A Study Of The Impact Of The July Bombings On Londoners’ Travel Behaviour

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A study of the impact of the July bombings on Londoners’ travel behaviour

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First Report

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Introduction

On the 7th of July 2005, at the peak of morning rush hour, three bombs exploded in short intervals on three London Underground trains. Nearly an hour later, a fourth bomb exploded on a double-deck bus. The bombings killed 52 commuters and the four suicide bombers, injuring over 700. This paper presents an analysis of the impact of these bombings (7/7) on Londoners’ use of transportation in the aftermath of 7/7 and the risk perception that this use reveals.

Analysis of behavioural reactions to 9/11 (the terrorist attack on US commercial passenger airlines on 11th of September 2001) suggests that terrorists ‘strike twice’ – first claiming lives and damaging infrastructure directly, during the course of the attack, and then indirectly, through people’s heightened perception of the risk of a repeated attack on the mode directly attacked, causing a shift to a riskier transport mode (Gigerenzer, 2006). However, Spaniards’ reactions to the Madrid train bombings on 11th of March 2004 (M/11) did not show evidence of such second indirect damage (López-Rousseau, 2005). This paper examines whether Londoners’ experience was closer to the US or Madrid, and finds that although London’s terrorist attack met the conditions for unleashing similar reactions to M/11, Londoners’ experience of 7/7 was different from both US citizens reactions to 9/11 and Spaniards’ reactions to M/11. We examine four different explanations for the disparity and offer a policy implication, to be substantiated by further analysis.

Behavioural reactions to 9/11 and M/11

The impact of terrorist attacks on travelers’ behaviour has been analyzed both in the aftermath of 9/11 (Gigerenzer, 2004, 2006), and in the aftermath of M/11 (López-Rousseau, 2005). These analyses revealed that the attacks had a powerful effect on travellers. For instance, Gigerenzer (2006) found that for a period of one year after 9/11, air travel dropped below the five-year average preceding the event and was substituted by car travel. Since travelling by car kills more than travelling by air

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1 The terrorists struck twice in London in the same month. The second attack occurred exactly two weeks later on July 21st: three bombings were attempted on the London Underground, and one on a bus. None of the main explosive charges detonated, and there were no casualties. It is possible that both attacks influenced people’s behaviour. Due to the short interval between the two attacks, it is impossible to single out their individual effects. So the subsequent analysis can be viewed as examining their joint impact, with 7/7, the attack that had incurred direct life losses being the leading factor underlying Londoners’ subsequent behavioural changes.
(Slivak and Flannagan, 2003), he hypothesized, and found, that such substitution claimed lives: Highway fatalities increased as a result of drivers avoiding airplanes, the *dread risk* (defined as an event with low-probability of happening but high-damage).

Gigerenzer’s ‘dread hypothesis’ rests on three interlinked conditions, and an implicit fourth: 1) dread avoidance, evidenced by a decrease in the use of the transportation mode directly attacked by the terrorists and therefore ‘dreaded’; 2) substitution, evidenced by an increase in the use of the modes that serve as the substitute of the mode attacked and dreaded; and 3) increase in fatality. For 3) to take place, an important implicit condition is that 4) the substitution mode is riskier, that is, associated with higher fatality rates than the attacked mode. This was the case in the US, where after 9/11 car travels increased especially on the rural interstate highways. Interstate highways are the more likely candidates for substituting within-US air travels; they are also associated with a higher fatality rate than air travel (appropriate ref?). Indeed, Gigerenzer found that more people died on the roads following 9/11. Immediately following the attack, the number of fatal crashes rose above the five-year maximum (1996-2000) for each month and remained so for a period of six months; this number only returned to the five-year average one year after 9/11. Gigerenzer considers this the ‘indirect’ damage caused by terrorists. Terrorists strike twice, first physically on people and infrastructure, then psychologically, through people’s minds.

Interestingly, analysis of Spaniards’ travel reactions to the Madrid terrorist attack yields different results from the US. Specifically, López-Rousseau found dread avoidance (rail usage fell following M/11), but no dread-induced substitution (no increase in car patronage). Consequently, he found no increase in fatality (measured by *interannual variations*, or the percentage difference between a measure in a given period and the same period a year earlier, also called *year-on-year changes*).

