A DESCRIPTION OF COMMERCIAL CROSS BORDER TRIPS IN THE CASCADE GATEWAY AND TRADE CORRIDOR

Susan Albrecht[I,II], Anne Goodchild[III], and Li Leung[II]
University of Washington

Abstract
This paper presents a description of commercial vehicle delay, transportation patterns and commodity profile at the Western Cascade Gateway, the primary border crossing between Southwest British Columbia, Canada, and Northwestern Washington, United States. With a long term delay data set observed seasonal, daily, and time of day delay patterns are described including the average and variability of delay. Using five data sources for comparison—a probe vehicle border delay data set, a detailed border operations survey data set, loop detector volume counts, manifest sampling, and data from the Bureau of Transportation Statistics, the transportation, trade, and delay patterns can be synthesized to provide a more complete description of regional freight transportation. This context can be used to consider the impact delay has on regional supply chains, and also in developing appropriate freight transportation policy solutions for the border.

Background

[I] Jackson School of International Studies
[II] Graduate Research Assistant, Goods Movement Collaborative, Department of Civil and Environmental Engineering
[III] Assistant Professor, Department of Civil and Environmental Engineering

The U.S. and Canada are each others' largest trading partners, with the value of trade between the two the highest between any two countries worldwide. For the United States, trade with Canada is larger than its trade with the European Union countries. Canada's international trade is strongly oriented toward the U.S. which accounts for nearly 75% of Canada's trade in goods (OCC 2005). The long land border favors surface modes of transport. In terms of total trade (north and southbound combined), trucking is arguably the most important mode, comprising almost 63 percent of total value and slightly more than 35% of weight (Bowen and Slack 2007). The North American freight distribution system is constantly adapting to global trends in economics and transport geography that work toward reducing costs and improving efficiency. Increased growth in trade has placed greater pressure on international gateways and the movement of freight impacts the U.S. transportation network, in particular major border entry points and north-south highway corridors. Between 1994 and 2000, U.S trade with Canada grew by 8.9% annually (USDOT/BTS 2001).

Due to its larger trade volumes, border trade research on the northern U.S. border has typically focused on trade along the eastern portion of the border between Michigan, New York, and Ontario, and on immigration and customs issues on the southern border with Mexico. As a result, less attention has been given to the western portion of the northern border, and, while some local transportation studies have been undertaken, a description of trade in this region is lacking from the national dialogue. This research begins to fill that gap by providing a description of regional trade in the Cascade Gateway, the grouping of four Washington state-British Columbia border stations. The Pacific Highway border crossing at Blaine is the main commercial crossing of the Cascade Gateway, and the fourth busiest commercial crossing on the northern border. Other crossings include Peace Arch (for non-commercial vehicles), Lynden/Aldergrove, and Sumas/Huntington. Pacific Highway is approximately 100 miles north of Seattle and 30 miles south of Vancouver, BC, on Washington State Route 543 and British Columbia Provincial Highway 15. About 11 miles to the east is the Lynden/Aldergrove crossing on the British Columbia Provincial Highway 13 and Washington State Route 539 (used by 58,957 trucks in 2007). Another 10 miles to the east is the Sumas/Huntington crossing on Washington State Route 9 and British Columbia Provincial Highway 11 (used by trucks 135,678 in 2007).

Interstate 5, which is the main north-south route for traffic in the corridor, links major cities along the west coast from Vancouver, B.C. to San Diego, CA. The region that straddles the border shares a certain level of economic and organizational linkages as well as socio-cultural similarities. Geography, history, demography, and transportation corridors all play a crucial role in shaping cross-border regional linkages, the level of trade and recent growth in trade (PRI 2006). The crossing at Pacific Highway carries 69% of total crossings, and is the primary commercial crossing in the Cascade Gateway. This paper draws upon data at this primary border crossing facility as representative of the profile of trade for the Cascade Gateway.

