

THE EFFECT OF DISRUPTIONS ON TRAVEL TIMES: A REGRESSION ANALYSIS FROM COLOMBIA

Christian E. Dunkerley

*International Division, TRL Limited, Old Wokingham Road, Crowthorne, Berkshire,
RG45 6AU, United Kingdom
E-mail: cdunkerley@trl.co.uk*

1 INTRODUCTION

Little research is available on the behaviour of drivers under disruptions in developing countries, as most resources are spent on strengthening transport infrastructure and planning for normal operations. Typical analysis of travel times (e.g. May et.al., 1987 and Mohammadi, 1997) focus on volumes of traffic and the variance of travel times caused by either by congestion or natural disasters. Additionally, policy makers need estimates of the specific delays caused by disruptions on specific corridors, in order to include them in cost benefit analysis. This paper shows a simple model that isolates the specific effect of road infrastructure disruptions on the travel times of trucks travelling on the Bogota-Medellin corridor in Colombia, taking into consideration the normal logistic operation of drivers in Colombia.

2 DATA SUPPLIED

The firm CMC *Comunicación Mobil de Colombia* provided all the records of trucks' travel times used in this analysis. This firm was set up to provide radio monitoring of freight vehicles in exchange of a monthly fee, encouraged by the high levels of road piracy in Colombia (7,790 cases reported to the Road Police in 1997 alone). Although the service is costly, it brings immediate benefits to subscribers: improved safety against robberies, cheaper insurance, and faster reactions to logistic problems. The service started successfully in 1990, and at the end of 1998 this firm was already monitoring 450 vehicles 24 hours a day 365 days of the year.

Drivers then report to CMC on departure, on arrival, every hour or when delays occur. As the objective is to improve security, they must state the landmark point closest to their location, and any cause of delays. Meanwhile, at CMC headquarters in Bogota, this information is typed into a computer, which automatically assigns a date and time to each radio report produced as ASCII files. CMM provided compressed files with trucks operations from January 1996 to February 1998. As the longest continuous record for which

information about disruptions was obtained corresponded to January-May, this was chosen for the analysis. After consultation with CMC, the route Bogota-Medellin was selected for the regression as it is an important route connecting two major industrial centres in the country, which ensured enough records for analysis and it suffers disruptions very often. Among all firms only Alpina was chosen for the analysis, because most of its fleet is made up of the same type of refrigerated trucks transporting milk products, and had a large number of records for the analysis on the Bogota-Medellin route during the period Jan-May 1996. The firm Alpina demands a high level of service from its drivers, as the products transported are perishable. The electronic reports had to be copied and pasted to one another in order to build up a database. There were more than 30,000 files in more than 200 Mbytes that were processed and pasted. Many records had to be disposed of as they were incomplete, and only a few were used for this analysis.

The main route favoured by truckers is 399 Km long, and goes to Medellin through the city of Doradal. The alternative path goes through Manizales, and is 520 Km long. In both cases truckers had to descent from Bogota, at 2,600 m high, to almost sea level reaching the city of Honda, and then climbing up 1,500 m again up to Medellin.

3 GENERAL TRAVEL CHARACTERISTICS ON THE CORRIDOR

The average travel time of the trucks from Bogota to Medellin is 26.21 hours, and 22.18 hours on the way back. In the outbound journey, the average departure time in the sample was 07:36, while the departure for the return journey was 13:01. The standard deviation for the departure time for outbound trips is 2:24, much lower than on the way back from Medellin, (3:49) as vehicles travel empty in this direction. Very few voluntary stops were found in the database for the period analysed, perhaps because they were rather short. In all cases lunch never took longer than one hour, and coffee breaks were always less than 20 minutes. The main types of vehicle breakdowns found in the analysis for this firm and period of study were the replacement of punctured wheels, and engine problems. The average time taken to replace a wheel was 48 minutes, while an engine failure took an average of 2 hours and 26 minutes to repair.

4 MAJOR REACTIONS TO DISRUPTIONS

Interestingly, looking at the datasets it seems that the departure time is unchanged even when disruptions happened. Drivers do not depart much earlier than 6:00, because there is a higher risk of robberies.

If the main route is partially closed, that is, only one lane is available, drivers still use it: they wait for their turn to pass, because the alternative route is much longer. If the route is

closed for only for a few hours, such as the temporary closure of a bridge for repairs, drivers wait either at the nearest town close to the closing, or at the bridge itself. When some major disruption occurs, the datasets showed that drivers go back to the nearest town to wait, and in some cases spend the night there. This has many advantages: they can use the time for other routine operations, such as vehicle washing and servicing, and the vehicle and its load are much safer than parked along the road. Also, many towns are located at crossroads, so alternative roads depart from them. An interesting aspect of disruptions is that as soon as they occur, the supply of beds and food in the nearest town quickly runs out, as many drivers make use of them. Repeated complaints of lack of rest places were found across the dataset on dates of disruptions.

Queues also built up during disruptions, meaning that even after reopened, the effects of the disruptions would still be felt. In most cases drivers knew about disruptions in advance, so they tried to avoid the areas affected by them if they were large. This means that many disruptions would have effects in other parts of the network, as alternative links become congested.