López-Rousseau (also see Gigerenzer, 2006) proposed three explanations for the apparent disparities between the US and Spain and for the lack of substitution in particular. First, Spain has a history of terrorist attacks which the US has not. Past exposure to a risk increases people’s knowledge of the risk, and thereby decreases its perceived ‘riskiness’ (Slovic, 1987). Second, Spain is less of a ‘car culture’ than the States. Third, Spain has more developed public transportation systems. These two suggest that compared to Americans, Spaniards are less likely to replace the affected public transportation mode (train travel) as well as less likely to substitute it with car.
On these three accounts, we consider Britain to be more similar to Spain than to the US, leading us to expect that Londoners’ reactions to 7/7 should also show no evidence for indirect damage in terms of increased fatality, as well as no evidence of substitution. First of all, the UK has for decades had to deal with terrorist events. For instance, in 1993, the Provisional Irish Republican Army (IRA) detonated a truck bomb in London’s financial district in the City of London, killing one person and injuring 44. In terms of the efficiency of public transportation systems, London has well-developed underground and bus networks. The car culture is perhaps most distinctive in the States. Americans have the highest number of vehicles per capita, almost twice as many as British or Spaniards\(^2\). Besides the attitude, the incentive to substitute public with private transportation (car) might even be lower in London than Madrid, due to the congestion charge introduced in February 2003. This is a daily charge of £8 ($16) for anyone who drives into the congestion charge zone, which covers most of central London. A last important aspect that makes 7/7 similar to M/11 is the fact that both were attacks on ground transit – unlike 9/11.

**Methodology**

We collected five-year transportation data, from 2002 to 2006, from the transportation authorities of the UK and London, i.e. *Department of Transport* and *Transport for London*. These include: yearly traffic volume of buses\(^3\), cars\(^4\) and taxis (as one mode), pedal cycles and powered-2-wheelers\(^5\), weekly traffic volume of London underground (in charts), and fine-grained fatality and casualty data by London borough, by transportation mode, and by month. We analyzed the data by measuring interannual variations. For fatalities and casualties, we also compared the data to the average, maximum and minimum of each month of three years before 2005 (from 2002 to 2004). We measured the ‘riskiness’ of each transportation mode by *fatality rate* in persons killed per million vehicle kilometres, or the number of fatal injuries divided by traffic volume of each transportation mode. This measurement allows us to tease out the usage of a mode as a contributing factor of the changes in the fatality. To examine whether the changes in fatality in 2005 were due to 7/7, we


\(^3\) Buses include buses and coaches.

\(^4\) Cars do not include goods vehicles.

\(^5\) Powered-2-wheelers include motor cycles and mopeds.
computed 6-month fatality ratios, by using the total fatalities in the second-half of 2005 (from July to Dec) divided by those in the first half (from Jan to June), and again compared this ratio in 2005 to those in the previous three years (from 2002 to 2004).

**Results**

The following section presents our results in the logical order suggested by Gigerenzer’s ‘dread-hypothesis’: 1. Did avoidance occur?; 2. Did substitution occur? and 3. Did fatalities increase?

1) **Did avoidance occur?**

The modes of transportation directly affected by the terrorists were the London underground (also called the ‘tube’) and buses. Avoidance would therefore occur if we found that passenger volumes decreased on both the tube and buses immediately following the attack of 7/7 (and possibly after the failed attack of 21/7), and gradually returned to the pre-7/7 baseline.