To evaluate the impact of delay, or the consequences of changes in border policy and operation, an understanding of regional trade patterns and supply chain operations is required. Border policies developed at a national level will have different impacts, and different levels of success depending on regional characteristics such as the commodity profile, border crossing patterns, and typical distances traveled. In national conversations, the northern border is typically characterized by the automotive sector, in which vehicles cross the border between elements in a manufacturing supply chain. This is not true on the Western US/Canada border, which is typically characterized by wood and agricultural products. The nature of our border freight transportation is not well understood at the national level, and this paper begins to fill that gap.

Introduction

The paper combines loop detector data from the British Columbia Ministry of Transportation (BC MoT), vehicle delay data collected by GPS receivers from a private vehicle fleet, origin/destination data from a Whatcom Council of Governments (WCOG) manifest sample, commodity and volume data from the Bureau of Transportation Statistics (BTS), and travel time data from a detailed WCOG border operations survey. With these datasets the following can be described:

1) Describe typical patterns of truck arrival at the southbound crossing.
2) Identify daily and seasonal variation in the arrival pattern for Free and Secure Trade (FAST) approved vehicles.
3) Describe average and standard deviation in delay for FAST approved vehicles.
4) Describe daily and seasonal variation in delay to FAST approved vehicles.
5) Describe the typical origin and destination profile.
6) Describe the commodity profile for commercial vehicles at the crossing.

The Pacific Highway border crossing has dedicated FAST lanes both northbound and southbound. Of the three lanes southbound, one is dedicated to serving FAST approved vehicles between 8:00 am and 8:00 pm. The northbound lane was under construction during the study period. During this construction, data was not considered for the northbound approach. The FAST lane can be used by commercial carriers who comply with program requirements including that both the carrier and driver is FAST approved and the importer of the goods must be C-TPAT approved. C-TPAT, or the Customs Trade Partnership Against Terrorism is a voluntary program in which companies must comply with a variety of security measures designed to increase the level of trust between the importer of the goods and the U.S. Customs and Border Protection Agency (CBP). The term 'FAST' is used in this paper to refer to any vehicle using the FAST lane when transiting the border.

Data

In addition to data gathered from the literature, including travel distances, this paper uses five datasets, described below:

1. GPS probe dataset (both southbound and northbound) obtained from a private truck fleet which provides border crossing times. Referred to as GPS dataset.
2. Pacific Highway Port-of-Entry Commercial Vehicle Operations (CVO) Survey (southbound only) from the

Whatcom Council of Governments (WCOG) which provides more detailed operational data such as primary booth processing times. Referred to as CVO data.

3. Fixed Vehicle Count Loop Detector data (southbound only) from the British Columbia Ministry of Transportation (BC MoT) which provides vehicle volumes. Referred to as BC MoT data.
4. Cascade Gateway Commercial Carrier Origin and Destination and Commodity Manifest Data (bi-national) from the Whatcom Council of Governments (WCOG) which provides origin/destination data, manifest data on commodities, and percentage of empty vehicles. Referred to as CG Manifest Data.
5. Data from the Bureau of Transportation Statistics (BTS) TransBorder Database, which provides commercial vehicle commodity profile and volume information. Referred to as BTS data.

The GPS dataset was collected using a fleet of private vehicles that cross the border every day. The border crossing time, or the time between arrival at the back of the queue, and departure from the border, is recorded for each vehicle in the fleet for each border crossing. The research team entered into a data-sharing agreement with the company in the spring of 2005 and receives daily information on border delay experienced by all company drivers. Drivers are paid by the hour and self-report their arrival (at the back of the queue) and departure times from the border. Drivers are required to report arrival at the back of the queue and border departure time but their remuneration is not dependent on border delay. This company and its drivers are FAST approved and use the FAST lane when it is operating. This data is used to consider crossing time for FAST vehicles between July 2005 through April 2008, thereby allowing for analysis of daily, seasonal and temporal variation which is otherwise unavailable.

