950,339	$729,774
PSRV	Personal Services	$1,466	$182	$16,045	$1,989	$32,090	$3,978
OBSV	Other Business Services	$26,410	$2,645	$289,032	$28,946	$578,064	$57,893
ENTR	Entertainment	$97,861	$4,509	$1,070,999	$49,349	$2,141,998	$98,698
MEDC	Medical Services	$1,702	$109	$18,626	$1,194	$37,252	$2,388
Total		**$819,250**	**$78,597**	**$8,965,929**	**$860,167**	**$17,931,857**	**$1,720,335**

Table A38. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Satellite 2 (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$10,167	$905	$111,264	$9,909	$222,528	$19,818
MPET	Petroleum Refining	$3,482	$186	$38,103	$2,033	$76,206	$4,065
MOND	Other Non-Durables Mftg	$52,522	$3,812	$574,805	$41,714	$1,149,611	$83,427
TAIR	Air Transport	$35,713	$5,721	$390,842	$62,613	$781,683	$125,226
TRAL	Rail Transport	$380	$56	$4,160	$608	$8,320	$1,216
TOTH	Other Transport	$1,976	$289	$21,622	$3,160	$43,244	$6,321
TLTP	Private Transit	$2,428	$355	$26,575	$3,884	$53,149	$7,769
HOTR	Hotels and Restaurants	$69,049	$9,985	$755,675	$109,273	$1,511,350	$218,546
PSRV	Personal Services	$372	$54	$4,075	$596	$8,151	$1,191
OBSV	Other Business Services	$6,708	$792	$73,412	$8,669	$146,825	$17,337
ENTR	Entertainment	$24,856	$1,350	$272,027	$14,779	$544,054	$29,557
MEDC	Medical Services	$432	$33	$4,731	$358	$9,462	$715
Total		**$208,085**	**$23,537**	**$2,277,291**	**$257,595**	**$4,554,582**	**$515,189**

Table A39. Changes in Expenditure by U.S. Residents (upper-bound estimates for LAX Satellite 2; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$679,042	-$66,101	-$9,280,975	-$903,446	-$18,561,949	-$1,806,893
Increased Spending on U.S. Airlines to Travel Abroad	$95,228	$11,209	$1,301,560	$153,207	$2,603,120	$306,413

Table A40. Changes in Expenditure by U.S. Residents (lower-bound estimates for LAX Satellite 2; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$120,925	-$17,197	-$1,656,603	-$235,374	-$3,313,205	-$470,749
Increased Spending on U.S. Airlines to Travel Abroad	$16,958	$2,916	$232,321	$39,915	$464,642	$79,830

Table A41. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for LAX Satellite 2; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$2,253	-$30,787	-$61,575
MPET	Petroleum Refining	-$6,907	-$94,410	-$188,819
MOND	Other Non-Durables Mftg	-$3,560	-$48,655	-$97,310
TAIR	Air Transport	-$6,595	-$90,132	-$180,264
TRAL	Rail Transport	-$180	-$2,461	-$4,922
TOTH	Other Transport	-$28	-$376	-$752
TLTP	Private Transit	-$876	-$11,976	-$23,952
HOTR	Hotels and Restaurants	-$29,075	-$397,388	-$794,775
PSRV	Personal Services	-$175	-$2,389	-$4,779
OBSV	Other Business Services	-$13,055	-$178,434	-$356,868
ENTR	Entertainment	-$3,398	-$46,438	-$92,876
Total		**-$66,101**	**-$903,446**	**-$1,806,893**

Table A42. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for LAX Satellite 2; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$586	-$8,021	-$16,042
MPET	Petroleum Refining	-$1,797	-$24,596	-$49,193
MOND	Other Non-Durables Mftg	-$926	-$12,676	-$25,352
TAIR	Air Transport	-$1,716	-$23,482	-$46,964
TRAL	Rail Transport	-$47	-$641	-$1,282
TOTH	Other Transport	-$7	-$98	-$196
TLTP	Private Transit	-$228	-$3,120	-$6,240
HOTR	Hotels and Restaurants	-$7,564	-$103,531	-$207,062
PSRV	Personal Services	-$45	-$623	-$1,245
OBSV	Other Business Services	-$3,396	-$46,487	-$92,975
ENTR	Entertainment	-$884	-$12,099	-$24,197
Total		**-$17,197**	**-$235,374**	**-$470,749**

Table A43. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Satellite 5 (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$29,068	$2,196	$156,585	$11,828	$313,171	$23,655
MPET	Petroleum Refining	$9,955	$450	$53,624	$2,426	$107,247	$4,853
MOND	Other Non-Durables Mftg	$150,170	$9,243	$808,943	$49,790	$1,617,885	$99,581
TAIR	Air Transport	$102,109	$13,874	$550,045	$74,736	$1,100,089	$149,472
TRAL	Rail Transport	$1,087	$135	$5,855	$726	$11,710	$1,452
TOTH	Other Transport	$5,649	$700	$30,429	$3,772	$60,858	$7,545
TLTP	Private Transit	$6,943	$861	$37,399	$4,636	$74,798	$9,273
HOTR	Hotels and Restaurants	$197,423	$24,213	$1,063,487	$130,430	$2,126,973	$260,861
PSRV	Personal Services	$1,065	$132	$5,735	$711	$11,471	$1,422
OBSV	Other Business Services	$19,179	$1,921	$103,316	$10,347	$206,631	$20,694
ENTR	Entertainment	$71,068	$3,275	$382,833	$17,640	$765,666	$35,280
MEDC	Medical Services	$1,236	$79	$6,658	$427	$13,316	$854
Total		**$594,950**	**$57,078**	**$3,204,908**	**$307,470**	**$6,409,816**	**$614,941**

Table A44. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Satellite 5 (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$8,253	$719	$44,455	$3,874	$88,910	$7,748
MPET	Petroleum Refining	$2,826	$148	$15,224	$795	$30,448	$1,589
MOND	Other Non-Durables Mftg	$42,634	$3,028	$229,661	$16,309	$459,321	$32,618
TAIR	Air Transport	$28,989	$4,544	$156,159	$24,480	$312,318	$48,961
TRAL	Rail Transport	$309	$44	$1,662	$238	$3,324	$476
TOTH	Other Transport	$1,604	$229	$8,639	$1,236	$17,278	$2,471
TLTP	Private Transit	$1,971	$282	$10,618	$1,519	$21,235	$3,037
HOTR	Hotels and Restaurants	$56,049	$7,931	$301,926	$42,723	$603,853	$85,446
PSRV	Personal Services	$302	$43	$1,628	$233	$3,257	$466
OBSV	Other Business Services	$5,445	$629	$29,332	$3,389	$58,663	$6,778
ENTR	Entertainment	$20,176	$1,073	$108,687	$5,778	$217,374	$11,556
MEDC	Medical Services	$351	$26	$1,890	$140	$3,780	$280
Total		**$168,908**	**$18,696**	**$909,881**	**$100,714**	**$1,819,762**	**$201,427**

Table A45. Changes in Expenditure by U.S. Residents (upper-bound estimates for LAX Satellite 5; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$448,219	-$43,631	-$2,407,302	-$234,336	-$4,814,604	-$468,672
Increased Spending on U.S. Airlines to Travel Abroad	$62,858	$7,399	$337,599	$39,739	$675,198	$79,478

Table A46. Changes in Expenditure by U.S. Residents (lower-bound estimates for LAX Satellite 5; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$86,163	-$11,907	-$462,966	-$63,967	-$925,932	-$127,934
Increased Spending on U.S. Airlines to Travel Abroad	$12,083	$2,019	$64,926	$10,848	$129,852	$21,695

Table A47. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for LAX Satellite 5; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$1,487	-$7,986	-$15,971
MPET	Petroleum Refining	-$4,559	-$24,488	-$48,976
MOND	Other Non-Durables Mftg	-$2,350	-$12,620	-$25,240
TAIR	Air Transport	-$4,353	-$23,379	-$46,757
TRAL	Rail Transport	-$119	-$638	-$1,277
TOTH	Other Transport	-$18	-$98	-$195
TLTP	Private Transit	-$578	-$3,106	-$6,213
HOTR	Hotels and Restaurants	-$19,192	-$103,075	-$206,149
PSRV	Personal Services	-$115	-$620	-$1,240
OBSV	Other Business Services	-$8,617	-$46,282	-$92,564
ENTR	Entertainment	-$2,243	-$12,045	-$24,090
Total		**-$43,631**	**-$234,336**	**-$468,672**

Table A48. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for LAX Satellite 5; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$406	-$2,180	-$4,360
MPET	Petroleum Refining	-$1,244	-$6,685	-$13,369
MOND	Other Non-Durables Mftg	-$641	-$3,445	-$6,890
TAIR	Air Transport	-$1,188	-$6,382	-$12,763
TRAL	Rail Transport	-$32	-$174	-$349
TOTH	Other Transport	-$5	-$27	-$53
TLTP	Private Transit	-$158	-$848	-$1,696
HOTR	Hotels and Restaurants	-$5,237	-$28,136	-$56,273
PSRV	Personal Services	-$31	-$169	-$338
OBSV	Other Business Services	-$2,352	-$12,634	-$25,267
ENTR	Entertainment	-$612	-$3,288	-$6,576
Total		**-$11,907**	**-$63,967**	**-$127,934**

Table A49. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Satellite 7 (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$17,012	$1,285	$107,080	$8,088	$214,160	$16,176
MPET	Petroleum Refining	$5,826	$264	$36,670	$1,659	$73,340	$3,318
MOND	Other Non-Durables Mftg	$87,887	$5,409	$553,190	$34,049	$1,106,379	$68,097
TAIR	Air Transport	$59,759	$8,120	$376,144	$51,108	$752,288	$102,216
TRAL	Rail Transport	$636	$79	$4,004	$496	$8,008	$993
TOTH	Other Transport	$3,306	$410	$20,809	$2,580	$41,618	$5,159
TLTP	Private Transit	$4,063	$504	$25,575	$3,171	$51,150	$6,341
HOTR	Hotels and Restaurants	$115,542	$14,171	$727,258	$89,194	$1,454,515	$178,388
PSRV	Personal Services	$623	$77	$3,922	$486	$7,844	$972
OBSV	Other Business Services	$11,225	$1,124	$70,652	$7,076	$141,303	$14,151
ENTR	Entertainment	$41,593	$1,916	$261,798	$12,063	$523,595	$24,126
MEDC	Medical Services	$723	$46	$4,553	$292	$9,106	$584
Total		**$348,196**	**$33,405**	**$2,191,653**	**$210,261**	**$4,383,306**	**$420,523**

Table A50. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Satellite 7 (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$4,939	$429	$31,088	$2,698	$62,175	$5,396
MPET	Petroleum Refining	$1,691	$88	$10,646	$553	$21,292	$1,107
MOND	Other Non-Durables Mftg	$25,516	$1,805	$160,603	$11,358	$321,207	$22,716
TAIR	Air Transport	$17,349	$2,709	$109,203	$17,049	$218,406	$34,098
TRAL	Rail Transport	$185	$26	$1,162	$166	$2,325	$331
TOTH	Other Transport	$960	$137	$6,041	$861	$12,082	$1,721
TLTP	Private Transit	$1,180	$168	$7,425	$1,058	$14,850	$2,115
HOTR	Hotels and Restaurants	$33,544	$4,727	$211,139	$29,754	$422,278	$59,507
PSRV	Personal Services	$181	$26	$1,139	$162	$2,277	$324
OBSV	Other Business Services	$3,259	$375	$20,512	$2,360	$41,024	$4,721
ENTR	Entertainment	$12,075	$639	$76,006	$4,024	$152,011	$8,048
MEDC	Medical Services	$210	$15	$1,322	$97	$2,644	$195
Total		**$101,089**	**$11,143**	**$636,286**	**$70,140**	**$1,272,572**	**$140,280**

Table A51. Changes in Expenditure by U.S. Residents (upper-bound estimates for LAX Satellite 7; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$500,063	-$48,678	-$3,657,476	-$356,033	-$7,314,952	-$712,066
Increased Spending on U.S. Airlines to Travel Abroad	$70,129	$8,255	$512,923	$60,376	$1,025,846	$120,752

Table A52. Changes in Expenditure by U.S. Residents (lower-bound estimates for LAX Satellite 7; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$95,621	-$13,240	-$698,884	-$96,792	-$1,397,768	-$193,583
Increased Spending on U.S. Airlines to Travel Abroad	$13,410	$2,245	$98,011	$16,414	$196,022	$32,828

Table A53. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for LAX Satellite 7; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$1,659	-$12,133	-$24,266
MPET	Petroleum Refining	-$5,087	-$37,205	-$74,410
MOND	Other Non-Durables Mftg	-$2,622	-$19,174	-$38,348
TAIR	Air Transport	-$4,856	-$35,520	-$71,039
TRAL	Rail Transport	-$133	-$970	-$1,940
TOTH	Other Transport	-$20	-$148	-$296
TLTP	Private Transit	-$645	-$4,719	-$9,439
HOTR	Hotels and Restaurants	-$21,411	-$156,604	-$313,208
PSRV	Personal Services	-$129	-$942	-$1,883
OBSV	Other Business Services	-$9,614	-$70,318	-$140,636
ENTR	Entertainment	-$2,502	-$18,300	-$36,601
Total		**-$48,678**	**-$356,033**	**-$712,066**

Table A54. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for LAX Satellite 7; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$451	-$3,298	-$6,597
MPET	Petroleum Refining	-$1,384	-$10,115	-$20,229
MOND	Other Non-Durables Mftg	-$713	-$5,213	-$10,425
TAIR	Air Transport	-$1,321	-$9,656	-$19,313
TRAL	Rail Transport	-$36	-$264	-$527
TOTH	Other Transport	-$6	-$40	-$81
TLTP	Private Transit	-$175	-$1,283	-$2,566
HOTR	Hotels and Restaurants	-$5,824	-$42,575	-$85,149
PSRV	Personal Services	-$35	-$256	-$512
OBSV	Other Business Services	-$2,615	-$19,117	-$38,233
ENTR	Entertainment	-$681	-$4,975	-$9,950
Total		**-$13,240**	**-$96,792**	**-$193,583**

Table A55. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Terminal 4 (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$7,444	$562	$27,169	$2,052	$54,339	$4,104
MPET	Petroleum Refining	$2,549	$115	$9,304	$421	$18,609	$842
MOND	Other Non-Durables Mftg	$38,459	$2,367	$140,361	$8,639	$280,722	$17,278
TAIR	Air Transport	$26,150	$3,553	$95,439	$12,968	$190,878	$25,935
TRAL	Rail Transport	$278	$35	$1,016	$126	$2,032	$252
TOTH	Other Transport	$1,447	$179	$5,280	$655	$10,560	$1,309
TLTP	Private Transit	$1,778	$220	$6,489	$804	$12,978	$1,609
HOTR	Hotels and Restaurants	$50,560	$6,201	$184,527	$22,631	$369,055	$45,262
PSRV	Personal Services	$273	$34	$995	$123	$1,990	$247
OBSV	Other Business Services	$4,912	$492	$17,926	$1,795	$35,853	$3,591
ENTR	Entertainment	$18,201	$839	$66,426	$3,061	$132,852	$6,121
MEDC	Medical Services	$317	$20	$1,155	$74	$2,310	$148
Total		**$152,368**	**$14,618**	**$556,089**	**$53,350**	**$1,112,178**	**$106,699**