The tube weekly passenger entry data collected from Transport for London (Table 1) showed a 12.8% drop in the week immediately following 7/7 during weekdays; the impact on weekends was even larger – a 32% decrease occurred.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-12.8%</td>
<td>-15.9%</td>
<td>-16.5%</td>
<td>-14.0%</td>
<td>-8.6%</td>
<td>-5.6%</td>
</tr>
<tr>
<td>Weekend entries</td>
<td>-32.7%</td>
<td>-11.6%</td>
<td>-34.0%</td>
<td>-23.4%</td>
<td>-13.5%</td>
<td>-11.7%</td>
</tr>
<tr>
<td>Weekly total entries</td>
<td>-16.5%</td>
<td>-15.1%</td>
<td>-19.7%</td>
<td>-15.7%</td>
<td>-9.5%</td>
<td>-8.4%</td>
</tr>
</tbody>
</table>

Source: Transport for London

As shown in Fig.1, the decrease probably lasted for at least two months till mid-September (the solid line). But since underground patronage had been increasing robustly since the beginning of 2005 (the lines were well above the 0% base-line, which indicates the monthly average of the previous three years), seasonally-corrected data revealed that the effect might have lasted till early December (the dashed line). While these results do not allow us to distinguish between avoidance on directly hit lines (which were closed in certain sections until early August) and avoidance on lines
not hit, research that has examined this difference found that avoidance occurred also on lines not hit (second working paper by CREATE & LSE team).

**Change in LUL entry numbers after 7 July**

<table>
<thead>
<tr>
<th>Week</th>
<th>Change in entries on week before 7 July</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.00%</td>
<td></td>
</tr>
<tr>
<td>50.00%</td>
<td></td>
</tr>
<tr>
<td>40.00%</td>
<td></td>
</tr>
<tr>
<td>30.00%</td>
<td></td>
</tr>
<tr>
<td>20.00%</td>
<td></td>
</tr>
<tr>
<td>10.00%</td>
<td></td>
</tr>
<tr>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>10.00%</td>
<td></td>
</tr>
<tr>
<td>20.00%</td>
<td></td>
</tr>
<tr>
<td>30.00%</td>
<td></td>
</tr>
<tr>
<td>40.00%</td>
<td></td>
</tr>
<tr>
<td>50.00%</td>
<td></td>
</tr>
<tr>
<td>60.00%</td>
<td></td>
</tr>
</tbody>
</table>

**Fig.1. Weekly tube usages in 2005 compared to 2004.**

The baseline (0%) is the weekly entry of 2004 in the same week. The solid (red) line shows the actual weekly entries in 2005 compared to 2004; the dashed (green) line show the seasonally-corrected weekly entries. The sudden drop corresponded to the week of 7/7. Although the actual weekly entries suggest that the tube usages recovered in mid-September, the seasonally-corrected data show that the recovery did not occur till early December. Source: Transport for London.

As for buses, avoidance is less obvious (Fig.2), mainly because the data currently available is aggregated yearly. The traffic volume of bus and coach in 2005 was comparable to that in 2004. Nevertheless, the year on year % change reveal that before 2005, bus use had been increasing robustly for two years in a row, but stopped in 2005 (0.33%), and again resumed in 2006 at the 2004 rate. Thus, it is possible that bus use was affected. To better address this question, we will continue to seek monthly bus traffic volume data for 2005.
Million vehicle kilometres | 2002 | 2003 | 2004 | 2005 | 2006
--- | --- | --- | --- | --- | ---
Bus or Coach | 534 | 582 | 600 | 602 | 621
Year on year change (%) | 8.99% | 3.09% | 0.33% | 3.16%

![Graph showing yearly traffic volume of bus or coach in London.](image)

**Fig.2. Yearly traffic volume of bus or coach in London.**

The trend lines show that the bus usage in 2005 was comparable to 2004.

Source: Department of Transportation

2) Did substitution occur?

The dread hypothesis posits that travellers avoid the transportation mode directly hit by the terrorists (underground and bus) by substituting it with viable substitutes. Among the possible transportation modes, e.g. pedestrian, pedal cycle, powered-2-wheeler, car and taxi (as one mode), airline, and boat, we considered pedal cycle, powered-2-wheeler, and car and taxi as the most likely substitutes for underground and bus. Table 2 and Fig.3 show the yearly transportation volume by transportation mode in London between 2002 and 2006, as well as the interannual variations of each mode.
Table 2. Yearly London traffic volume (in million vehicle kilometres) and interannual variations (as %).