The CVO data (southbound only) was provided by the Whatcom Council of Governments (WCOG). WCOG and Halcrow Consulting (HCI) undertook a border operations survey in June 2001 and June

2006 to evaluate the commercial vehicle operations at this crossing (HCI 2007). The WCOG data was collected for southbound commercial vehicles at the Blaine crossing between 8:00 am and 5:00 pm from Monday June 5 through Thursday June 8, 2006, using handheld personal digital assistants to capture when trucks arrived in queue and exited primary processing. The usable dataset includes 579 FAST observations over three days (June 6 was removed as the FAST lane was opened to all traffic), and 1480 nonFAST (vehicles that did not use the FAST lane) observations. This data does not contain data from a long enough period to consider variations across day, week, and hour, but it does contain nonFAST vehicles, and allows for comparison of the FAST observations between the GPS and CVO datasets.

Vehicle counts were obtained from the BC MoT for the period November 13, 2006 to December 31, 2007. This data set is used to understand how the rate of truck arrivals varies over the course of a day. Each observation represents the number of vehicles crossing over double loop detectors in a 5 minute period. Each lane of traffic, including the FAST lane, has a separate set of loop detectors. This paper presents arrival volumes for the FAST lane only, so that comparisons can be made with delay observations (which are measured for FAST vehicles only). The total number of observations for our data set for FAST vehicles is 328,450. Although loop detectors can undercount volumes in congested states, the intent of this research is not to convey *specific* volumes, rather the *pattern* of arrivals by time of day, week, and season.

The CG Manifest data is used to provide origin destination data, for loaded trips crossing the border southbound at Pacific Highway between for the four days in June 2006 when a sample of manifests was obtained. In addition, the effort also measured the percentage of empty vehicles, or empties which crossed the border during this time frame. Empties range from 25-40% during the time period measured.

Delay

Using the GPS data, which includes only FAST vehicles, the average crossing time both southbound and northbound in 2007 is about 22 minutes With the CVO data (2006), the average crossing time for southbound FAST vehicles is also 22 minutes. Although the CVO data is limited in scale, the consistency in crossing times with the GPS data gives confidence that this small dataset is reasonably representative of typical conditions, and that the GPS data, although obtained from one carrier, is reasonably representative of all FAST carriers. Table 1 summarizes delay observations from both the GPS and CVO datasets.

Table 1: GPS dataset and CVO data for Border Crossing Times

Dataset	*Number of observations (vehicle volume)*	*Mean crossing time per vehicle (hh:mm:ss)*	*Standard Deviation in crossing time per vehicle (hh:mm:ss)*	*Average Primary Inspection time (hh:mm:ss)*	*Co-efficient of variation*
GPS FAST (*s-bound*)	19,729	00:21:57	00:22:54		1.04
GPS FAST: (*n-bound*)	24,184	00:21:50	00:18:35		0.85
CVO FAST (*s-bound*)	579	00:22:00	00:21:00	00:01:26	0.95
CVO non-FAST (s-bound)	1480	01:23:00	00:26:00	00:02:00	0.39

Source: GPS and CVO datasets.

Notice the coefficient of variation (standard deviation over the mean) for FAST vehicles is close to one, and would not be described as low variance, or high variance. However, the coefficient of variation for the nonFAST vehicles indicates a low variance crossing time. The average border crossing time in 2007 for southbound vehicles *during FAST hours only* is 00:18:58, less than 00:21:57 shown above for all hours. Also, the standard deviation of crossing times for southbound *during FAST hours only* is 00:20:19 and for all hours is 00:22:54 (as shown above). Outside of FAST hours (8:00 pm to 8:00 am), the crossing time is longer, and more variable. FAST primary booth processing times have an average of 86 seconds compared to 120 seconds for the nonFAST lanes. It is clear from comparing the GPS dataset and CVO dataset in combination, that using the FAST lane provides shorter primary inspection times, and therefore shorter crossing times with, on average, an hour reduction in total crossing time.

Freight Origin and Destination

About half of the cross-border trips occur between the Lower Mainland of British Columbia and Whatcom County, Puget Sound, and Western Washington (HCI 2007).