Table A56. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Terminal 4 (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$1,828	$164	$6,672	$598	$13,344	$1,197
MPET	Petroleum Refining	$626	$34	$2,285	$123	$4,570	$245
MOND	Other Non-Durables Mftg	$9,444	$690	$34,468	$2,519	$68,935	$5,038
TAIR	Air Transport	$6,422	$1,036	$23,436	$3,781	$46,873	$7,562
TRAL	Rail Transport	$68	$10	$249	$37	$499	$73
TOTH	Other Transport	$355	$52	$1,297	$191	$2,593	$382
TLTP	Private Transit	$437	$64	$1,594	$235	$3,187	$469
HOTR	Hotels and Restaurants	$12,416	$1,808	$45,313	$6,598	$90,626	$13,196
PSRV	Personal Services	$67	$10	$244	$36	$489	$72
OBSV	Other Business Services	$1,206	$143	$4,402	$523	$8,804	$1,047
ENTR	Entertainment	$4,469	$245	$16,312	$892	$32,624	$1,785
MEDC	Medical Services	$78	$6	$284	$22	$567	$43
Total		**$37,416**	**$4,262**	**$136,555**	**$15,554**	**$273,110**	**$31,109**

Table A57. Changes in Expenditure by U.S. Residents (upper-bound estimates for LAX Terminal 4; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$294,942	-$28,711	-$1,076,430	-$104,784	-$2,152,861	-$209,568
Increased Spending on U.S. Airlines to Travel Abroad	$41,363	$4,869	$150,958	$17,769	$301,916	$35,539

Table A58. Changes in Expenditure by U.S. Residents (lower-bound estimates for LAX Terminal 4; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$46,233	-$6,918	-$168,732	-$25,248	-$337,464	-$50,497
Increased Spending on U.S. Airlines to Travel Abroad	$6,484	$1,173	$23,663	$4,282	$47,326	$8,563

Table A59. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for LAX Terminal 4; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$978	-$3,571	-$7,142
MPET	Petroleum Refining	-$3,000	-$10,950	-$21,900
MOND	Other Non-Durables Mftg	-$1,546	-$5,643	-$11,286
TAIR	Air Transport	-$2,864	-$10,454	-$20,908
TRAL	Rail Transport	-$78	-$285	-$571
TOTH	Other Transport	-$12	-$44	-$87
TLTP	Private Transit	-$381	-$1,389	-$2,778
HOTR	Hotels and Restaurants	-$12,629	-$46,090	-$92,180
PSRV	Personal Services	-$76	-$277	-$554
OBSV	Other Business Services	-$5,670	-$20,695	-$41,390
ENTR	Entertainment	-$1,476	-$5,386	-$10,772
Total		**-$28,711**	**-$104,784**	**-$209,568**

Table A60. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for LAX Terminal 4; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$236	-$860	-$1,721
MPET	Petroleum Refining	-$723	-$2,638	-$5,277
MOND	Other Non-Durables Mftg	-$373	-$1,360	-$2,720
TAIR	Air Transport	-$690	-$2,519	-$5,038
TRAL	Rail Transport	-$19	-$69	-$138
TOTH	Other Transport	-$3	-$11	-$21
TLTP	Private Transit	-$92	-$335	-$669
HOTR	Hotels and Restaurants	-$3,043	-$11,106	-$22,211
PSRV	Personal Services	-$18	-$67	-$134
OBSV	Other Business Services	-$1,366	-$4,987	-$9,973
ENTR	Entertainment	-$356	-$1,298	-$2,596
Total		**-$6,918**	**-$25,248**	**-$50,497**

Table A61. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Tom Bradley (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$40,644	$3,070	$1,181,476	$89,242	$2,362,952	$178,484
MPET	Petroleum Refining	$13,919	$630	$404,603	$18,307	$809,206	$36,614
MOND	Other Non-Durables Mftg	$209,970	$12,924	$6,103,672	$375,680	$12,207,345	$751,360
TAIR	Air Transport	$142,770	$19,399	$4,150,223	$563,903	$8,300,445	$1,127,806
TRAL	Rail Transport	$1,520	$188	$44,176	$5,477	$88,352	$10,953
TOTH	Other Transport	$7,898	$979	$229,596	$28,464	$459,191	$56,927
TLTP	Private Transit	$9,707	$1,203	$282,186	$34,984	$564,372	$69,967
HOTR	Hotels and Restaurants	$276,040	$33,855	$8,024,269	$984,130	$16,048,537	$1,968,259
PSRV	Personal Services	$1,489	$185	$43,275	$5,365	$86,549	$10,730
OBSV	Other Business Services	$26,817	$2,686	$779,542	$78,070	$1,559,084	$156,141
ENTR	Entertainment	$99,369	$4,579	$2,888,569	$133,098	$5,777,139	$266,196
MEDC	Medical Services	$1,728	$111	$50,236	$3,220	$100,472	$6,440
Total		**$831,870**	**$79,807**	**$24,181,823**	**$2,319,940**	**$48,363,645**	**$4,639,879**

Table A62. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in LAX Tom Bradley (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$9,267	$844	$269,378	$24,547	$538,756	$49,094
MPET	Petroleum Refining	$3,173	$173	$92,250	$5,036	$184,500	$10,071
MOND	Other Non-Durables Mftg	$47,873	$3,555	$1,391,645	$103,335	$2,783,290	$206,671
TAIR	Air Transport	$32,552	$5,336	$946,256	$155,108	$1,892,512	$310,217
TRAL	Rail Transport	$346	$52	$10,072	$1,506	$20,144	$3,013
TOTH	Other Transport	$1,801	$269	$52,348	$7,829	$104,696	$15,659
TLTP	Private Transit	$2,213	$331	$64,339	$9,623	$128,678	$19,245
HOTR	Hotels and Restaurants	$62,937	$9,312	$1,829,543	$270,697	$3,659,087	$541,394
PSRV	Personal Services	$339	$51	$9,867	$1,476	$19,733	$2,951
OBSV	Other Business Services	$6,114	$739	$177,737	$21,474	$355,473	$42,948
ENTR	Entertainment	$22,656	$1,259	$658,597	$36,610	$1,317,195	$73,221
MEDC	Medical Services	$394	$30	$11,454	$886	$22,908	$1,771
Total		**$189,667**	**$21,952**	**$5,513,486**	**$638,128**	**$11,026,972**	**$1,276,255**

Table A63. Changes in Expenditure by U.S. Residents (upper-bound estimates for LAX Tom Bradley; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$897,322	-$87,349	-$29,820,681	-$2,902,862	-$59,641,361	-$5,805,723
Increased Spending on U.S. Airlines to Travel Abroad	$125,840	$14,813	$4,182,039	$492,268	$8,364,078	$984,536

Table A64. Changes in Expenditure by U.S. Residents (lower-bound estimates for LAX Tom Bradley; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$162,053	-$22,922	-$5,378,531	-$761,162	-$10,757,062	-$1,522,324
Increased Spending on U.S. Airlines to Travel Abroad	$22,726	$3,887	$754,283	$129,078	$1,508,566	$258,156

Table A65. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for LAX Tom Bradley; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$2,977	-$98,923	-$197,846
MPET	Petroleum Refining	-$9,128	-$303,347	-$606,694
MOND	Other Non-Durables Mftg	-$4,704	-$156,333	-$312,667
TAIR	Air Transport	-$8,714	-$289,604	-$579,207
TRAL	Rail Transport	-$238	-$7,908	-$15,815
TOTH	Other Transport	-$36	-$1,209	-$2,417
TLTP	Private Transit	-$1,158	-$38,480	-$76,959
HOTR	Hotels and Restaurants	-$38,421	-$1,276,846	-$2,553,691
PSRV	Personal Services	-$231	-$7,677	-$15,355
OBSV	Other Business Services	-$17,252	-$573,325	-$1,146,651
ENTR	Entertainment	-$4,490	-$149,210	-$298,421
Total		**-$87,349**	**-$2,902,862**	**-$5,805,723**

Table A66. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for LAX Tom Bradley; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$781	-$25,939	-$51,877
MPET	Petroleum Refining	-$2,395	-$79,541	-$159,082
MOND	Other Non-Durables Mftg	-$1,234	-$40,992	-$81,985
TAIR	Air Transport	-$2,287	-$75,937	-$151,874
TRAL	Rail Transport	-$62	-$2,073	-$4,147
TOTH	Other Transport	-$10	-$317	-$634
TLTP	Private Transit	-$304	-$10,090	-$20,180
HOTR	Hotels and Restaurants	-$10,083	-$334,803	-$669,606
PSRV	Personal Services	-$61	-$2,013	-$4,026
OBSV	Other Business Services	-$4,527	-$150,332	-$300,664
ENTR	Entertainment	-$1,178	-$39,125	-$78,249
Total		**-$22,922**	**-$761,162**	**-$1,522,324**

Table A67. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in MIA Central Terminal (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$37,366	$1,756	$1,166,615	$54,821	$2,333,230	$109,642
MPET	Petroleum Refining	$12,796	$360	$399,514	$11,246	$799,028	$22,492
MOND	Other Non-Durables Mftg	$193,040	$7,392	$6,026,897	$230,778	$12,053,793	$461,555
TAIR	Air Transport	$297,448	$26,243	$9,286,640	$819,338	$18,573,280	$1,638,677
TRAL	Rail Transport	$1,397	$108	$43,620	$3,364	$87,241	$6,729
TOTH	Other Transport	$7,261	$560	$226,708	$17,485	$453,415	$34,970
TLTP	Private Transit	$8,925	$688	$278,637	$21,490	$557,273	$42,980
HOTR	Hotels and Restaurants	$253,782	$19,363	$7,923,334	$604,544	$15,846,669	$1,209,087
PSRV	Personal Services	$1,369	$106	$42,730	$3,296	$85,460	$6,591
OBSV	Other Business Services	$24,654	$1,536	$769,737	$47,958	$1,539,473	$95,916
ENTR	Entertainment	$91,356	$2,619	$2,852,235	$81,761	$5,704,470	$163,522
MEDC	Medical Services	$1,589	$63	$49,604	$1,978	$99,208	$3,956
Total		**$930,984**	**$60,794**	**$29,066,270**	**$1,898,059**	**$58,132,540**	**$3,796,117**

Table A68. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in MIA Central Terminal (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$13,136	$687	$410,120	$21,439	$820,240	$42,878
MPET	Petroleum Refining	$4,499	$141	$140,448	$4,398	$280,896	$8,796
MOND	Other Non-Durables Mftg	$67,863	$2,891	$2,118,738	$90,252	$4,237,476	$180,503
TAIR	Air Transport	$104,567	$10,263	$3,264,692	$320,424	$6,529,383	$640,848
TRAL	Rail Transport	$491	$42	$15,335	$1,316	$30,669	$2,631
TOTH	Other Transport	$2,553	$219	$79,698	$6,838	$159,397	$13,676
TLTP	Private Transit	$3,137	$269	$97,954	$8,404	$195,908	$16,809
HOTR	Hotels and Restaurants	$89,216	$7,573	$2,785,425	$236,423	$5,570,851	$472,846
PSRV	Personal Services	$481	$41	$15,022	$1,289	$30,043	$2,578
OBSV	Other Business Services	$8,667	$601	$270,599	$18,755	$541,197	$37,511
ENTR	Entertainment	$32,116	$1,024	$1,002,695	$31,975	$2,005,390	$63,950
MEDC	Medical Services	$559	$25	$17,438	$774	$34,876	$1,547
Total		**$327,285**	**$23,775**	**$10,218,163**	**$742,287**	**$20,436,327**	**$1,484,573**

Table A69. Changes in Expenditure by U.S. Residents (upper-bound estimates for MIA Central Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$2,081,202	-$177,297	-$56,389,923	-$4,803,852	-$112,779,845	-$9,607,703
Increased Spending on U.S. Airlines to Travel Abroad	$658,736	$67,859	$17,848,380	$1,838,618	$35,696,759	$3,677,237

Table A70. Changes in Expenditure by U.S. Residents (lower-bound estimates for MIA Central Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$459,019	-$52,904	-$12,473,250	-$1,436,194	-$24,946,500	-$2,872,389
Increased Spending on U.S. Airlines to Travel Abroad	$145,287	$20,248	$3,947,998	$549,687	$7,895,996	$1,099,373

Table A71. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for MIA Central Terminal; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$6,042	-$163,704	-$327,409
MPET	Petroleum Refining	-$18,527	-$501,999	-$1,003,999
MOND	Other Non-Durables Mftg	-$9,548	-$258,711	-$517,422
TAIR	Air Transport	-$17,688	-$479,256	-$958,511
TRAL	Rail Transport	-$483	-$13,086	-$26,172
TOTH	Other Transport	-$74	-$2,000	-$4,000
TLTP	Private Transit	-$2,350	-$63,679	-$127,357
HOTR	Hotels and Restaurants	-$77,986	-$2,113,010	-$4,226,021
PSRV	Personal Services	-$469	-$12,705	-$25,410
OBSV	Other Business Services	-$35,017	-$948,778	-$1,897,555
ENTR	Entertainment	-$9,113	-$246,923	-$493,847
Total		**-$177,297**	**-$4,803,852**	**-$9,607,703**

Table A72. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for MIA Central Terminal; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$1,803	-$48,942	-$97,884
MPET	Petroleum Refining	-$5,528	-$150,081	-$300,163
MOND	Other Non-Durables Mftg	-$2,849	-$77,346	-$154,692
TAIR	Air Transport	-$5,278	-$143,282	-$286,563
TRAL	Rail Transport	-$144	-$3,912	-$7,825
TOTH	Other Transport	-$22	-$598	-$1,196
TLTP	Private Transit	-$701	-$19,038	-$38,076
HOTR	Hotels and Restaurants	-$23,270	-$631,721	-$1,263,442
PSRV	Personal Services	-$140	-$3,798	-$7,597
OBSV	Other Business Services	-$10,449	-$283,653	-$567,307
ENTR	Entertainment	-$2,719	-$73,822	-$147,644
Total		**-$52,904**	**-$1,436,194**	**-$2,872,389**

Table A73. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in MIA South Terminal (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$81,329	$3,822	$1,301,105	$61,141	$2,602,210	$122,281
MPET	Petroleum Refining	$27,851	$784	$445,571	$12,542	$891,142	$25,085
MOND	Other Non-Durables Mftg	$420,156	$16,088	$6,721,693	$257,382	$13,443,387	$514,764
TAIR	Air Transport	$647,404	$57,119	$10,357,229	$913,794	$20,714,458	$1,827,588
TRAL	Rail Transport	$3,041	$235	$48,649	$3,752	$97,298	$7,504
TOTH	Other Transport	$15,805	$1,219	$252,843	$19,501	$505,686	$39,002
TLTP	Private Transit	$19,425	$1,498	$310,759	$23,968	$621,517	$47,935
HOTR	Hotels and Restaurants	$552,363	$42,145	$8,836,757	$674,237	$17,673,515	$1,348,474
PSRV	Personal Services	$2,979	$230	$47,656	$3,676	$95,313	$7,351
OBSV	Other Business Services	$53,661	$3,343	$858,474	$53,487	$1,716,948	$106,974
ENTR	Entertainment	$198,839	$5,700	$3,181,048	$91,187	$6,362,097	$182,374
MEDC	Medical Services	$3,458	$138	$55,323	$2,206	$110,645	$4,412
Total		**$2,026,310**	**$132,320**	**$32,417,108**	**$2,116,872**	**$64,834,215**	**$4,233,744**