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal cycles</td>
<td>502</td>
<td>542</td>
<td>523</td>
<td>585</td>
<td>630</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.97%</td>
<td>-3.51%</td>
</tr>
<tr>
<td>2-wheeled motor vehicles</td>
<td>762</td>
<td>864</td>
<td>809</td>
<td>845</td>
<td>823</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.39%</td>
<td>-6.37%</td>
</tr>
<tr>
<td>Car &amp; Taxi</td>
<td>26,795</td>
<td>26,376</td>
<td>26,269</td>
<td>26,136</td>
<td>26,398</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.56%</td>
<td>-0.41%</td>
</tr>
</tbody>
</table>

Source: Department of Transportation

Fig.3. Interannual variations of London traffic volume by mode.

Shaded bars show the change percentages of 2005 compared to 2004 (shaded bars), which suggest an increase in pedal cycles and 2-wheeled motor vehicles (powered-2-wheelers), but a decrease in cars and taxis.

The year-on-year changes between 2005 and 2004 (the green shaded bars) reveal an increase in the use of pedal cycles and powered-2-wheelers, but a slight decrease in that of cars and taxis. These data suggest that pedal cycle and two-wheeled motor vehicles, and in particular the former, probably served as the substitutes for the tube and buses.
3) Did fatality increase?

The last condition of the dread hypothesis requires that fatalities increased as a result of avoidance and substitution. We examine evidence for this condition by first comparing the yearly fatalities (number of deaths) caused by the three modes reputed to be substitutes to the tube and buses. Note that we also included 2006 data, as this would allow us to examine whether an increase in 2005 fatality was unique or simply reflected a general trend towards long term increase.

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal Cycle</td>
<td>20</td>
<td>19</td>
<td>8</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>Powered-2-wheeler</td>
<td>66</td>
<td>63</td>
<td>47</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>Car &amp; Taxi</td>
<td>76</td>
<td>63</td>
<td>54</td>
<td>55</td>
<td>61</td>
</tr>
</tbody>
</table>

Fig. 4. Yearly fatality by mode.

These trend lines show that the fatality of pedal cycle was the highest in 2005 compared to both the years before and the year after, a distinctive pattern not shared by the other two modes, i.e. powered-2-wheeler and car and taxi.

Fig. 4 shows that the fatality of pedal cycle increased in 2005 compared to 2004, but that of powered-2-wheeler decreased. This point is perhaps better illustrated in the interannual variations in fatality (Fig.5):
Among the three potential substitute modes of underground and bus, only pedal cycle shows a salient increase in fatality in 2005 compared to the years before as well as after.

It is clear from Fig.5 that the only salient increase in fatalities in 2005 happens to pedal cycle. Since as discussed, pedal cycle is a substitute mode for avoiding the dread of underground and buses, this increase could provide support for Gigerenzer’s dread hypothesis if we find evidence that this increase is due to the July bombings. That is, the increase in fatalities should occur in the second-half of 2005, from July to December, rather than in the first half, from January to June. To investigate this, we first collected monthly fatality data for the three transportation modes, plotted below. This is then followed by the half-monthly data analyses.
Fig. 6. London Monthly fatalities for Pedal Cycles, Powered-two-wheelers and Cars & Taxis.

The solid and dashed lines show respectively the fatality of 2005 and the three-year average between 2002 and 2004. The squares and diamonds are respectively the maximum and the minimum month fatalities between 2002 and 2004.
The top panel of Fig. 6 shows that, despite the overall high fatalities in pedal cycles in 2005 (the solid line of the top panel) compared to the previous three years (the dashed line), this increase had already started to take place before the bombings. The fatalities in April, May and June 2005 were either the same as or higher than the maximum fatalities for the same month between 2002 and 2004. Therefore, there is no reason to believe that the increase in fatalities was due to the bombings alone.

An alternative way to capture this is to compute the ‘6-month fatality ratio’, or the total fatalities in the second-half (between July and December) divided by the total fatalities in the first-half (between January and June) of each year. The result is shown in Table 3.