Table 2: Pacific Highway Vehicle Origins and Destination

Destinations

Origins	Whatcom County	Puget Sound	West WA	West USA	Rest USA	TOTAL
West Lower Mainland	10.5%	34.9%	4.4%	28.4%	11.6%	93.2%
Rest BC	0.6%	0.7%	0.2%	1.7%	0.4%	3.7%
Alberta	0.2%	0.8%	0.1%	0.7%		1.9%
East Lower Mainland	0.1%	0.2%		0.1%		0.4%
Whatcom County	0.1%			0.1%		0.2%
West Canada				0.1%		0.1%
East Canada	0.1%	0.4%		0.1%		0.5%
TOTAL	11.6%	37.1%	4.8%	31.0%	12.1%	

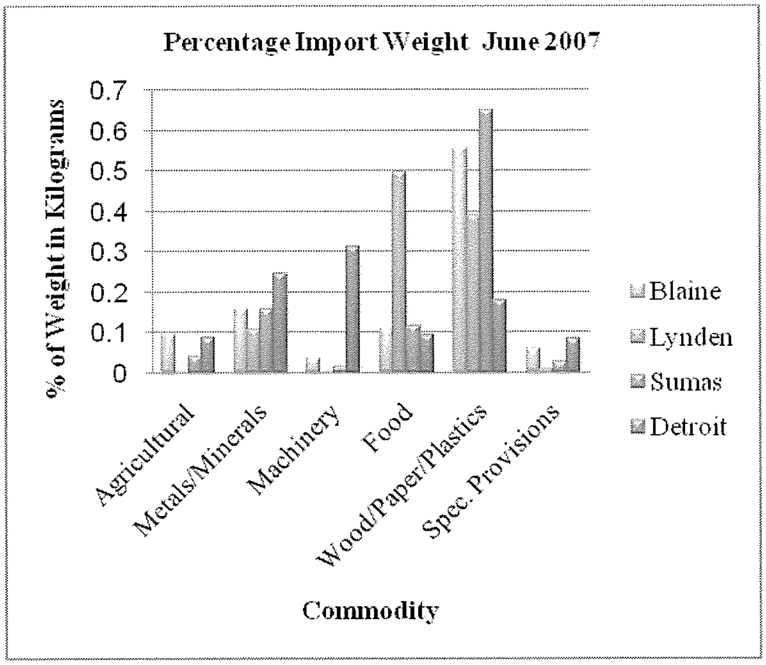
Source: CG Manifest Data.

The distance between the greater Vancouver region and the Puget Sound region is approximately 150 miles. Accounting for the border crossing, congestion, travel speed, and a drop-off and pick-up, this trip can be completed in one full day of work. The regional or greater Vancouver to greater Puget Sound trips (about 35% of the total) are served by drivers based in the region, who can reasonably make one round trip from their home, to origin, destination, and return, in one working day and not exceed hours of service regulations.

Freight Commodity Profile

Figure 1 shows the commodity profile by import weight at the Cascade Gateway, and for comparison, the Detroit crossing. Notice the dominance of wood, paper, and plastics at the Cascade Gateway. These commodities are not viewed as particularly time critical as they do not move in a strictly scheduled environment, although in fact a significant proportion of these goods are highly perishable (seafood and fish, in particular). Both of these factors are significantly different than at the eastern portion of the northern border, where manufactured goods are flowing across the border in a time sensitive business environment which requires more precise delivery time estimates.