Table A74. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in MIA South Terminal (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$28,039	$1,470	$448,568	$23,521	$897,136	$47,042
MPET	Petroleum Refining	$9,602	$302	$153,615	$4,825	$307,229	$9,650
MOND	Other Non-Durables Mftg	$144,853	$6,189	$2,317,366	$99,016	$4,634,733	$198,031
TAIR	Air Transport	$223,199	$21,974	$3,570,751	$351,539	$7,141,502	$703,078
TRAL	Rail Transport	$1,048	$90	$16,772	$1,443	$33,544	$2,887
TOTH	Other Transport	$5,449	$469	$87,170	$7,502	$174,340	$15,004
TLTP	Private Transit	$6,697	$576	$107,137	$9,220	$214,274	$18,441
HOTR	Hotels and Restaurants	$190,432	$16,213	$3,046,554	$259,381	$6,093,109	$518,762
PSRV	Personal Services	$1,027	$88	$16,430	$1,414	$32,860	$2,828
OBSV	Other Business Services	$18,500	$1,286	$295,967	$20,577	$591,934	$41,153
ENTR	Entertainment	$68,552	$2,193	$1,096,696	$35,080	$2,193,392	$70,160
MEDC	Medical Services	$1,192	$53	$19,073	$849	$38,146	$1,697
Total		**$698,589**	**$50,904**	**$11,176,099**	**$814,366**	**$22,352,198**	**$1,628,733**

Table A75. Changes in Expenditure by U.S. Residents (upper-bound estimates for MIA South Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$753,795	-$64,216	-$11,626,697	-$990,477	-$23,253,394	-$1,980,954
Increased Spending on U.S. Airlines to Travel Abroad	$238,589	$24,578	$3,680,049	$379,094	$7,360,099	$758,187

Table A76. Changes in Expenditure by U.S. Residents (lower-bound estimates for MIA South Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$150,730	-$17,971	-$2,326,291	-$277,295	-$4,652,583	-$554,590
Increased Spending on U.S. Airlines to Travel Abroad	$47,709	$6,878	$736,311	$106,131	$1,472,622	$212,263

Table A77. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for MIA South Terminal; in 2012$)

USCGE Sector		**+1 Officer**	**Wait Time Falls by 50%**	**Wait Time Falls by 100%**
MOFD	Other Food Mftg	-$2,188	-$33,753	-$67,506
MPET	Petroleum Refining	-$6,710	-$103,504	-$207,008
MOND	Other Non-Durables Mftg	-$3,458	-$53,342	-$106,684
TAIR	Air Transport	-$6,406	-$98,815	-$197,630
TRAL	Rail Transport	-$175	-$2,698	-$5,396
TOTH	Other Transport	-$27	-$412	-$825
TLTP	Private Transit	-$851	-$13,129	-$26,259
HOTR	Hotels and Restaurants	-$28,246	-$435,669	-$871,338
PSRV	Personal Services	-$170	-$2,620	-$5,239
OBSV	Other Business Services	-$12,683	-$195,623	-$391,245
ENTR	Entertainment	-$3,301	-$50,912	-$101,823
Total		**-$64,216**	**-$990,477**	**-$1,980,954**

Table A78. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for MIA South Terminal; in 2012$)

USCGE Sector		**+1 Officer**	**Wait Time Falls by 50%**	**Wait Time Falls by 100%**
MOFD	Other Food Mftg	-$612	-$9,450	-$18,899
MPET	Petroleum Refining	-$1,878	-$28,977	-$57,954
MOND	Other Non-Durables Mftg	-$968	-$14,934	-$29,867
TAIR	Air Transport	-$1,793	-$27,664	-$55,329
TRAL	Rail Transport	-$49	-$755	-$1,511
TOTH	Other Transport	-$7	-$115	-$231
TLTP	Private Transit	-$238	-$3,676	-$7,351
HOTR	Hotels and Restaurants	-$7,905	-$121,970	-$243,941
PSRV	Personal Services	-$48	-$733	-$1,467
OBSV	Other Business Services	-$3,549	-$54,767	-$109,534
ENTR	Entertainment	-$924	-$14,253	-$28,507
Total		**-$17,971**	**-$277,295**	**-$554,590**

Table A79. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in MIA North Terminal (Upper-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$11,271	$530	$388,262	$18,245	$776,524	$36,490
MPET	Petroleum Refining	$3,860	$109	$132,962	$3,743	$265,925	$7,485
MOND	Other Non-Durables Mftg	$58,228	$2,230	$2,005,815	$76,805	$4,011,631	$153,610
TAIR	Air Transport	$89,721	$7,916	$3,090,693	$272,685	$6,181,385	$545,369
TRAL	Rail Transport	$421	$33	$14,517	$1,120	$29,035	$2,239
TOTH	Other Transport	$2,190	$169	$75,451	$5,819	$150,901	$11,638
TLTP	Private Transit	$2,692	$208	$92,733	$7,152	$185,466	$14,304
HOTR	Hotels and Restaurants	$76,550	$5,841	$2,636,970	$201,199	$5,273,940	$402,397
PSRV	Personal Services	$413	$32	$14,221	$1,097	$28,442	$2,194
OBSV	Other Business Services	$7,437	$463	$256,177	$15,961	$512,353	$31,922
ENTR	Entertainment	$27,556	$790	$949,254	$27,211	$1,898,508	$54,422
MEDC	Medical Services	$479	$19	$16,509	$658	$33,018	$1,317
Total		**$280,818**	**$18,338**	**$9,673,564**	**$631,694**	**$19,347,128**	**$1,263,388**

Table A80. Increased Expenditure by Foreign Visitors due to Wait Time Reduction in MIA North Terminal (Lower-bound Estimates; in 2012$)

USCGE Sector		+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
		Leisure	Business	Leisure	Business	Leisure	Business
MOFD	Other Food Mftg	$3,707	$196	$127,698	$6,747	$255,396	$13,494
MPET	Petroleum Refining	$1,269	$40	$43,731	$1,384	$87,462	$2,768
MOND	Other Non-Durables Mftg	$19,151	$825	$659,706	$28,403	$1,319,412	$56,806
TAIR	Air Transport	$29,509	$2,927	$1,016,519	$100,841	$2,033,038	$201,681
TRAL	Rail Transport	$139	$12	$4,775	$414	$9,549	$828
TOTH	Other Transport	$720	$62	$24,815	$2,152	$49,631	$4,304
TLTP	Private Transit	$885	$77	$30,500	$2,645	$60,999	$5,290
HOTR	Hotels and Restaurants	$25,177	$2,160	$867,291	$74,405	$1,734,582	$148,809
PSRV	Personal Services	$136	$12	$4,677	$406	$9,355	$811
OBSV	Other Business Services	$2,446	$171	$84,256	$5,902	$168,511	$11,805
ENTR	Entertainment	$9,063	$292	$312,207	$10,063	$624,413	$20,126
MEDC	Medical Services	$158	$7	$5,430	$243	$10,859	$487
Total		**$92,360**	**$6,781**	**$3,181,604**	**$233,605**	**$6,363,208**	**$467,210**

Table A81. Changes in Expenditure by U.S. Residents (upper-bound estimates for MIA North Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$194,720	-$16,588	-$7,085,935	-$603,650	-$14,171,871	-$1,207,300
Increased Spending on U.S. Airlines to Travel Abroad	$61,632	$6,349	$2,242,820	$231,040	$4,485,641	$462,080

Table A82. Changes in Expenditure by U.S. Residents (lower-bound estimates for MIA North Terminal; in 2012$)

	+1 Officer		Wait Time Falls by 50%		Wait Time Falls by 100%	
	Leisure	Business	Leisure	Business	Leisure	Business
Total Reduced Domestic Spending	-$42,179	-$4,891	-$1,529,619	-$177,576	-$3,059,238	-$355,151
Increased Spending on U.S. Airlines to Travel Abroad	$13,350	$1,872	$484,151	$67,965	$968,301	$135,930

Table A83. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (upper-bound estimates for MIA North Terminal; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$565	-$20,571	-$41,142
MPET	Petroleum Refining	-$1,733	-$63,081	-$126,162
MOND	Other Non-Durables Mftg	-$893	-$32,510	-$65,019
TAIR	Air Transport	-$1,655	-$60,223	-$120,446
TRAL	Rail Transport	-$45	-$1,644	-$3,289
TOTH	Other Transport	-$7	-$251	-$503
TLTP	Private Transit	-$220	-$8,002	-$16,004
HOTR	Hotels and Restaurants	-$7,296	-$265,520	-$531,040
PSRV	Personal Services	-$44	-$1,597	-$3,193
OBSV	Other Business Services	-$3,276	-$119,223	-$238,446
ENTR	Entertainment	-$853	-$31,028	-$62,057
Total		**-$16,588**	**-$603,650**	**-$1,207,300**

Table A84. Offset in Domestic Expenditures by U.S. Residents Traveling on International Business (lower-bound estimates for MIA North Terminal; in 2012$)

USCGE Sector		+1 Officer	Wait Time Falls by 50%	Wait Time Falls by 100%
MOFD	Other Food Mftg	-$167	-$6,051	-$12,103
MPET	Petroleum Refining	-$511	-$18,557	-$37,113
MOND	Other Non-Durables Mftg	-$263	-$9,563	-$19,127
TAIR	Air Transport	-$488	-$17,716	-$35,432
TRAL	Rail Transport	-$13	-$484	-$967
TOTH	Other Transport	-$2	-$74	-$148
TLTP	Private Transit	-$65	-$2,354	-$4,708
HOTR	Hotels and Restaurants	-$2,151	-$78,108	-$156,216
PSRV	Personal Services	-$13	-$470	-$939
OBSV	Other Business Services	-$966	-$35,072	-$70,144
ENTR	Entertainment	-$251	-$9,128	-$18,255
Total		**-$4,891**	**-$177,576**	**-$355,151**

Volume II:

Modeling Flows and Wait Time of Traffic at U.S. Border Crossings

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Volume II Summary

The first chapter of volume II significantly develops the methodology used to quantify the impacts of extra primary inspection processing booths on wait time outcomes at land border crossings. As opposed to the methodology used in our earlier study, which was an approximation to the true relationship, the methodology presented here is an exact analysis. We apply the methodology to three land passenger vehicle border crossings (San Ysidro, Bridge of the Americas-El Paso POE, and Peace Arch-Blaine POE) and determine the quantity and value of wait time saved for FY 2013 vehicle traffic if additional officers had been deployed at each crossing. Results show that the reductions in wait time resulting from one extra officer are much greater under the new methodology than in our earlier study. We also quantify reductions in wait time resulting from a second extra officer, third extra officer, etc, and the size of these reductions falls as more and more officers are added. It should now be possible to develop analysis of a particular border crossing based on this methodology that also takes into account factors such as infrastructure constraints, productivity of unstacked versus stacked booths, technologies that affect the traffic processing rate, and other important factors influencing processing outcomes at border crossings. Results from such analysis could be used as an input to estimation of optimal processing capacities at particular crossings.

The second chapter of volume II reviews available projections of vehicle and passenger flows at ports of entry, which CBP needs in order to understand what processing resources will likely be required in order to achieve given wait time outcomes. We review here available projections of land and air flows and find that only projections of international air passenger arrivals at U.S. airports are currently available. We thus focus on the key gap in projections that CBP faces. We begin with a review of historical trends in passenger and commercial vehicle flows on the northern and southern borders during 1995-2012. We then propose a methodology to project these flows at ports of entry on the northern and southern land borders, and provide estimated models and forecasts of these flows in aggregate on the northern and southern borders.

Chapter 8: Exact Analysis of Congested Queuing at U.S. Land Border Crossings

Bryan Roberts

An analysis of the impact of an extra inspection officer on queue length and wait time at passenger and commercial vehicle land border crossings was developed in Roberts et al. (2013) and applied to empirical data for 17 passenger vehicle crossings and 13 commercial vehicle crossings. However, the methodology that they developed only approximated the true impact of adding an additional inspection officer. In particular, it considered the case of a deterministic queue at a congested border crossing that was unchanging over time, and how an extra officer impacted this initial queue over eight consecutive hours but without taking into account the *cumulative* impact of the officer on the queue.[70] We develop here a methodology that permits exact analysis of congested queuing at a border crossing that is based on analysis of cumulative arrivals and removals, and apply the methodology to three land passenger vehicle crossings. This methodology permits analysis of the marginal impact on queue length and wait time of more than one additional officer.

The methodology is fully described by figure 8-1, which illustrates congested queuing at any bottleneck for which arrivals exceed removals over a fixed amount of time. The cumulative arrivals line shows the total number of cumulative arrivals through the hour on the x axis. In the land border crossing context, this is the total number of vehicles that came to the crossing to enter the U.S. through hour x. The cumulative removals line shows the total number of vehicles removed from (processed by) the crossing through hour x. Removals take place at a certain rate per hour: this rate will depend on the number of booths open, and the rate at which individual booths process vehicles.[71] Both of these variables will change over time. For purposes of simplicity, the analysis presented in figure 8-1 assumes that the removal rate is fixed at a constant rate of 4 vehicles per hour. Prior to point A, arrivals are less than removals, and no

[70] See Roberts et al. (2013), appendix 2A, section C for a detailed development of this analysis. As noted there, results developed in the field of queuing theory almost exclusively pertain to the case of non-deterministic queues that appear randomly. These results are irrelevant for U.S. land border crossings, which are characterized by saturated queuing conditions, rush hours, and associated deterministic queues. See Newell (1982) for a review of queuing theory results for deterministic queues. These results are unfortunately not useful or practical for analyzing questions such as the impact of adding extra processing resources or speeding up processing time.

[71] This depends on processing technology available at the booth and its impact on the speed with which primary inspection can be carried out, pre-primary-processing activities which could speed up primary processing, and the rate at which vehicles are identified as requiring secondary inspection (because primary inspection takes longer for these vehicles.) This secondary referral rate might in turn depend on systematic factors such as smuggling strategies and idiosyncratic factors such as the specific officer manning the inspection booth. Another factor that could influence the average time taken to conduct primary inspection is the length of the queue: Roberts et al. (2013) show that for the San Ysidro passenger vehicle crossing, the average number of seconds taken to do a primary inspection falls as the queue length and wait time rise. This endogeneity is not taken into account in the analysis developed in this chapter but might be materially important in some instances.

queue is present.[72] Starting at point A (hour 5), the arrivals rate is 6 cars per hour and exceeds the removals rate, and a queue emerges. The length of the queue in number of vehicles at any given point in time equals the difference between the cumulative arrivals line and the cumulative removals line. The maximum queue length is reached at point B (hour 14), after which the hourly arrivals rate falls to 1 vehicle, which is below the hourly removals rate of 4 vehicles. The queue falls until point C is reached, when it becomes zero and the congested queuing period (the rush hour) is over. The total amount of time that vehicles spend waiting in the queue is the area of the triangle ABC.