Table 3. Six-month fatality ratios (Jul-Dec/Jan-May) between 2002 and 2005

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>Average (02-04)</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal Cycle</td>
<td>150%</td>
<td>90%</td>
<td>100%</td>
<td>113%</td>
<td>91%</td>
</tr>
<tr>
<td>2-wheeled motor vehicles</td>
<td>136%</td>
<td>103%</td>
<td>135%</td>
<td>125%</td>
<td>144%</td>
</tr>
<tr>
<td>Car &amp; Taxi</td>
<td>117%</td>
<td>91%</td>
<td>104%</td>
<td>104%</td>
<td>157%</td>
</tr>
</tbody>
</table>

Table 3 shows that the 2005 fatality ratio for pedal cycles is actually smaller (91%) than the average of the three previous years (113%). It follows that the increase in fatality in 2005 was mainly due to the increase in the first half of the year, prior to the London bombings. A second insight from this analysis is that while there is no evidence for an increase in fatalities in 2005 for powered-2-wheelers and cars and taxis, this is perhaps because the fatalities decreased significantly a lot in the first-half of 2005.

**Results Summary**

Our analyses reveal that following the 7/7 bombings, Londoners avoided underground, and, most likely, buses - the two modes of transportation directly hit by the terrorists. Londoners thus showed ‘dread avoidance’, much like American citizens after 9/11 (Gigerenzer, 2006) and Spaniards following M/11 (Lopez-Rousseau, 2005). Like Gigerenzer and unlike López -Rousseau, we find evidence for travel mode substitution, evidenced by the increased use of pedal cycles and powered-2-wheelers.
in 2005 compared to 2004 and 2006. However, unlike Gigerenzer, we find no
evidence that fatalities increased as a result of avoidance and substitution. Thus, our
data fail to support the notion that as a result of avoiding the dread risk, Londoners
suffered a greater loss of life. This is a surprising result, because it shows that
Londoners behaved differently from American as well as Spaniards. In the next
sections, we offer some plausible explanations for this.

Discrepancy between 7/7 and M/11

First, we turn to the discrepancy between 7/7 and M/11. This is unexpected,
given that both 7/7 and M/11 were attacks on ground transportation, and that both
Britain and Spain are comparable on the characteristics proposed by López -Rousseau
(lack of car culture, efficiency of public transport, history of terrorism). So, why did
substitution occur in London and not in Madrid?

In addition to our findings and those of Gigerenzer (2006), avoidance and
substitution were found, as far as we know, in only one other comparable study
(Becker & Rubinstein, 2004). This study found that an attack on a bus in Israel caused
a 30% reduction of bus traffic in the first and second month. At the same time Israelis
used taxis more frequently after the attacks; that is, there was substitution. We
therefore think that the surprising result is the lack of substitution found in Spain,
which we attribute to the different methodologies employed by us vs. López -
Rousseau. First, López -Rousseau analysed country-wide, rather than city-wide, data,
as we did. His choice was motivated by the need to compare the results with
Gigerenzer’s, who examined US-wide travel response. We on the other hand focussed
on London-wide data – a necessary choice given that the terrorist attacks were
concentrated on London public transport. In our future research, we aim to collect
UK-wide data on traffic and fatalities, to allow for a direct comparison with the
Spain-wide data. Second, López -Rousseau assumed that the substitution mode for
train was car travel. Again, this choice was motivated by the need to compare his
results with Gigerenzer’s, which examined highway traffic. By contrast, we collected
data on all transportation modes, ruling out the unlikely ones (e.g. boat, airplane),
before focusing on the three most likely substitutes to underground and buses as the
means of transportation within London.
A second crucial factor that distinguishes Londoners’ transportation choice is the fact that Londoners’ travel behaviour was heavily influenced by the congestion charge levied against anyone who drove private vehicles into the congestion charge zone, which covered most of the central London area (Zone 1) where the bombings occurred. This charge was originally introduced in February 2003 at a daily price of £5 and later increased to £8 on July 4th, 2005, just 3 days before the bombings. This measure was taken to alleviate congestion within central London. The effect of the congestion charge on Londoners’ reactions cannot be ignored, and, while current analysis cannot tease out its direct effect, we have reasons to believe that it has powerfully shaped how Londoners reacted to the bombings, and in particular their willingness to substitute means of public transportation.