5 THE EFFECT OF DISRUPTIONS: A REGRESSION MODEL

A regression model using ordinary least squares was chosen for the analysis, as there are many factors that affect travel times which needed to be looked at separately. Disruptions that happen before or during the trip of a particular vehicle were introduced as dummy variables in the regressions. A total of 134 observations were finally employed in the regression analyses, after deleting incomplete records. There were 61 recorded trips from Bogota to Medellin, and 73 in the opposite direction. Two different sets of regressions were carried out, differing only in the source of disruption data, and the way disruptions were represented in the models. The first set used data from national disruption reports provided by CMC, called *Notivias*, which showed the date and position of disruptions, but in most cases their duration was not available. The second set took the disruptions from the travel diaries themselves, as reported by drivers. Only the second set are presented here, as they were more accurate. The main variables are:

$D_{\text{direction}}$: 0 if travelling from Bogota to Medellin, 1 in the opposite direction.

D_{route} : 0 if using Route 1 (main), and 1 if using Route 2 (through Manizales)

$D_{\text{mechanical}}$: if there were mechanical problems reported 1, 0 otherwise.

sleep: amount of time taken for overnight rest in hours.

D_{return} : 1 if the trip was affected by a Return Operation, 0 otherwise.

D_{bridge} : 1 if the trip was delayed by a partial or total closure of a bridge, 0 otherwise.

D_{lands} : 1 if a delay was caused by a landslide, either blocking totally or partially the road, 0 otherwise.

D_{other} : 1 if the vehicle was delayed by other reasons, 0 otherwise.

Table 1: Coefficients of the second set of regression models (t tests in parenthesis)

Model	Constant	Adj. R ²	D _{direction}	D _{route}	D _{mechanical}	Sleep	D _{return}	D _{bridge}	D _{lands}	D _{other}
4	15.74	0.20	-2.02 (6.40)	0.83 (1.46)	0.16 (0.34)	-0.02 (0.39)	1.12 (1.08)	1.19 (2.60)	2.05 (1.81)	-0.22 (0.43)
5	15.75	0.21	-2.03 (6.45)	0.84 (1.48)		-0.02 (0.35)	1.18 (1.15)	1.18 (2.59)	2.09 (1.86)	-0.23 (0.44)
6	15.58	0.21	-1.99 (6.65)	0.81 (1.45)			1.09 (1.10)	1.17 (2.57)	2.07 (1.84)	-0.26 (0.51)
7	15.57	0.22	-2.02 (6.84)	0.83 (1.48)			1.07 (1.08)	1.20 (2.67)	2.09 (1.87)	
8	15.57	0.22	-1.96 (6.75)	0.78 (1.40)				1.17 (2.60)	2.06 (1.84)	

The second set of models seems to measure the effect of disruptions with more accuracy. Model 8 seems to be the best model, as it does not include many non-significant variables. D_{lands} and D_{route} are not significant, although this can be due to the lack of enough records with landslides or using the alternative route in the sample.

$D_{direction}$ clearly shows that vehicles returning from Medellin take 1.96 hours less than those ones in the opposite direction, because they are empty. Landslides seem to delay vehicles almost twice (2.06 hours) than disruptions at bridges (1.17 hours). The explanation lies in that in the case of bridges, most closures are scheduled, so drivers can adjust to them, in contrast with landslides, totally unexpected. Although these amounts do not seem very large when compared with average travel times of around 25 hours, they can affect the logistic chain and costs as they widen the delivery windows in an urban environment.

6 CONCLUSIONS

The model shows a simple way to use historical data, now easily available thanks to advances in vehicle tracking technology and GPS, to measure the effects of individual disruptions on travel times. This information can be employed in cost benefit analysis for improvements in reliability.

Unexpected disruptions such as landslides increase the travel time without overnight sleep by an average of 2 hours, while temporary bridge closures that are widely known did it by only 1.17 hours, because drivers can adjust in advance to them. The models showed that only those disruptions reported by drivers show any significance in the regression models. Infrastructure disruptions reported on the same route and days may not affect drivers at all. Drivers can adjust to problems well in advance, as they are well known. The disruptions

should be studied starting from the individual travel times, as this increase the accuracy of models.

The travel time diaries showed that drivers reacted in the same way as reported other disruptions (Dunkerley, 2000), showing similarities also with disruptions in other countries as shown in. Drivers waited for disruptions to pass, or used alternative roads, like Route 2 through Manizales. Interestingly, drivers manipulated their sleeping time to cushion the effects of disruptions, sleeping less when problems occur during their trips. Also, disruptions were felt in other areas of the Colombian network, as drivers tried other routes. This behaviour was seen in the French truckers' strikes, when Dutch and German ports received many more vehicles. Unfortunately the models did not show any significant effect of changes in departure times on travel times taking off periods of overnight stops. This is probably because drivers on this route do not have much flexibility: they can only depart at daylight, and they can not travel before 6:00 am because this increases the risk of robberies.

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