Figure 8-1
A Rush Hour Cycle With Congested Queueing

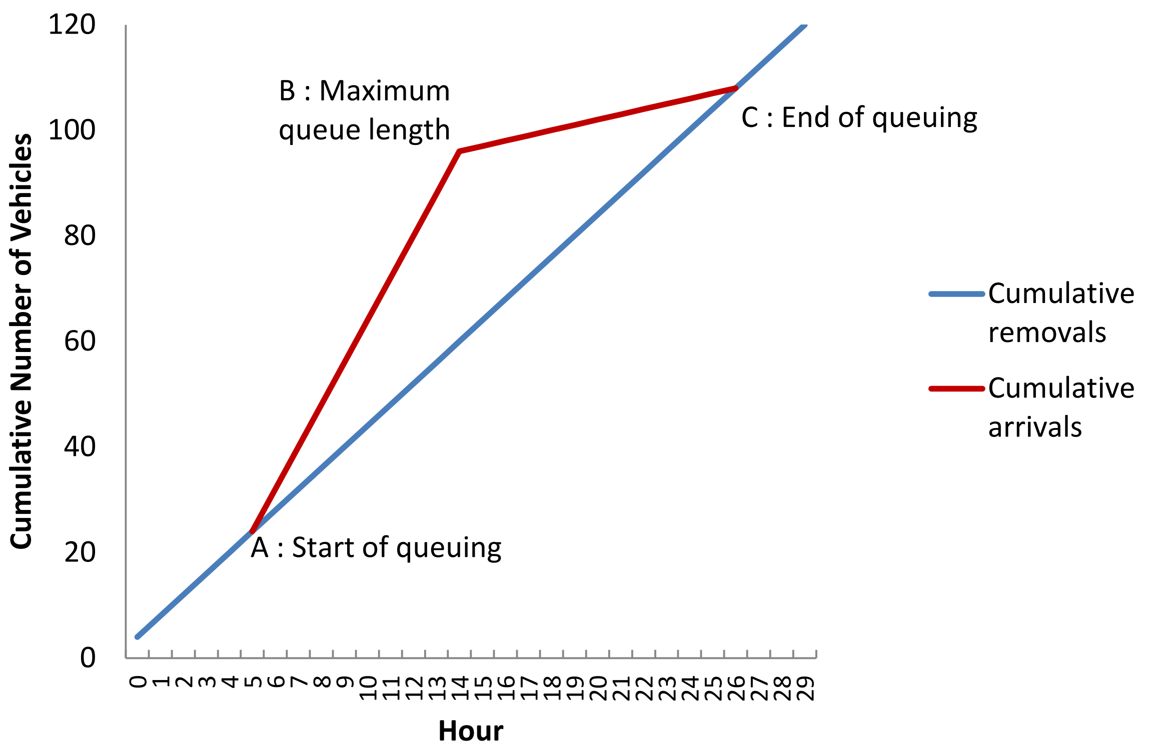
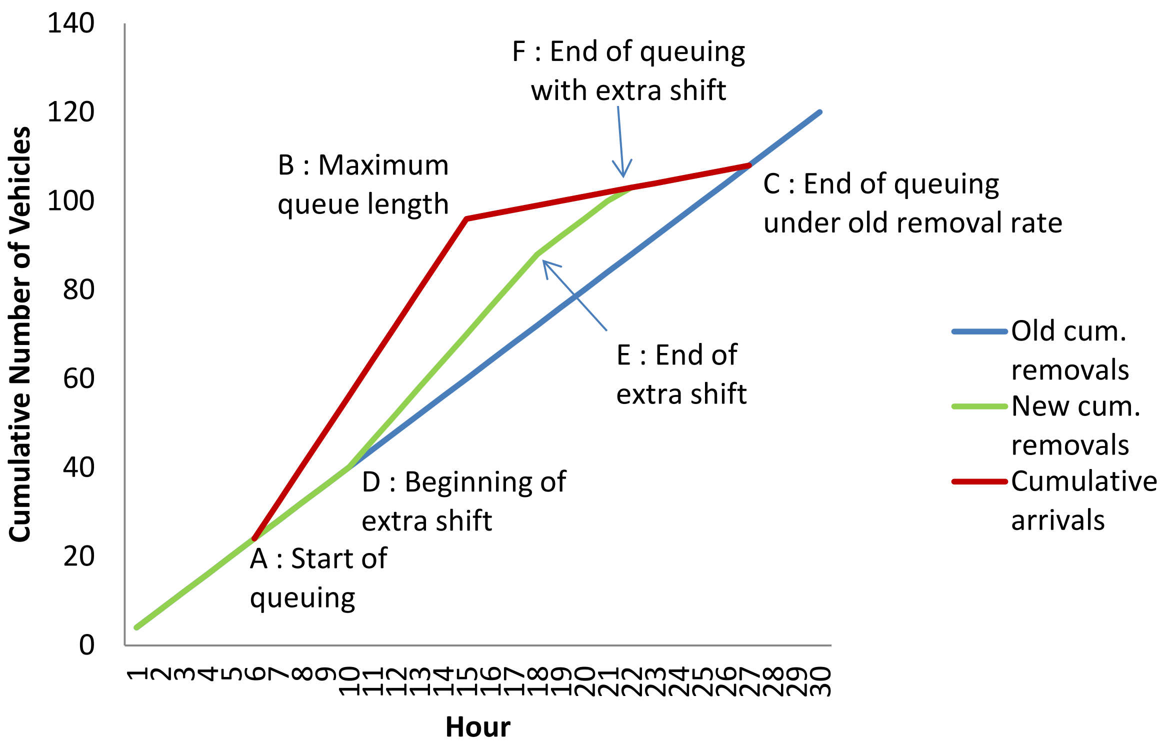


Figure 8-1 lays the basis for an exact analysis of the impact of extra processing booths or change in the efficiency of processing vehicles. Figure 8-2 shows what happens when the hourly removal rate rises to 6 vehicles per hour during hours 10-17, which could correspond to adding an extra booth for an 8-hour CBP-OFO officer shift. Two impacts happen, both of which serve to

[72] Queuing theory in fact focuses on analysis of the period prior to point A, because it analyzes situations when the *average* arrival rate is less than the *average* removal rate. However, because arrival and removal rates are random variables, queues will appear randomly when the arrival rate happens by chance to be above the removal rate.

lower the total amount of time waited during the rush hour. First, the queue is smaller at all points where it continues to exist, including after the end of the shift. Second, the congestion period (rush hour) ends earlier, at point F rather than at point C. The new total amount of time waited during the congested period is the area ABFED, which is significantly smaller than the triangle ABC, which is the original amount of total time waited.

Figure 8-2
Impact of Extra Processing Capacity over 8-Hour Shift



It is straightforward to evaluate the impacts of any change in processing capacity at a border crossing under this methodology, which could result from the following kinds of factors:

- Opening an extra lane, which corresponds to adding an inspection booth that has full processing productivity;
- Opening a stacked booth, which has less processing productivity than an extra lane;[73]
- Adding more than one lane or stacked booth to a crossing;
- Technology deployment that speeds up the inspection process;
- Infrastructure redesign that speeds up movement of flow.

[73]Evaluation of stacked-booth processing productivity suggests that a stacked booth is 50% as productive as a lane. Note that stacked booths are relevant only to land border crossings, not airport passport inspection sites.

8.1. Application to Three Land Passenger Vehicle Border Crossings

We use this methodology to evaluate the impact on amount and value of time waited at three passenger vehicle crossings of adding one or more primary inspection officers to them in FY 2013. Our analysis is conducted on FY 2013 hourly data for regular lanes at the San Ysidro, Bridge of Americas, and Peace Arch border crossings.[74] Rather than apply the methodology to all 365 days of FY 2013, we calculate average values for relevant variables used in the analysis for specific hours of a specific day of the week. We thus apply the methodology to a "typical week" in FY 2013.

In order to evaluate the impact of an extra officer, rules must be set regarding how that officer is deployed to conduct primary inspection. As in Roberts et al. (2013), we assume that an additional officer conducts primary inspection on 156 days out of their working year. We assume that on each of these days, an officer works an 8-hour shift, and that each shift must be followed by 16 hours when they do not work.[75] We also assume that the officer is deployed to 8-hour shifts on 5 consecutive days, and that each shift starts at the same time on each day. Optimal shift start times are identified by evaluating the level of congestion (total time waited) associated with all possible shift start times, and choosing the one that has the highest level of congestion. This approach thus builds in some constraints on how CBP-OFO can deploy the officer, and chooses the optimal deployment strategy given those constraints.[76]

The length of the queue in terms of the number of vehicles in it at a border crossing in a particular hour is calculated by multiplying the wait time in that hour by the number of removals per minute.[77] Cumulative removals are calculated by summing hourly values of the number of vehicles processed in regular lanes (VEH.) Cumulative arrivals are calculated as cumulative removals plus the length of the queue in vehicles. It is then straightforward to

---

[74] The Bridge of Americas crossing is part of the El Paso (Texas) port of entry on the southern border, and the Peace Arch crossing is part of the Blaine (Washington) port of entry on the northern border. The San Ysidro crossing is south of San Diego (California) on the southern border.

[75] This approach was not followed in Roberts et al. (2013), which did not work with "typical week" data but with data for all days of the year, identified the most optimal 8-hour shift in each day of the year, developed impact results for each of these 365 shifts, took average values across them, and multiplied the average by 156. This algorithm is not likely to produce realistic shift deployments that respect the constraints that CBP-OFO faces. The algorithm used here thus represents an improvement on the approach of Roberts et al. (2013).

[76] The first officer added to a border crossing will work 31 five-day shifts in the year, each of which start on the same time and day of the week. Because a year has 73 such five-day shifts, this means that 42 shifts starting on this time and day are left over. The second officer added to the border crossing will be assigned to 31 out of the remaining 42 of these optimal shifts. The third officer is assigned to the remaining 11 of these shifts. A second optimal shift with a new hour-day start time is identified, and the third officer is assigned to 20 of these shifts. The fourth officer is assigned to 31 of these shifts, and subsequent officers are assigned to shifts following the same logic.

[77] The number of removals per minute is the number of vehicles (VEH) processed in regular lanes in an hour divided by 60.

calculate the area between cumulative arrivals and removals as shown in figure 8-1. An extra new booth (officer) is assumed to remove (process) vehicles in a given hour at the same rate as the existing booths did in that hour. For the Bridge of Americas and Peace Arch, this is equivalent to assuming that a new lane is opened when an officer is added, because these crossings do note deploy stacked booths. For San Ysidro, however, the productivity of a new booth equals some average of the productivities of stacked and non-stacked booths, because both types of booths could have been deployed there in a given hour. This analysis thus does not take into account infrastructure constraints such that a new lane cannot be opened in a given hour at a border crossing due to the fact that it is already operating at maximum capacity. In this case, the analysis does provide results that show what the benefit to having a new lane would be.

Under these assumptions, it is straightforward to calculate the new cumulative removals line as in figure 8-2, and the area between the cumulative arrivals line (which remains unchanged) and the new cumulative removals line.[78]An algorithmic procedure was followed that permitted identifying when queue length and wait time fell to zero if enough officers had been added and ensuring that the difference between the cumulative arrivals and removals lines never became negative.

Figure 8-3 shows the reduction in time waited in inspection queues with the addition of each extra officer for San Ysidro, and figure 8-4 shows the value of this time in millions of $US.[79] Figures 8-5 and 8-6 show these impact curves for the Bridge of the Americas crossing at the El Paso port of entry, and figures 8-7 and 8-8 for the Peace Arch crossing at the Blaine port of entry. The reduction in the amount of time waited and the value of this time brought about by the first officer added are much greater than the impacts quantified in Roberts et al. (2013) for these crossings. For the San Ysidro crossing, the value of time saved due to adding one officer is roughly $25 million, which is ten times greater than the estimated impact of $2.5 million in Roberts et al. (2013). For the Bridge of the Americas crossing, the impact estimated here is $5.8 million as opposed to $1.8 million in Roberts et al. (2013), and for Peace Arch, $9.8 million versus $3.7 million. Although we do not calculate here the change in cross-border trips resulting from the new wait time after the addition of the officer and resulting impacts on U.S. GDP and employment, new estimates would also be substantially larger than those of Roberts et al. (2013).

Figures 8-3 through 8-8 describe the “marginal productivity” curves of extra officers in terms of both time and the value of time for the three crossings. As expected, marginal productivity falls

[78] It is important to note that arrivals at the border crossing are assumed to be fixed in this analysis. In particular, the volume of arrivals does not change in response to change in wait time at the crossing. Given the findings of Roberts et al. (2013), this is not a realistic assumption. It should, however, be straightforward to build an endogenous arrivals response into this analysis.

[79] Valuation of time follows the procedures and assumptions employed in Roberts et al. (2013).

as the number of officers increases. For San Ysidro, the value of time saved by an extra officer remains as high as $300,000 by the 23rd officer added. For the Bridge of the Americas, the 9th extra officer saves $300,000 worth of time, and for the Peace Arch crossing, the 7th officer save $600,000 worth of time. These curves suggest that the deployment of significant numbers of extra officers to these crossings might plausibly be supported by a full cost-benefit analysis.[80]

The exact methodology for analysis of wait time at border crossings reviewed here forms the basis for constructing border crossing simulator models that could permit CBP-OFO to evaluate a wide range of questions, such as the wait time impacts of extra processing capacity through increased staff or new technologies, the economic returns to building new infrastructure, and the wait time impacts of rising traffic volumes. These models would be crossing-specific, user-friendly, and menu-driven. They could accommodate a range of constraints on staffing deployment and other aspects of crossing operation. They could also be designed to be easily updated to incorporate the most recent year of crossing data.

[80] These curves do not take into account infrastructure constraints at the crossings. These constraints would affect the cost side of a cost-benefit analysis.