The congestion charge is likely to have decreased the benefit and increased the perceived cost of substituting dreaded risk (underground or bus) with car. As a result, we expect the substitution from underground and bus to car to be limited, while substitution to non-chargeable vehicles, e.g. pedal cycles and powered-2-wheelers to be more likely. This is what Table 4 shows: the initial introduction of the congestion charge in 2003 led to a large increase in the use of non-chargeable modes (i.e., taxis, buses and coaches, powered two-wheelers, pedal cycles), and decreases in the use of chargeable modes (cars, vans, lorries, etc.) This impact was further enhanced, when, just three days before the bombings, the charge increased from £5 to £8, producing an even larger incentive for people to continue using the underground and buses, or to use non-chargeable vehicles instead.
Consideration of the congestion charge allows us to better interpret the magnitude of the increase in pedal cycles traffic following 7/7. This magnitude (11.85%, see Fig 3) is even larger than the increase in 2003 (7.97%), when the congestion charge was first introduced. We are therefore confident that pedal cycles and two-wheeled motor vehicles, and in particular pedal cycles, served as the substitutes for the tube and buses.

In summary, the congestion charge could have influenced both Londoners’ willingness to substitute and the choice of substitute. It explains why car was not a substitute, but pedal cycle and powered-2-wheelers (non-chargeable) were. In our future research, we plan to consult an expert in transportation (Prof. Michael Bell at Imperial) and conduct more detailed analysis on these two hypotheses.

**Discrepancy between 7/7 and 9/11**

The second surprising finding pertains to the fact that substitution meant higher fatalities in the US (after 9/11), but did not mean increased fatalities in London. We explore the following four explanations for this discrepancy:

Explanation 1) Could substitute modes used by Londoners have been less risky than the modes attacked (i.e. underground and buses)?

---

**Table 4** Key year-on-year changes in traffic entering the central London charging zone during charging hours (07.00-18.30).

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All vehicles</td>
<td>-14%</td>
<td>0%</td>
<td>-2%</td>
<td>0%</td>
<td>-16%</td>
</tr>
<tr>
<td>Four or more wheels</td>
<td>-18%</td>
<td>0%</td>
<td>-3%</td>
<td>0%</td>
<td>-21%</td>
</tr>
<tr>
<td>Potentially chargeable</td>
<td>-27%</td>
<td>-1%</td>
<td>-3%</td>
<td>+1%</td>
<td>-30%</td>
</tr>
<tr>
<td>- Cars and minicabs</td>
<td>-33%</td>
<td>-1%</td>
<td>-3%</td>
<td>0%</td>
<td>-36%</td>
</tr>
<tr>
<td>- Vans</td>
<td>-11%</td>
<td>-1%</td>
<td>-3%</td>
<td>+2%</td>
<td>-13%</td>
</tr>
<tr>
<td>- Lorries and other</td>
<td>-11%</td>
<td>-5%</td>
<td>-4%</td>
<td>+6%</td>
<td>-13%</td>
</tr>
<tr>
<td>Non chargeable</td>
<td>+18%</td>
<td>+1%</td>
<td>-4%</td>
<td>-1%</td>
<td>+16%</td>
</tr>
<tr>
<td>- Licensed taxis</td>
<td>+17%</td>
<td>-1%</td>
<td>0%</td>
<td>-3%</td>
<td>+13%</td>
</tr>
<tr>
<td>- Buses and coaches</td>
<td>+23%</td>
<td>+8%</td>
<td>-4%</td>
<td>+3%</td>
<td>+25%</td>
</tr>
<tr>
<td>- Powered two-wheelers</td>
<td>+12%</td>
<td>-3%</td>
<td>-9%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>- Pedal cycles</td>
<td>+19%</td>
<td>+8%</td>
<td>+7%</td>
<td>+8%</td>
<td>+49%</td>
</tr>
</tbody>
</table>

Source: Transport for London
Explanation 2) Could fatalities have increased in some areas but not others?

