The Re-Opening of the Ancient Silk Road as a Route to Peace in the Middle East: Estimation of Economic Costs*

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Abstract

This study reports results from the research conducted to analyze the order of magnitude of time and economic loss generated by restrictions imposed on the movement of goods within and beyond Palestinian boundaries. A disaggregated itinerary choice analysis is undertaken for three of the most used itineraries connecting major locations in the West Bank and Israel: Jenin-Ramallah, Jenin-Haifa and Ramallah-Ashdod, for two political scenarios, "good" time and "bad" time and two alternative routes on each itinerary, "risky" and "safe". The "good" and "bad" months are identified from data using techniques of latent clustering. The "safe" alternative on each itinerary is the route with a low variability of travel times, whereas the "risky" route is characterized by high variability of travel times. This last option will be typically chosen by risk-loving agents. It is estimated that risk-neutral agents prefer the "risky" alternative: i) whenever the probability of "good" time is lower than 0.4, for trips between Jenin and Ramallah and between Ramallah and Ashdod, ii) it is always preferred by agents traveling between Jenin and Haifa. Using a numerical experiment calibrated on data collected through on-field interviews, it is estimated that the politically unstable situation generates on average 36% travel time loss on the "safe" routes and 71% time loss on the "risky" routes in "bad" times compared to "good" times. Finally, the estimated total cost in "bad" times compared to "good" times for the entire economy, given the percentage of transport services in the West Bank Gross Domestic Product, amounts to 28.90% of the total GDP for the year 2008.

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1 Introduction

For centuries, the Ancient Silk Road opened by the Venetian merchant Marco Polo, connected Europe with Asia through a complex network of trade routes. The explorer left Venice in 1271 and landed in Akko situated north of the actual Haifa city, in Israel. The natural re-opening of the Ancient Silk Road passes through the establishment of peace in the Middle East. It is generally believed that the solution to the Israeli-Palestinian conflict would be facilitated by the activation of stable economic and trade relationships between Israel and Palestine through the "*Peace Corridor*", linking Haifa to Sheickh-Hussein in Jordan crossing the West Bank, along the path signed by Marco Polo's footprints.

This ambitious political objective would open up the Palestinian "*cul-de-sac*" economy with benefits for both the Israeli and Palestinian party. A reduction of the occupation intensity would have the effect of increasing trade flows between the many enclave economies created within the West Bank by the network of military checkpoints. In peaceful periods, military control is exerted through a network of fixed checkpoints which limit free movements of people and goods by about half of the potential sustainable traffic in the existing road system [33]. It is estimated that Palestinians mobility is restricted from 41 road sections [25] in the West Bank by a system of permanent "fixed" blocks located. The restricted roads are major north-south and East-West transport routes reserved mainly to the movement of Israeli settlers. Palestinian drivers and commercial vehicles can apply for special permits to use these roads. In periods of political turmoil, the number of temporary "flying" checkpoints increases and can more than double in a very short period of time. During the last ten years, the monthly number of flying checkpoints in the West Bank has been strongly correlated with the ferment of the political situation (see for instance [25], [21], and [10]).

In situations of "bad" political times, cargo and people movements are reduced to a minimum because of the increased number of road blocks and longer checking times due to more scrupulous controls. The risk of loosing perishable loads also increases. The scant movements tend to follow alternative, but more risky routes, in order to get the checkpoints around. This strategic system of traffic blocks gives rise to many local enclave economies, as if they were cities under siege, leading to the economic paralysis of the whole economy. The majority of Palestinian families precipitate with no type of insurance parachute in a disaster situation of hunger and abyssal poverty. This situation generates strong collective resentment and retaliation rage, which both perpetuates a highly conflictual relationship, and condemns the Palestinian population to stay on the path of underdevelopment.

The objective of this study is to estimate the economic costs of the Palestinian-Israeli conflict caused by the military control of movements of goods and people, both inside and outside the Palestinian boundaries, paving the way to the evaluation of peace dividends stemming from a lower intensity of occupation. The paper is organized as follows. *Section 2* describes the relationship between political turmoil and movement restrictions in the West Bank using quantitative tools to differentiate the pattern of restrictions during "good" and "bad" political times. *Section 3* presents the theoretical model which formally reproduces the features of the Palestinian transportation system both in "good" and "bad" political scenarios. *Section 4* provides analytical solutions to the problem of route choice between a "risky" and a "safe" alternative, for risk-neutral and risk-averse agents. Data are described in *section 5*. *Section 6* presents the results of a numerical experiment using the analytical solutions previously obtained calibrated using data collected through on-field interviews and discusses both the economic and social implications of the occupation. The final *section* presents the conclusions and discusses interesting lines for future research.