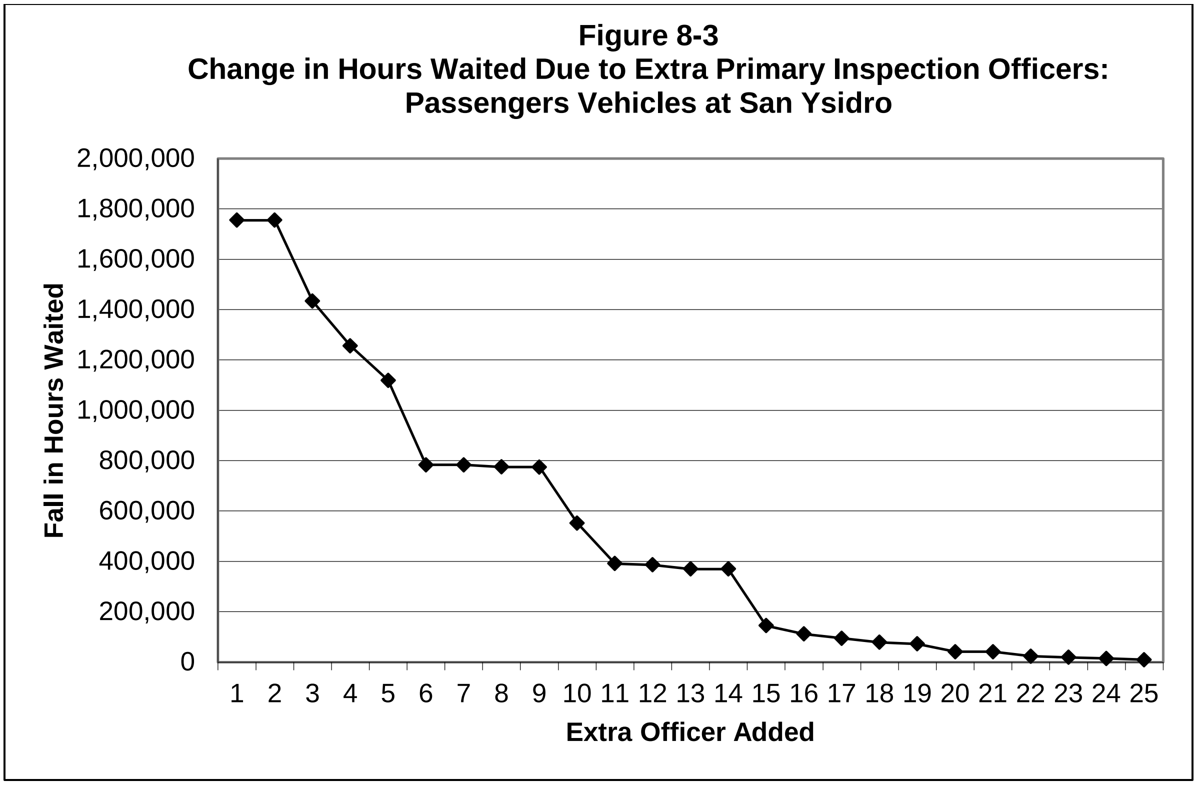


Figure 8-3
Change in Hours Waited Due to Extra Primary Inspection Officers:
Passengers Vehicles at San Ysidro
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Fall in Hours Waited
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Extra Officer Added

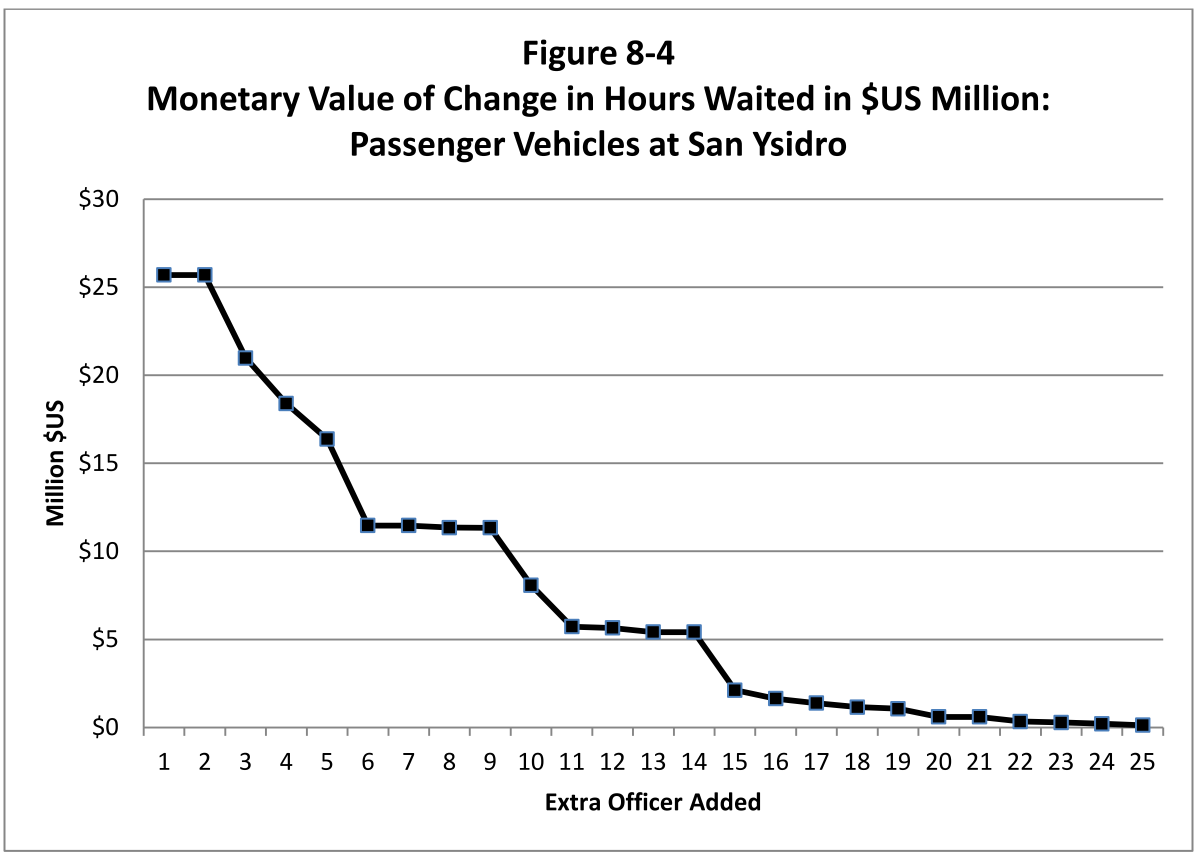


Figure 8-4
Monetary Value of Change in Hours Waited in $US Million:
Passenger Vehicles at San Ysidro
$30
$25
$20
$15
$10
$5
$0
Million $US
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Extra Officer Added

Figure 8-5
Change in Hours Waited Due to Extra Primary Inspection Officers: Regular Lanes at Bridge of the Americas

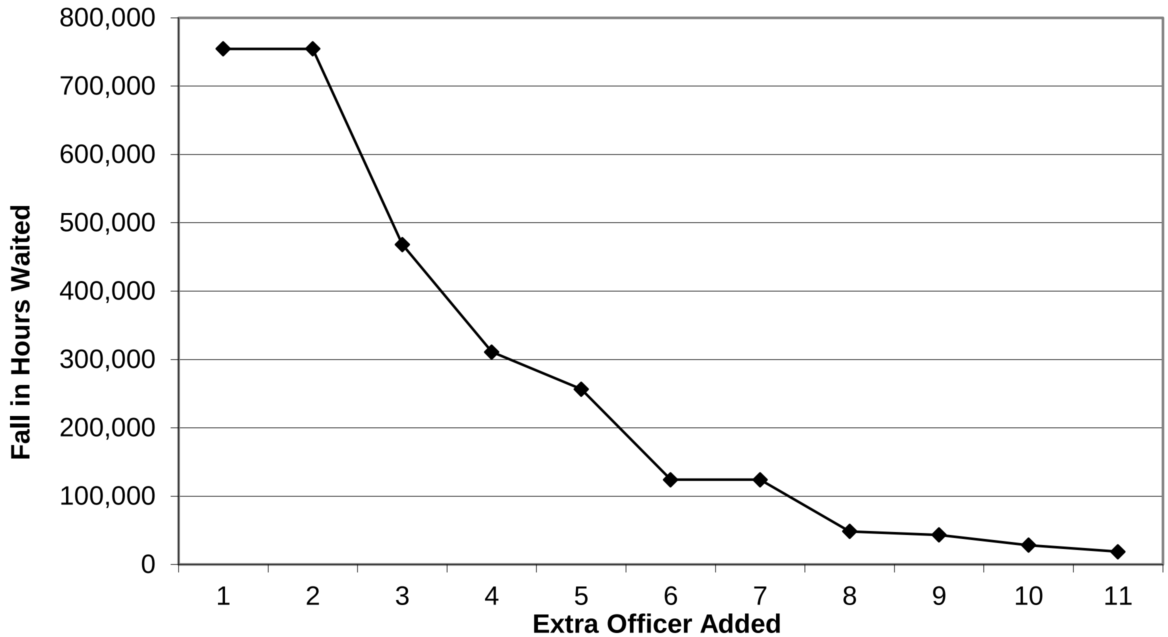


Figure 8-6
Monetary Value of Change in Hours Waited in $US Million: Passenger Vehicles at Bridge of the Americas

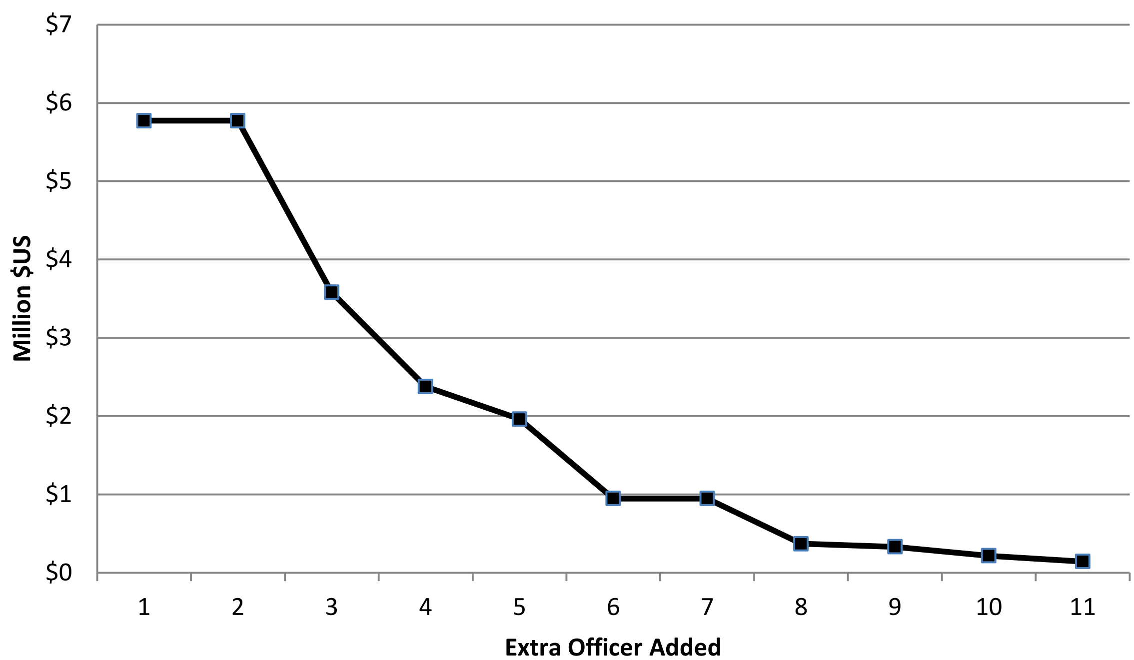


Figure 8-7
Change in Hours Waited Due to Extra Primary Inspection Officers: Regular Lanes at Peace Arch

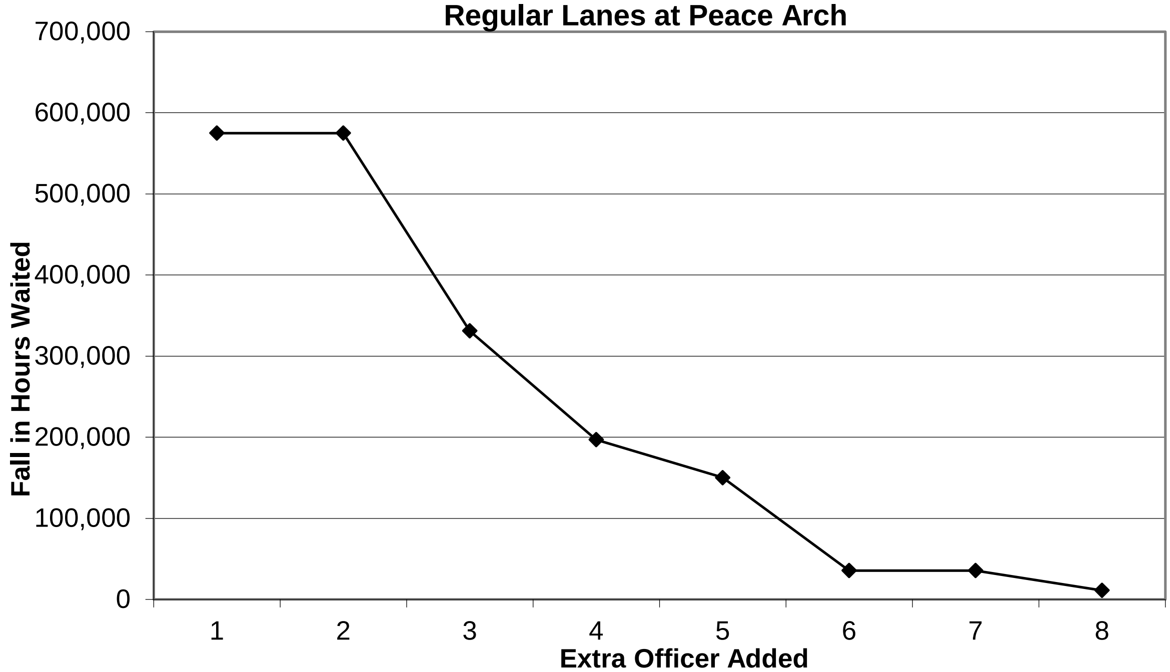
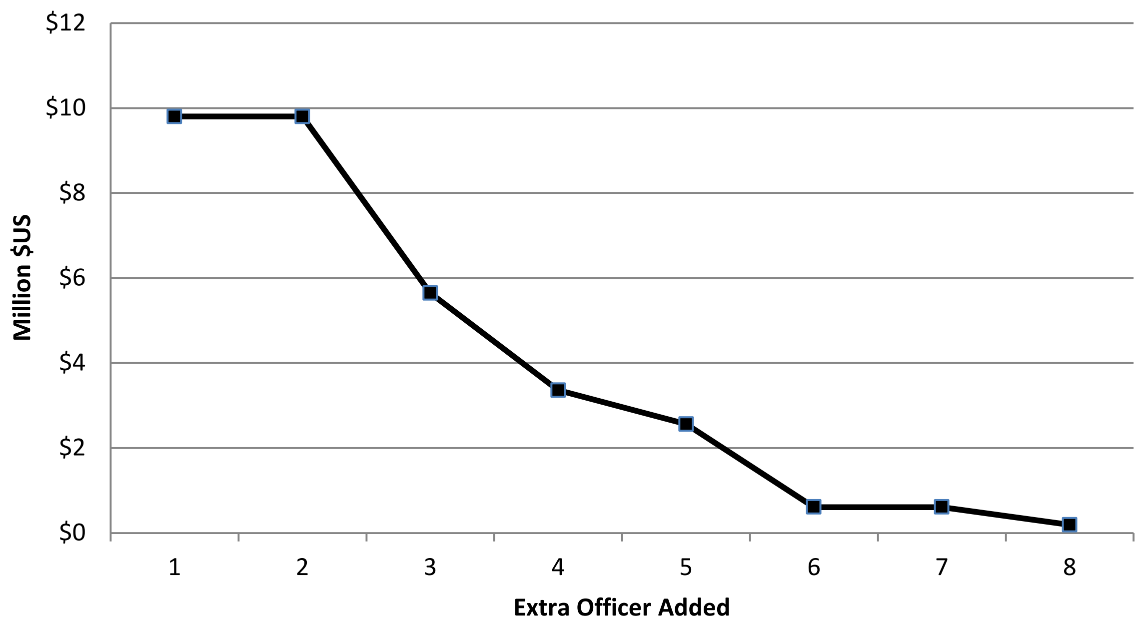


Figure 8-8
Monetary Value of Change in Hours Waited in $US Million: Passenger Vehicles at Peace Arch



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Chapter 9: Projections of Vehicle and Passenger Flows Across U.S. Borders

Bryan Roberts and Timothy Beggs

9.1. CBP-OFO Projection Needs

CBP-OFO needs projections of vehicle and passenger flows at ports of entry in order to understand what processing resources will likely be required in order to achieve given wait time outcomes. We review here available projections of land and air flows and find that only projections of international air passenger arrivals at U.S. airports are currently available. We thus focus on the key gap in projections that CBP faces. We begin with a review of historical trends in passenger and commercial vehicle flows on the northern and southern borders during 1995-2012. We then propose a methodology to project these flows at ports of entry on the northern and southern land borders, and provide estimated models and forecasts of these flows in aggregate on the northern and southern borders.