Explanation 3) Could casualties, instead of fatalities, have increased?

Explanation 4) Could fatalities have been prevented by the congestion-charge or other London-specific policy measure?

Explanation 1

One reason why fatalities might not have increased in London could be that the substitute modes chosen by Londoners are less risky than the modes avoided. To determine this, we measured the fatality rate of each transportation mode used as a substitute. This rate is the ratio between the yearly fatalities divided by the yearly traffic volume of each mode. Table 5 presents the result.

Table 5. Yearly fatality rate in persons killed per million vehicle kilometres

<table>
<thead>
<tr>
<th>Yearly Fatality Rate</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal Cycle</td>
<td>0.0398</td>
<td>0.0351</td>
<td>0.0153</td>
<td>0.0359</td>
<td>0.0302</td>
</tr>
<tr>
<td>Powered-2-wheelers</td>
<td>0.0866</td>
<td>0.0729</td>
<td>0.0581</td>
<td>0.0521</td>
<td>0.0522</td>
</tr>
<tr>
<td>Car &amp; Taxi6</td>
<td>0.0028</td>
<td>0.0024</td>
<td>0.0021</td>
<td>0.0021</td>
<td>0.0023</td>
</tr>
</tbody>
</table>

Source: Transport for London

In comparison, the yearly fatality rate of the modes directly attacked were extremely low: 5, 9 and 4 fatalities occurred on the London underground in 2002, 2003 and 2004\(^7\) whereas the numbers of fatalities for buses and coaches are 7, 5 and 4, respectively. The traffic volumes of buses and coaches are larger than that of pedal cycles or powered-2-wheelers (Fig.2 and Table 2), and it is reasonable to assume that Londoners travel more often as well as in longer distances by underground than by bike. As a result, the fatality rates of the two affected modes are likely to be lower than pedal cycle and powered-2-wheelers. That is, the substitution modes chosen by Londoners are riskier than the modes avoided – just like in the US, suggesting that this explanation does not hold. Indeed, we find that the fatality rates of all three transportation modes are lower in 2005 than those in 2002 (Table 5). The decrease in

\(^6\) Judged from the fatality rate, these data seem to suggest that cars are safer than buses. This seems to be a counter intuitive result. The reason is that London Taxi is the safest transportation mode, incurring only 1 fatality over the four years between 2002 and 2005. We are unable to separate fatality rates for car and taxi because the traffic volume data are only available for the sum.

\(^7\) London underground fatality data are based on financial rather than calendar years, i.e. from 05 April each year to 04 April of the following year. 

powered-2-wheelers is the largest. That is, the roads are actually becoming safer to use.

In the most recently published yearly review of the impact of congestion charging\(^8\), this improvement in road safety was attributed to the London-wide road safety initiatives over the recent years. In addition to these, *Transport for London*, the government body responsible for most aspects of the transport system throughout London, also introduced interventions including assisting pedestrians and cyclists at junctions and bus priority measures. These, incidentally, might be another reason why (1) road fatality decreased in the period examined, (2) car travel failed to increase after the bombings, (3) bus patronage did not fall in 2005 and (4) pedal cycles increased robustly since 2004.

**Explanation 2**

A second reason why we do not find an increase in fatalities London-wide could be that we aggregated fatalities across boroughs. Would a different picture emerge if we collected fatality data by borough and compared the fatalities of boroughs directly exposed to the bombings and boroughs not directly exposed?

We addressed this by considering the fatalities of the substitute modes (pedal cycles and powered-2-wheelers) for each of the 33 London boroughs separately. Next we aggregated the data for the three directly hit boroughs (Camden, City of London and City of Westminster). Last, we computed the share of the fatalities of these three directly affected boroughs to the London total. The results are presented below.