Figure 1: Cascade Gateway and Detroit Crossing Commodity Profile Percentage Import Weight

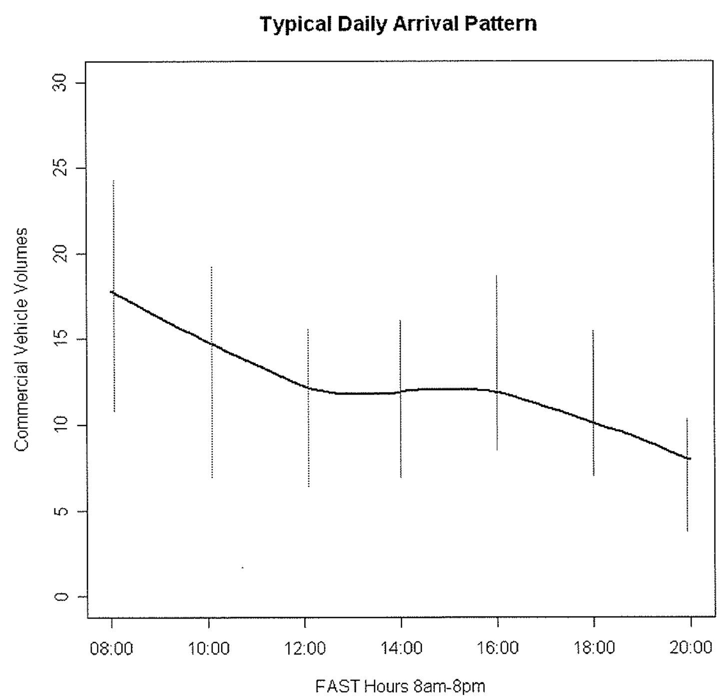


Source: BTS TransBorder Freight Database

Truck Arrival Patterns

Figure 2 shows the typical arrival pattern of FAST trucks at the southbound crossing at Pacific Highway during FAST hours. The loop detector that is just beyond the end of the typical queue is used to obtain 5 minute vehicle volumes. This figure shows a least squares line based on the average number of arrivals in each 5 minute period for all days in 2007. The vertical bars along the least squares line represent the standard deviation of the arrival volume for a particular hour. Much like with metropolitan transportation congestion, there is a clear daily pattern to truck arrivals at the border, but significant variability in daily realizations. The highest volumes are typically observed early in the day, followed by declining demand. At mid-day, there is typically a leveling off of demand. Regional drivers would typically be at their destination by late morning, returning in the afternoon, when variances in travel times and wait times spread the demand across a greater period. This compares well to the observations collected during the 2006 CVO survey which included nonFAST vehicles, however, there is much more variability in the CVO data given the brief time period.

Figure 2: Typical Daily Arrival Pattern for FAST Vehicles



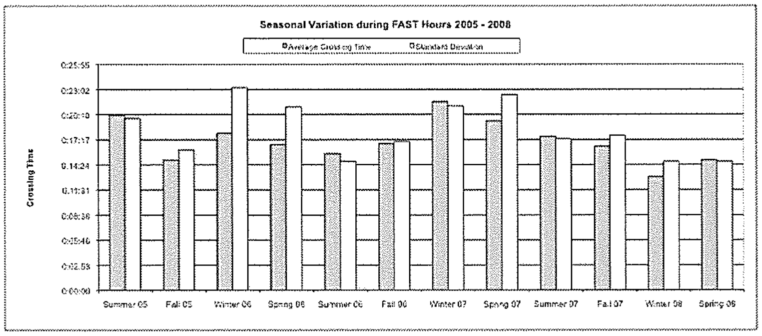
Source: BC MoT loop data.

The pattern is fairly consistent across days of the week, however there is a stronger morning peak on Fridays and an earlier drop-off in traffic volumes in the afternoon. Monday morning has the smallest morning peak. When considered seasonally, lower volumes can be observed in the winter and spring, with higher volumes in summer and fall, reflecting the dominance of agricultural trade in the region. The shape of the daily pattern remains consistent, with a peak in the morning, a leveling off at noon, and a gradual decline in volumes in the afternoon period.

Consider how these volumes impact crossing times. The average crossing time for all Mondays and Fridays is about 16 minutes and 30 seconds, Tuesdays and Wednesdays about 17 minutes, and Thursdays have a slightly smaller value, of 15 minutes and 30 seconds in the FAST lane during FAST hours. A strong or consistent delay pattern is not observed. For example, Mondays in 2006 exhibit the shortest average of the year, whereas in 2007 Mondays have one of the longest average delays. The data does suggest a higher variance on Fridays, indicating more volatility of traffic conditions on that day.