9.2. Existing Projections of Cross-Border Flows

Existing projections of cross-border passenger and vehicle flows are apparently available only for international air travelers. We have not been able to find any projections for passenger and vehicle flows on the land borders. The following projections of international air travelers arriving at U.S. airports are available:

- ***Officer of Travel and Tourism Industries (OTTI) of the U.S. Department of Commerce.*** OTTI regularly develops and updates projections of non-U.S.-resident international air travelers coming to the U.S. (See figure 2-1 and table 2-1 in Chapter 2 of Volume I of this report);
- ***Federal Aviation Administration (FAA).*** The FAA develops forecasts of total enplanements on international flights arriving in the U.S. out to 20 years[81];
- ***International Air Transportation Association (IATA).*** IATA develops five-year forecasts for over 2,000 international country pairs, from which a forecast of international arrivals to U.S. airports could presumably be derived.[82]

The clear gap in projections for CBP-OFO processing volumes is for land-border flows.

[81] See Federal Aviation Administration, *FAA Aerospace Forecast: Fiscal Years 2013-2033.*

[82] See http://www.iata.org/publications/Pages/airline-industry-forecast.aspx

9.3. Vehicle Flows on the Northern and Southern Borders

Data on passenger and commercial vehicle flows are available from the mid-1990s to the present. Monthly data has been reported for this period by the Bureau of Transportation Statistics of the Department of Transportation.[83] Figures 9-1 through 9-4 show historical quarterly values of passenger and commercial vehicles processed on the northern and southern borders, respectively. Each graph shows actual values and deseasonalized values.[84] Only passenger vehicle arrivals on the northern border are characterized by large seasonal swings. The other three flows are characterized by very small or no seasonal movements.

A review of these graphs suggests the following:

- **Passenger vehicles processed on the northern border.** Volumes declined somewhat in the second half of the 1990s and then more sharply after the 2001 recession. Volumes in the 2000s were systematically lower than levels in the 1990s. Factors that could potentially explain this are the depreciation of the U.S. dollar, and increased costs of crossing the border due to rise in wait time after 2001. After falling again during the Great Recession, volumes rose significantly after 2009, to a level slightly above the average level of the 2000s, but below the average level of the late 1990s. A key question for this flow is whether it will recover towards the pre-2002 level or not.
- **Commercial vehicles processed on the northern border.** Volumes rose rapidly in the second half of the 1990s and then stabilized at a long-run average level during 2000-2007. Volumes fell sharply during the Great Recession and recovered somewhat after 2009. Current levels are significantly below the average level prevailing during 2000-2007. A key question for this flow is whether there will be a recovery to that level over time as both the U.S. and Mexican economies experience continuing economic growth.
- **Passenger vehicles processed on the southern border.** Volumes hovered around a long-run average during 1997-2005 and then declined steadily during 2006-2011, rising slightly in 2012. Factors that could have played a role in this decline include the U.S. Great Recession, the fall in illegal immigration from Mexico that began after 2007, and the rise in border violence after 2006. A key question for this flow is whether there will be a recovery towards the pre-2006 level or not.
- **Commercial vehicles processed on the southern border.** Volumes rose rapidly in the second half of the 1990s, fell slightly during 2000-2003, rose again during 2004-2007,

[83] Monthly BTS-DOT data on border entries by type of vehicles and passengers at individual ports of entry are available starting in 1995. BTS-DOT reports data that it has obtained from the DHS (or the INS before 2003.) There are a few instances of missing values for some entry series for some ports for some months: we estimated these values using simple techniques. The only significant set of missing data is for the San Ysidro crossing for passenger vehicles and pedestrians during January 1995-February 1997. We thus use quarterly data on passenger vehicles processed on the southern border starting only in the second quarter of 1997, and annual data starting in 1998.

[84] Actual-value series were deseasonalized using the Census X-12 procedure.

fell sharply during the Great Recession, and then recovered rapidly to levels equal to the pre-recession peak. A key question for this flow is whether growth will continue as both the U.S. and Mexican economies experience continuing economic growth.

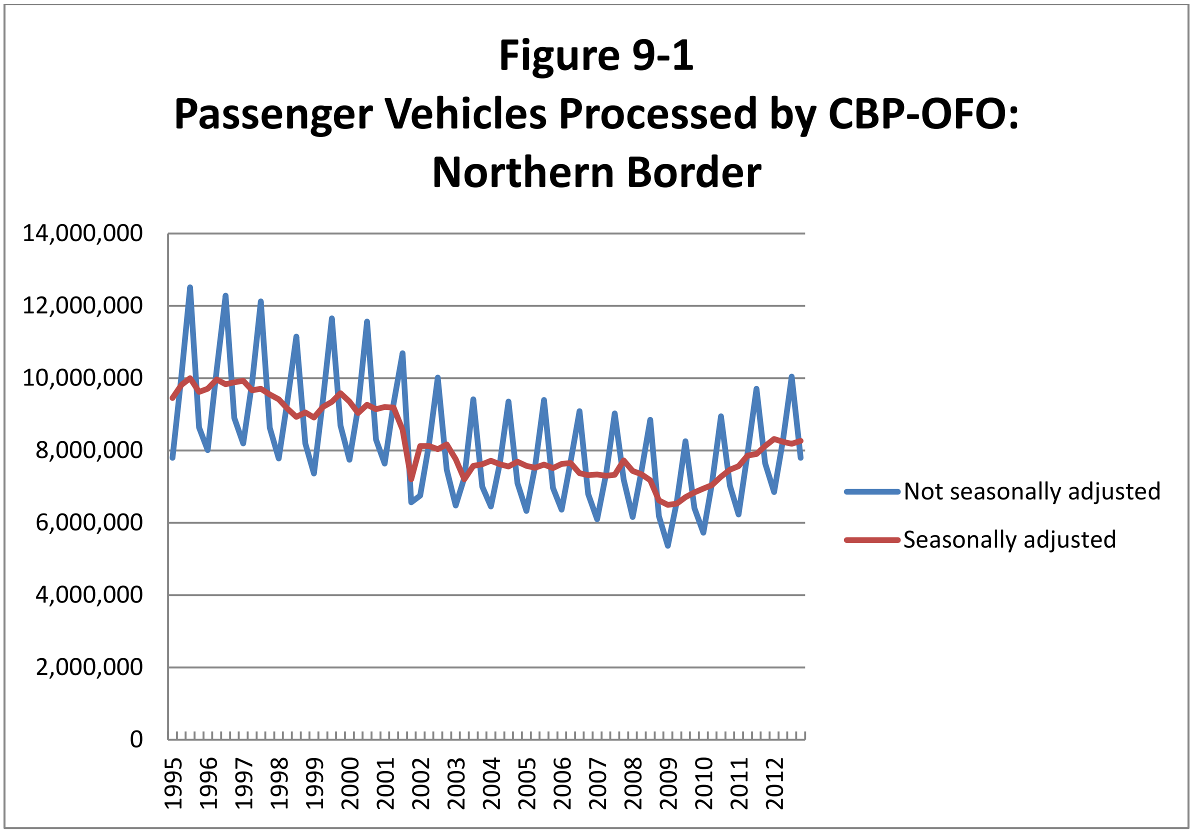


Figure 9-2
Commercial Vehicles Processed by CBP-OFO: Northern Border

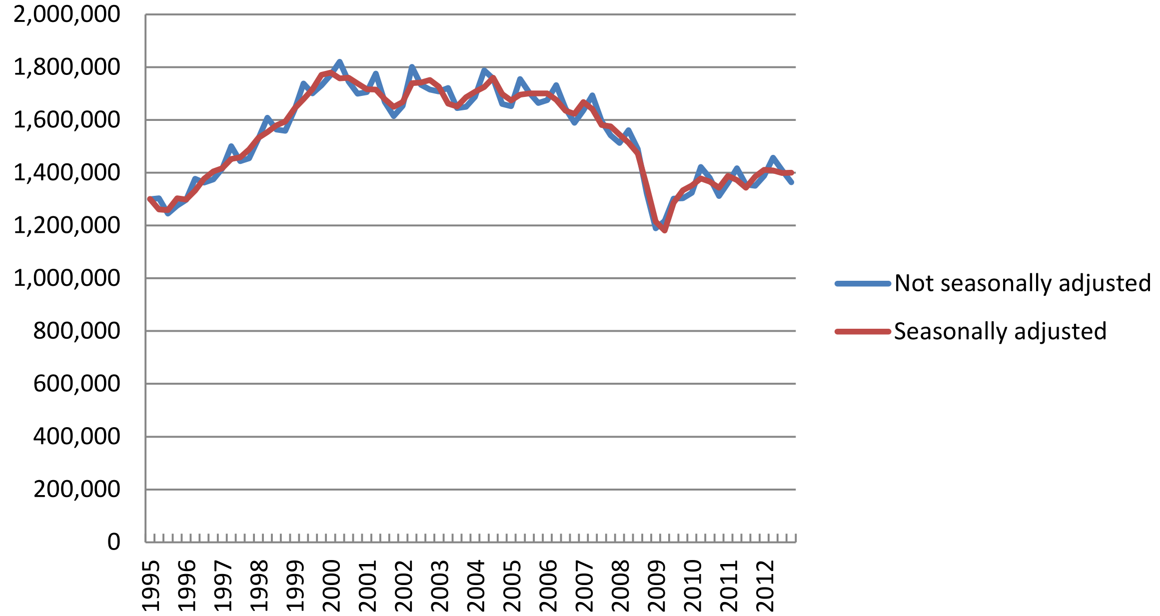
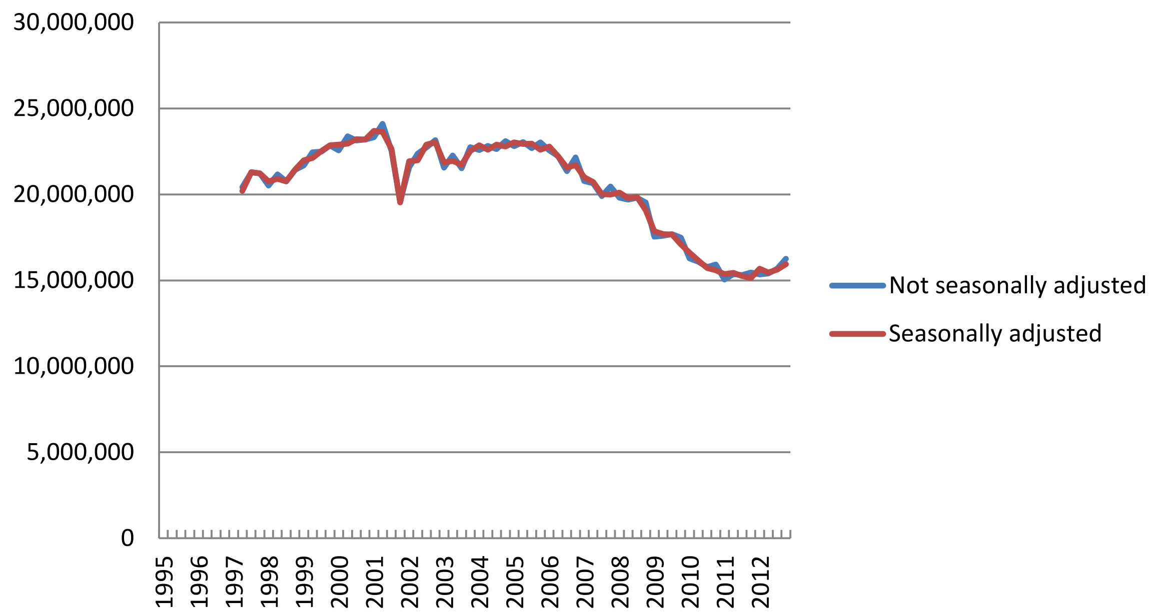
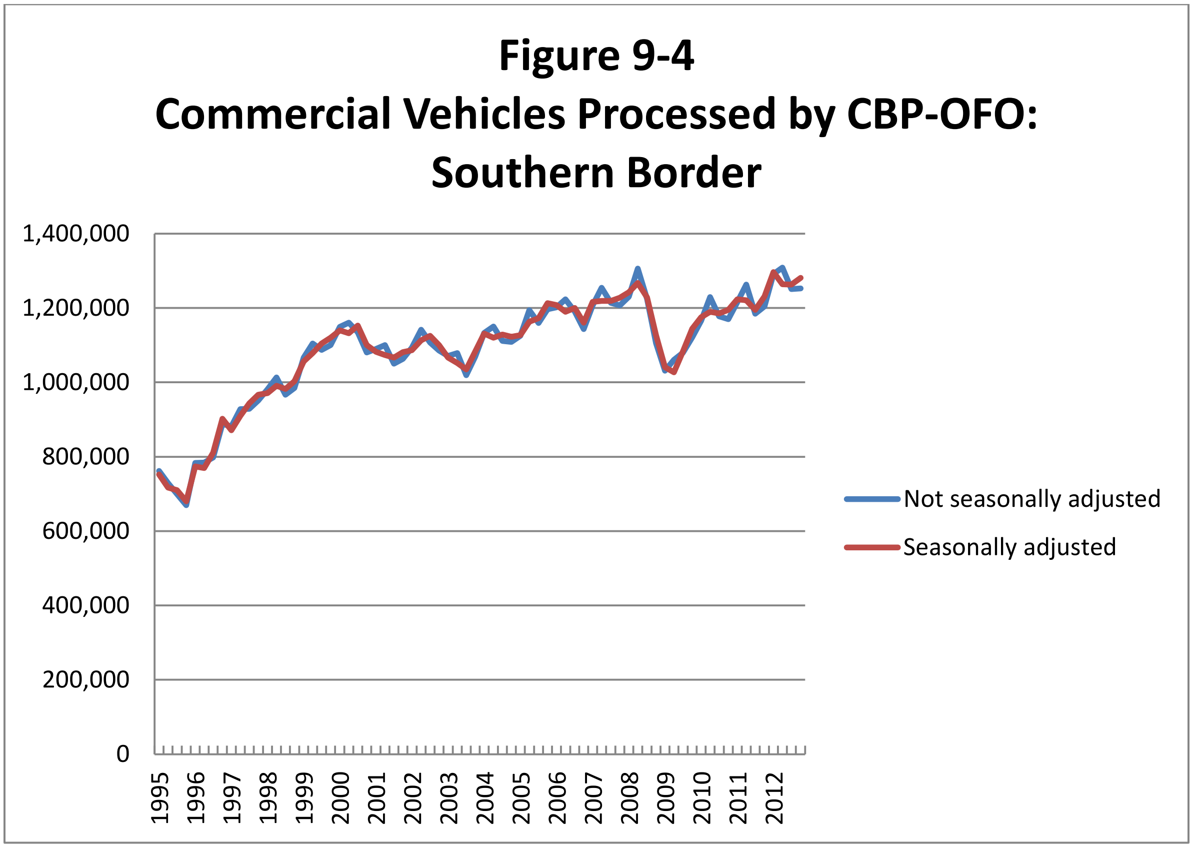


Figure 9-3
Passenger Vehicles Processed by CBP-OFO: Southern Border





9.4. A Methodology for Projecting Passenger and Commercial Vehicle Flows Through Land Ports of Entry

Development of projections of vehicle flows at particular ports of entry could be done on a port-by-port basis that tries to take into account all of the factors influencing flows at a particular port. This would be an extensive exercise requiring significant effort. We propose here a methodology that is based on the following three steps:

- Step 1: Develop projections of aggregate passenger vehicle and commercial vehicle flows on the northern and southern borders;
- Step 2: Develop projections of the shares of individual ports in northern- or southern-border passenger or commercial vehicle flows;
- Step 3: Multiply projected port shares by the aggregate northern- or southern-border passenger or commercial vehicle flow to get projections at the port level.