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>average (02-04)</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedal Cycle</td>
<td>30.0%</td>
<td>10.5%</td>
<td>25.0%</td>
<td>21.84%</td>
<td>19.0%</td>
<td>15.8%</td>
</tr>
<tr>
<td>Powered-2-wheeler</td>
<td>1.5%</td>
<td>11.1%</td>
<td>8.5%</td>
<td>7.05%</td>
<td>6.8%</td>
<td>4.7%</td>
</tr>
<tr>
<td>Car &amp; Taxi</td>
<td>2.6%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>8.77%</td>
<td>1.8%</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

As shown in Fig.7, for each of the three transportation modes, the shares of 2005 fatalities of these three directly hit boroughs were always bounded by the one in 2006 and the average of the previous three years, from 2002 to 2004. Hence, there is no evidence that the fatalities increased in these boroughs in 2005. On the contrary, in

these boroughs the share of fatalities of the two substitute modes, i.e. pedal cycles and powered-2-wheelers, actually decreased in 2005 compared to 2004.

![Graph showing the share of fatalities of pedal cycles, powered-2-wheelers, and car & taxi](image)

**Fig.7. % share of the fatalities of the three directly-hit boroughs to the London total.**

**Explanation 3**

As Gigerenzer and Lopez-Rousseau, we also used fatality data to assess whether the London bombings imposed a second indirect damage in terms of substation-induced fatalities. We found no evidence for an increase in fatalities due to the increased use of pedal cycles and powered-2-wheelers. A possibility, explored here, is that substitution led to an increase in road accidents but – perhaps due to the policy aimed at improving road infrastructure – these accidents did not kill. To test this we analysed casualties (not fatalities) by transportation mode (pedal cycles, powered-2-wheelers, cars and taxi).

As shown in Fig.8, casualties of powered-2-wheeler and car and taxi are below the minimum value of the previous three years (2002 to 2004). This is the case both before and after July 2005. A different and interesting case is offered by pedal cycle. Following 7/7, there was indeed an increase in pedal cycle casualties in August 2005, above the minimum of the previous three years. When computing the 6-month casualty ratio (i.e. dividing the number of casualties in the second-half of a given year by the number of casualties in the first half of the same year), we see that this ratio
was 1.09, 1.16, 1.11 for 2002, 2003, and 2004. In 2005, the ratio was 1.13, similar to 2006, when it was 1.14. Hence, there is no reason to believe that the casualties were abnormally high in the second half of 2005.
Fig. 8. Monthly casualties of Pedal Cycles, 2-wheeled motor vehicles and Cars & Taxis in London.

The solid and dashed lines show respectively the casualties of 2005 and those of the three-year average between 2002 and 2004. The squares and diamonds are the maximum and minimum fatalities in each month of 2002 and 2004.

Explanation 4

Londoners’ substitution of public transport with pedal cycles shows that Londoners had both a heightened perception of the dread risk (or else they would have continued using public transport) and awareness of the costs of substituting underground and bus with chargeable private transport (or else they would have substituted with cars and taxis more, as Becker and Rubinstein).

The absence of substitution-induced fatalities is in our view closely linked with London roads becoming safer due to Governmental action.

While these policy effects create a challenge in the data analysis of this project, they also offer an unprecedented opportunity to learn from a ‘social experiment’. In particular, the London experience suggests that one way for Governments to mitigate citizens’ reactions to attacks perpetrated by terrorists on public transport is to enhance the attractiveness of safer transportation substitutes (or, alternatively increase the relative cost of riskier modes e.g., charging for car travel) as well as to provide a better public transportation system which decreases the chance of substitution-induced fatalities.
Plans for future work (1.07-30.09.08)

To complete our analysis of the impact of the 7/7 terrorist attacks on Londoners’ travel and risk-taking behaviour the only step left is to find and analyse monthly traffic volume data for buses and achieve greater uniformity across modes. To better compare these results with Lopez-Rousseau, examination of data at country level might also be valuable.

Our more substantial next step is to move to the next level of analyses considering impact on travel attitudes.

We also are prepared to assist CREATE in conducting any additional analyses left over after the departure of Garrett Asay. For this purpose, we’d like to obtain any models, data, write-ups he had developed during the grant. We will then be able to estimate more precisely, what level of effort will be needed to complete this work jointly with the remaining staff at CREATE.

References