Figure 3 shows how the average and standard deviation of FAST crossing times varies over the seasons for our entire GPS data set. It was expected that average crossing times may be larger in summer and fall, as these seasons carry a larger volume of trucks. Over the 32 complete months of data, the average crossing time for FAST vehicles during FAST hours is 17 minutes and 53 seconds in Spring, 16 minutes and 58 seconds in Summer, 16 minutes and 13 seconds in Fall, and 12 minutes and 40 seconds in Winter. Higher crossing volumes do correlate, in the long term, with longer crossing times. However, consider figure 10 which shows the average and standard deviation in FAST crossing times for each season each year, no strong patterns between average crossing times, or the standard deviation in crossing times by season, are observed.

Figure 3: Average and standard deviation of crossing times (hh:mm:ss) by season FAST Hours



Source: GPS dataset.

Discussion and Conclusions

This paper presents a variety of data elements that come together to provide a more comprehensive picture of commercial trips at the Cascade Gateway. The manifest data demonstrates these trips are primarily regional, such as the trips between the Greater Vancouver and Puget Sound regions. In addition, the loop detector data shows that southbound trips peak early in the morning, and decline through the day, as drivers get underway early in the day in British Columbia, travel across the border to their destination in Puget Sound, and return in the afternoon, with the variability in travel distance and stopping time spreading out the trips over the afternoon. Monday mornings are slower than other days of the week, and Fridays drivers get an early start to make it home earlier in the day. Summer and Fall volumes are higher as many agricultural products are harvested and moved to market, and retail goods are moved in to inventories for the Christmas shopping season. Patterns of truck arrivals with season, time of day, and day of week are demonstrated, as are aggregate patterns with crossing times, however, when considering daily or monthly data, significant variability is observed due to the multitude of factors that influence border delay on any given day.

It is clear the Cascade Gateway is unlike the Eastern portion of the Northern Border, which is dominated by goods moving between factories on either side of the border, and that these features affect the impact of policy changes in the border region, for example, utilization of the FAST program. Table 3 shows the estimated northbound utilization estimate of border crossings produced by Customs and Border Protection. The FAST program is clearly more heavily utilized in the Eastern crossings.

Table 3: Northbound Utilization Estimate of Border Crossings

Port	# of Lanes	FAST Dedicated Lanes	Estimate FAST as % of all shipments
Detroit	14	5	44%
Port Huron	3	2	31%
Buffalo/Peace Bridge	7	0	23%
Buffalo/Lewiston Bridge	4	1	23%
Pembina	3	0	21%
Alexandria Bay	3	0	20%
Champlain	5	1	17%
Ogdensburg	3	0	16%
Sault Ste. Marie	2	0	15%
Derby Line	2	0	13%
Houlton	2	0	12%
Highgate Springs	1	0	9%
Oroville	2	0	8%
Blaine	3	1	8%
Massena	1	0	5%
Sweet Grass	2	0	3%

Source: Customs and Border Protection.

Commercial carriers using FAST lanes have shorter border crossing times than carriers who do not use FAST lanes; however, the program is poorly utilized at Pacific Highway. While the reasons for this limited enrollment require further investigation, some of the requirements for FAST and C-TPAT certification are more onerous for wood products, fruits, and vegetable supply chains (especially for small and medium producers), in particular physical control of the perimeter. Additional research is required to provide conclusive insights into this problem, but the example is used to highlight the importance of understanding the regional trade and transportation profile in developing policy solutions.

Every region has a unique commodity and trade profile that affects usage, operations, efficiency, and the use of the infrastructure. The predominance of regional trucking which drives border arrival patterns and commodity profile presented in this paper should be considered in the discussion of strategies designed to reduce the cost of border crossings to regional trade.

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