Modelling Aggregate Border Vehicle Flows

Macroeconomic factors that can potentially explain movement of passenger vehicles across the northern border include U.S. GDP, Canadian GDP, and the real exchange rate. Factors that can potentially explain movement of passenger vehicles across the southern border include U.S. GDP, Mexican GDP, and the real exchange rate. We analyze deseasonalized quarterly data on passenger vehicle flows for 1995:I-2012:IV for the northern border, and 1997:2-2012:IV for the southern border. We regress the growth rate of the aggregate passenger vehicle flow on the growth rates of explanatory variables, and we also include a dummy variable for the last two quarters of 2001, which captures the immediate impact of the aftermath of the 9/11 terrorist attacks. Table 9-1 gives results for several specifications of these regressions. For the northern border, the preferred specification (B) includes U.S. GDP and the real effective exchange rate of the U.S. dollar.[85] For the southern border, the preferred specification (E) includes U.S. GDP and the real peso-dollar exchange rate. Roughly one-third of the variance in the growth rate of passenger vehicle flows for each border is explained by these regressions.[86]

Macroeconomic factors that can potentially explain movement of commercial vehicles across the northern border include U.S. GDP, U.S. real imports, Canadian GDP, and the real exchange rate. Factors that can potentially explain movement of commercial vehicles across the southern border include U.S. GDP, U.S. real imports, Mexican GDP, and the real exchange rate. We analyze deseasonalized quarterly data on commercial vehicle flows for 1995:I-2012:IV for both borders. We regress the growth rate of the aggregate commercial vehicle flow on the growth rates of explanatory variables, and we also include the 9/11 dummy variable. Table 9-2 gives results for several specifications of these regressions. For the northern border, real exchange rate variables were never statistically significant. The preferred specification (C) includes U.S. real imports and Canadian real GDP. For the southern border, the preferred specification (D) includes Mexican real GDP and the real peso-dollar exchange rate. Almost half of the variance in the growth rate of commercial vehicle flows for each border is explained by these regressions.[87]

These regressions can be used to develop projections if assumptions are made about future trends in the explanatory macroeconomic variables. We have developed baseline forecasts for these flows during 2013-2017 that assumes that U.S. GDP grows at an annual rate of 3%, U.S. real imports grow at an annual rate of 2.2%, Canadian GDP grows at an annual rate of 2.5%, Mexican GDP grows at an annual rate of 2.8%, and there is no change in the real effective and peso-dollar exchange rates. Figures 9-5 to 9-8 present historical data for 1995-2012 and projected values for 2013-2017. The baseline forecast for northern passenger vehicles projects a rise in the flow at a less rapid rate than the recovery during 2009-2011. Northern commercial vehicles are projected to slightly decline. Southern passenger vehicles are projected to remain

[85] For the northern border regressions, the real Canadian dollar-U.S. dollar exchange rate is never statistically significant, but the real effective exchange rate for the U.S. dollar is.

[86] The 9/11 dummy variable is very statistically significant in all estimated regressions.

[87] Unlike for passenger vehicle flows, the 9/11 dummy variable is not statistically significant in any estimated regression for commercial vehicles on either border.

stable at 2012 levels, and southern commercial vehicles are projected to rise significantly. For northern commercial vehicles, we present an alternative forecast that assumes more rapid U.S. real import growth: in this alternative, the vehicle flow grows slightly over the forecast period.[88] For southern commercial vehicles, we present an alternative that assumes more rapid Mexican real GDP growth, which causes the vehicle flow to grow more strongly.

It is important to recognize key risks to these forecasts. For southern-border passenger vehicle flows, the regression does not capture factors such as the downturn in illegal immigration from Mexico and the rise in violence in the Mexican border area that may have depressed this flow. Change in immigration policies and/or diminishment in the intensity of violence would cause this flow to grow more rapidly. Change in real exchange rates could potentially affect flows on both borders.

The simple models estimated here could be refined and augmented with additional explanatory variables if quarterly data is available on them.

[88] U.S. imports have grown unusually slowly during recovery from the Great Recession, due in part to depreciation of the U.S. dollar. It is not clear whether this unusually slow growth will be sustained.

Table 9-1

Estimated Models for Passenger Vehicles

Dependent Variable: Change in the natural log of passenger vehicles processed							
Frequency: Quarterly							
Independent Variables: Change in the natural log (except for 9/11 dummy variable)							
	Northern Border			**Southern Border**			
	(A)	***(B)***	(C)	(D)	***(E)***	(F)	(G)
Constant	-0.004 (-0.843)	***-0.005*** ***(-1.029)***	-0.002 (-0.393)	-0.003 (-0.597)	***-0.007*** ***(-1.529)***	-0.004 (-1.076)	-0.007 (-1.423)
U.S. real GDP index		***1.003**** ***(1.862)***			***1.036***** ***(1.946)***		1.133* (1.852)
Canada real GDP index	0.872 (1.570)						
Mexico real GDP index				0.224 (0.625)			-0.132 (-0.330)
U.S. real import index			0.219 (1.456)			0.266* (1.850)	
Real effective U.S. exchange rate	-0.366** (-2.356)	***-0.308***** ***(-1.959)***	-0.348** (-2.227)				
Real peso-dollar exchange rate				-0.196** (-2.300)	***-0.155**** ***(-1.834)***	-0.175** (-2.126)	-0.158* (-1.847)
9/11 dummy variable	-0.119*** (-5.651)	***-0.116****** ***(-5.473)***	-0.116*** (-5.354)	-0.095*** (-4.787)	***-0.089****** ***(-4.615)***	-0.880*** (-4.485)	-0.090*** (-4.590)
Adj. R^2	0.358	***0.367***	0.355	0.308	***0.346***	0.342	0.336
Durbin-Watson	2.361	***2.329***	2.380	2.031	***2.189***	2.100	2.208
Included observations	71	***71***	71	62	***62***	62	62

T-statistics in parentheses. Regressions estimated using OLS procedure.

Table 9-2

Estimated Models for Commercial Vehicles

Dependent Variable: Change in the natural log of commercial vehicles processed							
Frequency: Quarterly							
Independent Variables: Change in the natural log (except for 9/11 dummy variable)							
	Northern Border			**Southern Border**			
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Constant	-0.009*** (-3.299)	-0.013*** (-3.184)	***-0.013*** (-3.691)***	***-0.006* (-1.759)***	-0.003 (-0.669)	-0.002 (-0.535)	-0.007* (-1.898)
U.S. real GDP index		2.249*** (1.862)			1.597*** (2.714)		
Canada real GDP index			***0.984* (1.693)***				
Mexico real GDP index				***1.774*** (6.948)***			1.525*** (4.552)
U.S. real import index	0.823*** (8.040)		***0.620*** (3.950)***			0.693*** (4.747)	0.193 (1.140)
Real effective U.S. exchange rate							
Real peso-dollar exchange rate				***-0.242*** (-3.759)***	-0.198** (-2.362)	-0.186** (-2.483)	-0.223*** (-3.364)
9/11 dummy variable	0.005 (0.315)	-0.006 (-0.362)	***0.002 (0.122)***				
Adj. R^2	0.481	0.278	***0.495***	***0.475***	0.190	0.325	0.499
Durbin-Watson	1.837	1.757	***1.772***	***2.398***	2.196	2.222	2.241
Included observations	71	71	***71***	***71***	71	71	71

T-statistics in parentheses. Regressions estimated using OLS procedure.

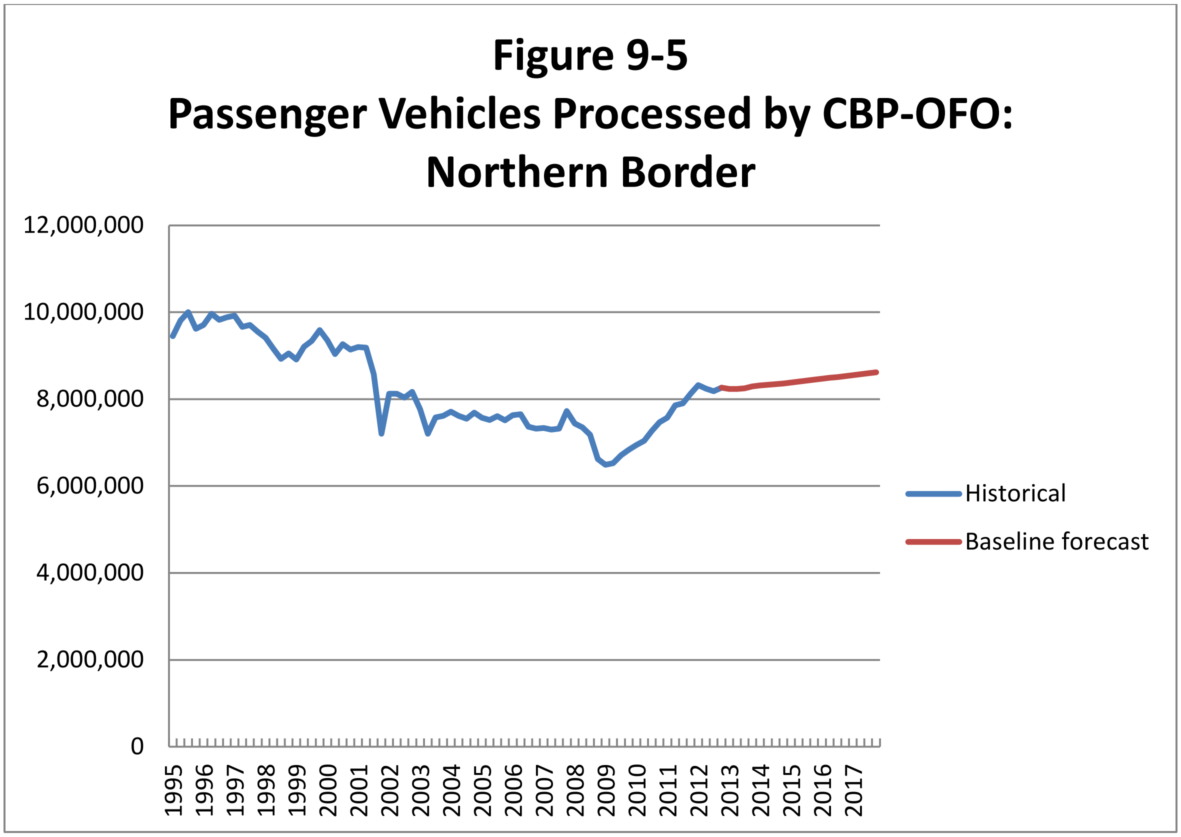


Figure 9-5
Passenger Vehicles Processed by CBP-OFO: Northern Border
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Historical
Baseline forecast

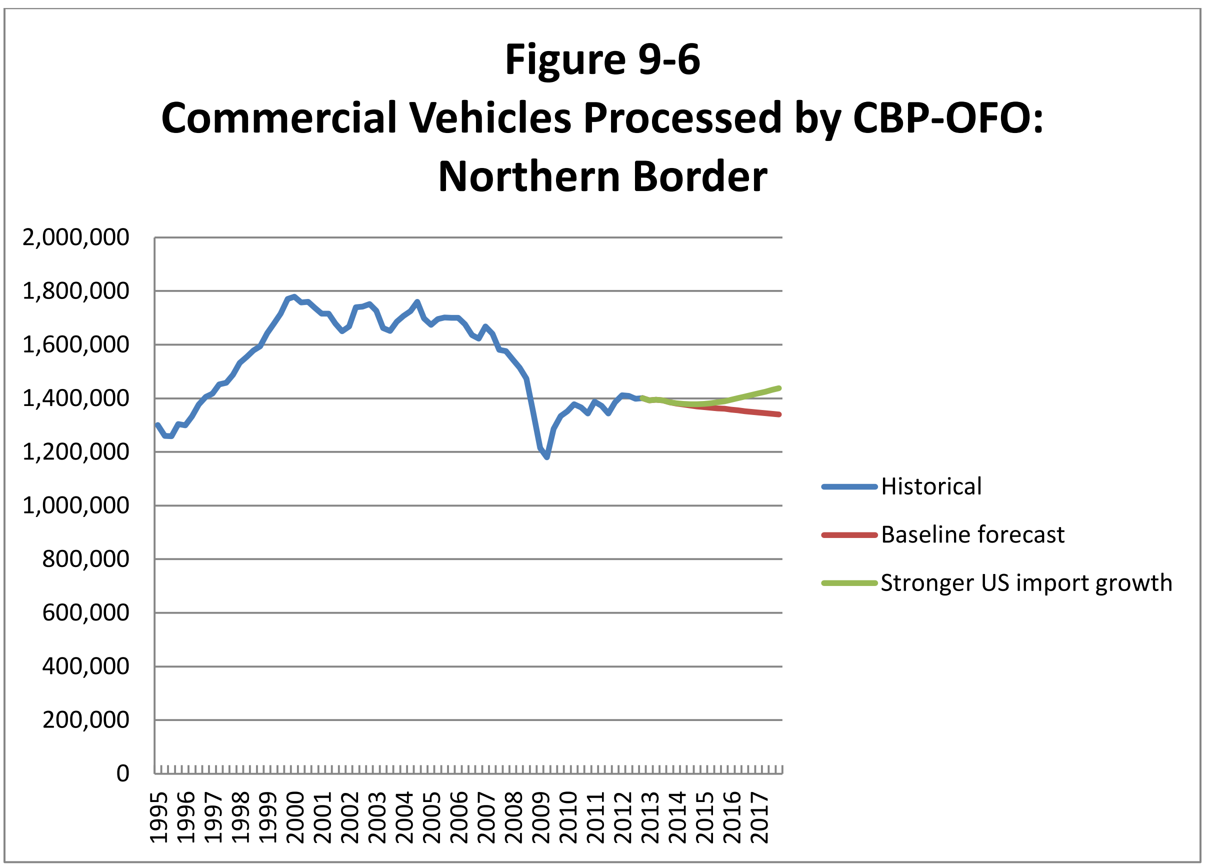
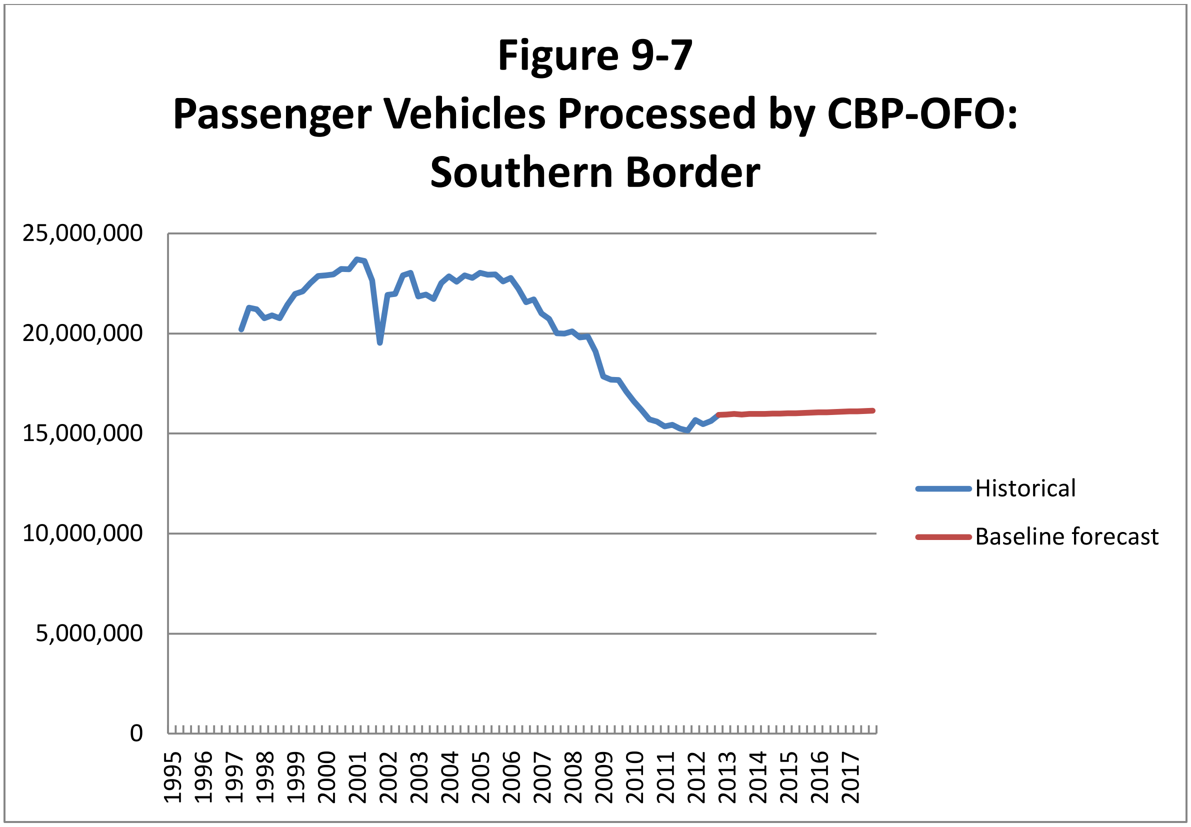
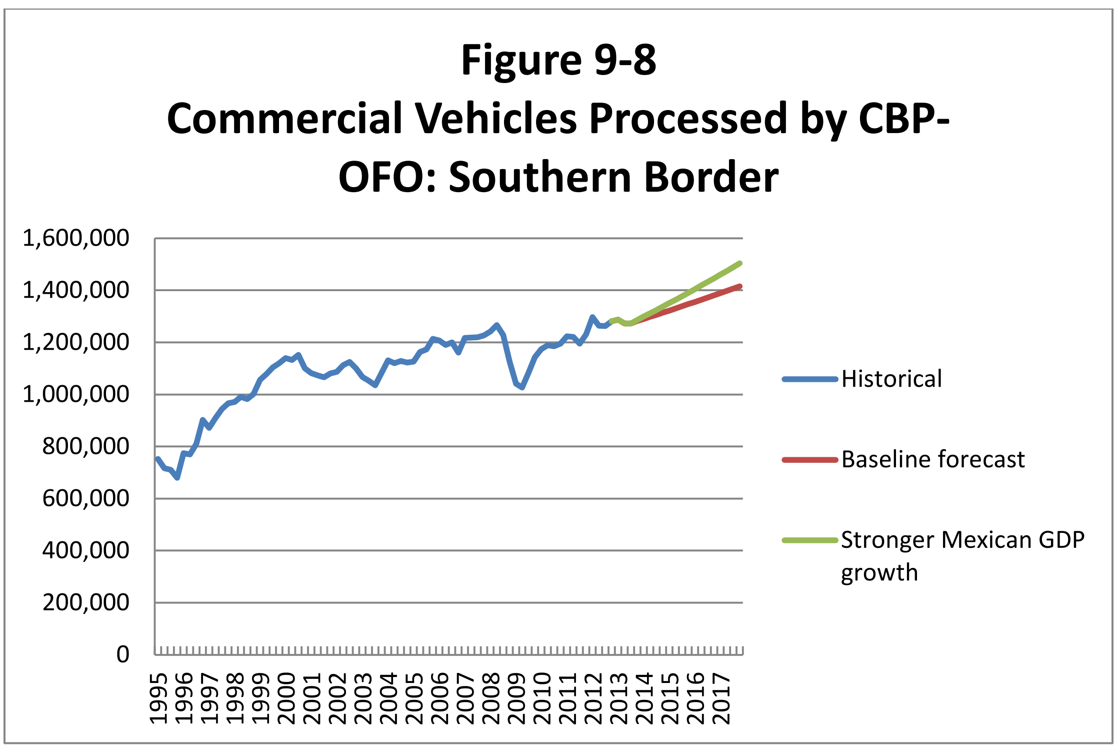


Figure 9-6
Commercial Vehicles Processed by CBP-OFO: Northern Border
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Historical
Baseline forecast
Stronger US import growth





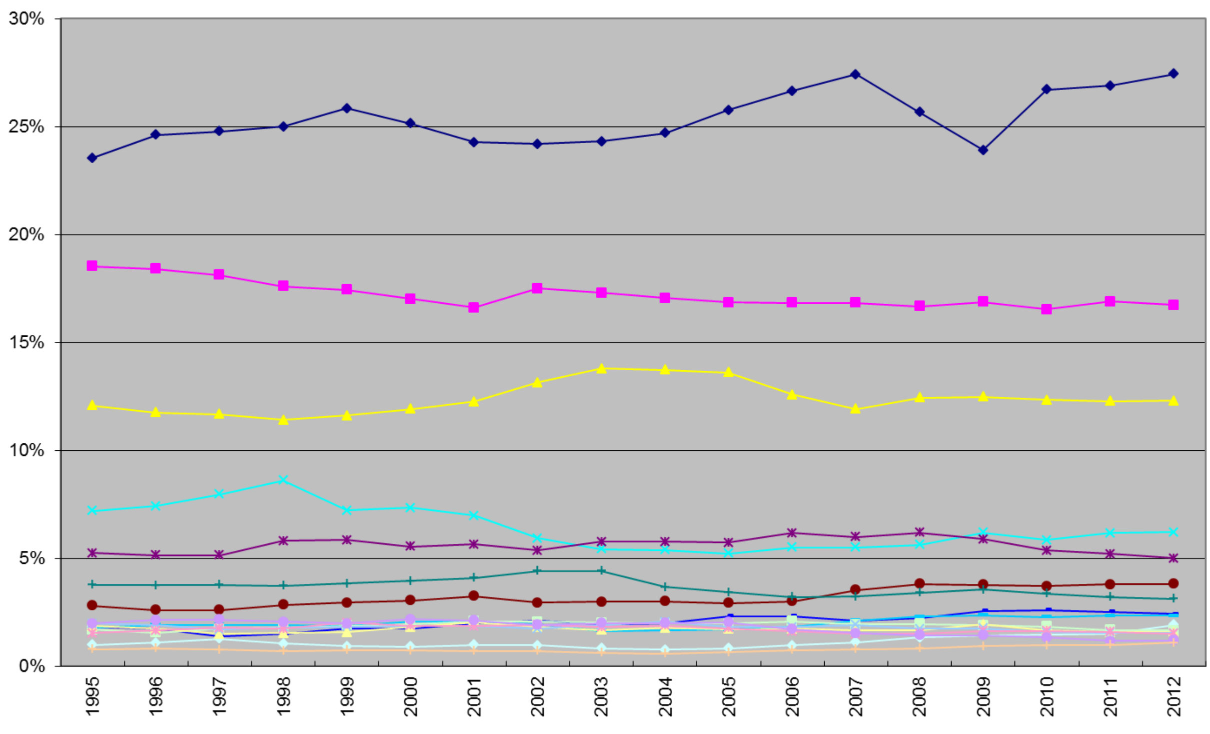
Individual Port Shares

The Bureau of Transportation Statistics provides data for 25 ports on the southern border and 84 ports on the northern border. Many of these ports have very small shares of their border's aggregate traffic. On the southern border, 90% of commercial vehicle crossings take place at 7 ports, and 90% of personal vehicle crossings take place at 12 ports. The northern border is more diffuse, as 90% of commercial vehicle crossings take place at 17 ports, and 90% of personal vehicle crossings take place at 23 ports.

Figures 9-9 and 9-10 graph individual port shares in aggregate northern border crossings for passenger vehicles and commercial vehicles, respectively. Figures 9-11 and 9-12 graph individual port shares in aggregate southern border crossings for passenger vehicles and commercial vehicles, respectively. These graphs show that port shares are generally quite stable over time. Although projections could be developed for these shares, they are very likely to show that future values of port shares will hold at roughly their 2012 values.[89]

It would be straightforward to multiply 2012 port shares by the projections for aggregate border flows shown in figures 9-5 to 9-8 to get projections at the individual port level.

Figure 9-9
Port Shares: Commercial Vehicle Crossings on Northern Border
(ports accounting for 90% of crossings)



[89] One important exception is personal vehicle crossings on the northern border: the Detroit port of entry's share has fallen significantly during 2004-2012, and the Blaine port of entry's share has risen significantly. These two changes add up to almost zero. It is not clear how the shares of these two ports should be projected into the future.

Figure 9-10
Port Shares: Personal Vehicle Crossings on Northern Border
(ports accounting for 90% of crossings)

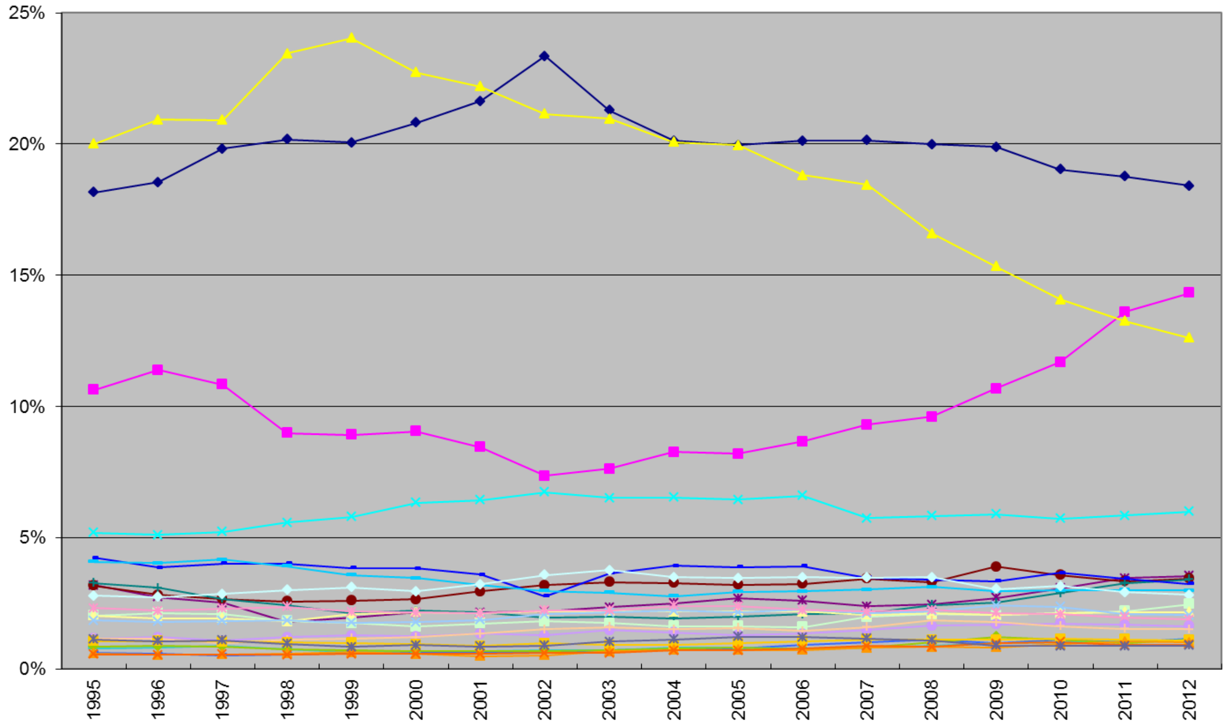


Figure 9-11
Port Shares: Trucks on Southern Border
(ports accounting for 90% of crossings)

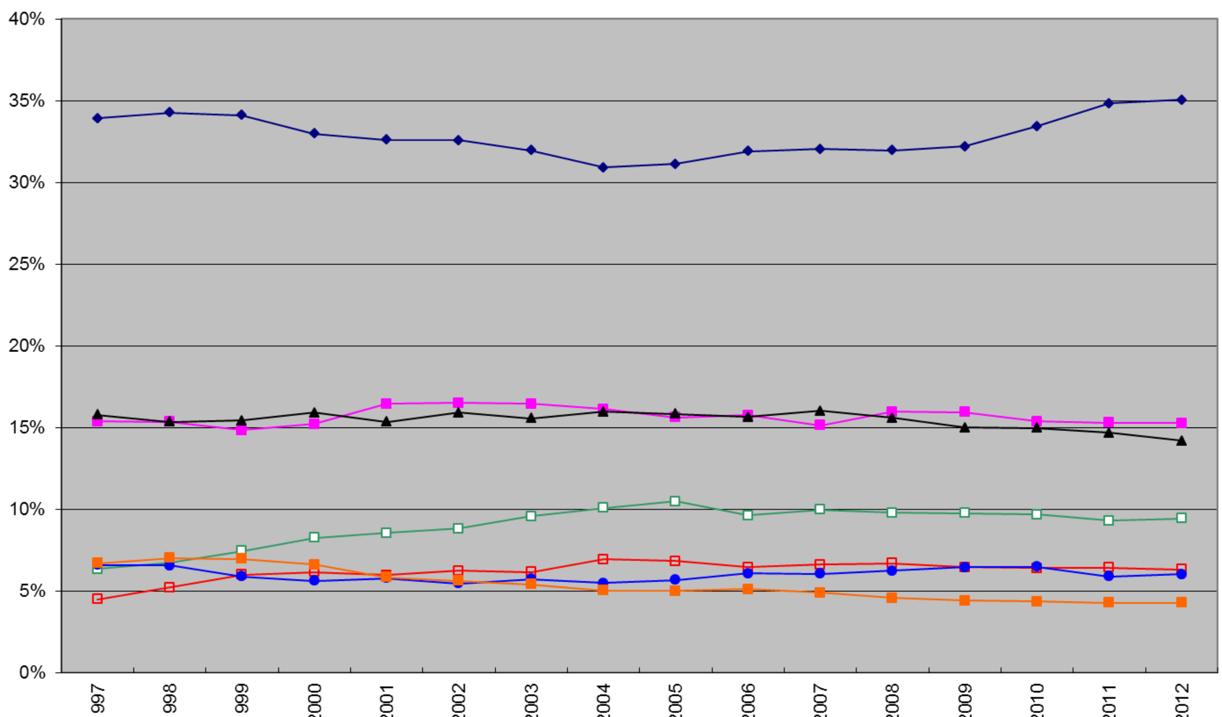


Figure 9-12
Port Shares: Personal Vehicles on Southern Border
(ports accounting for 90% of crossings)