2 Political Turmoil and Movement Restrictions in Palestine

Following the "Six-Days" war in 1967, the Israeli authorities initially sought forms of integration with the Palestinian economy by expanding bilateral trade and investment opportunities. Good neighborhood relationships further improved thanks to the 1993 Oslo Accords that granted greater labor mobility and freedom of movements. These mutual exchanges, however, contributed to growing dependence of the Palestinian economy that has become more and more vulnerable to deterioration in the political peace process. The Second Intifada in year 2000 led to the escalation of terrorist attacks against Israel and exacerbated the fragility of the Palestinian economy. To prevent terrorist actions, in 2002 the State of Israel started to construct the 703 kilometers long Israeli West Bank barrier consisting of concrete fences up to 8 meters high, located mainly on Israeli-occupied territories in the West Bank and partly along the 1949 Armistice line, or "*Green Line*" between Israel and Jordan, defining the West Bank boundaries to be completed in 2010. More restrictive controls on commodity shipments and the mobility of Palestinian residents both within Palestinian territories and on the borders were also introduced. The barriers under military surveillance channel the passage of all travel flows through checkpoints (a map showing their location across the West Bank is represented in *figure 1*). The typology of movement restrictions can take the form of impediments to traveling, such as "fixed" and "flying" or random checkpoints,[6] road barriers and blocks, earth-mounds or trenches.

The existence of a correlation between the agenda of political events and the number of military blocks on the West Bank roads is proved through certified evidence concerning the monthly number of flying checkpoints during the last ten years (among the most relevant providers of data in this field there are: [25], [21], and [10]). Associating these data with the sequence of political events, it is indeed observed that they are strongly correlated, as supported by the following arguments. The series of political events is generally observed on-field and reported by local and international observers, such as [22] and [18] (a detailed description of the available data follows in *section 5*). Following the series of events, we create an index of political alert, $PA3$ based on historical evidence provided by the sources cited just above, which allocates each significant, reported event to three major groups: *1*- "signature of agreement", *2*- " death of political representative or leader, or election times", and *3*- "inciting behavior on behalf of non-military leaders, occurrence of military attacks or actions of land occupation", ordered as an increasing scale of political upheaval. As represented in *figures 2* and *3*, it may be noted that the social unrest before the start of the Second Intifada during June and July 2000, allocated to the third $PA3$ group above, is also associated to a sharp and constant increase in the number of flying checkpoints on the Palestinian roads, with a peak of 914 checkpoints during Intifada, turned out into a frightful loss of human lives.

In fact, the level of political turmoil is the subject of our further investigation beyond the mere observation of a qualitative variable such as $PA3$. Using the latent cluster analysis, we identify, from the available data on the last ten years, those months that should be objectively considered as "bad" times for both the West Bank and Israel's economies. Given the nature of the conflict, with prevailing religious origins, it is confirmed by the local experts that, during religious feasts, a higher number of private cars use the same roads, generating congestion. *T*hus, in order to avoid long queues and everlasting waiting at checkpoints, Palestinian cargo deliveries follow alternative secondary roads, of a lower quality, such as roads n. 588, 508, 505 and 458 or other off-roads. Using dummy variables to indicate religious feasts and the occurrence of significant political events for both Israeli and Palestinians, such as a more detailed qualitative variable, similar to $PA3$, to account for the signature of agreements, election times, death of politicians, explicit inciting behavior, suicide bombs and land occupation (see [18], [22] and

[6] For more detailed definitions, see sub-section 3.1

[19]), we identify the number of "groups" in the data, corresponding to the states of the nature ω, using the method of latent clustering. The output of this method is the number of clusters that minimizes intra-group variance and maximizes inter-group variance of data with respect to the first moment of the distribution. In several experiments using different combinations of the dummies above and the number of flying checkpoints throughout the Palestinian governorates, we obtain similar results that exactly identify two distinct groups in the data (statistics on the final result are enclosed in *table 2*). The resulting binary variable of political alert PA, defines the state in which each observation (i.e. month) i is classified: conventionally, $PA = 0$ corresponds to good time, and $PA = 1$ corresponds to bad time.

On the same line, it may be noted that before starting the "Defensive Shield" operation in the West Bank during March 2002, the Israeli Defense Force increased the number of flying checkpoints during November and December 2001. When Israel was attacked by Hezbollah bombs sent over the borders of Haifa, at north, during July 2006, the Israeli Defense Force, as a measure of control, increased the number of controls on the Palestinian roads from 600 to almost 900 in a single month. However, this practice has not been implemented during the Gaza War operation "Cast Lead" in December 2008, when the number of flying checkpoints in the West Bank remained at a "moderate" level around the monthly average of 300. This may be due to the peculiar political context in which the operation took place, in which the moderate Palestinian Fatah party, popular in the West Bank, entertained good relationships with Israel, focusing on economic agreements, and dissociated from the extremist ideas of Hamas leaders in Gaza. On the other side, Israel needed to maintain the calm in the West Bank, while clashing the Hamas movement, and so, the number of flying checkpoints in the West Bank maintained to moderate levels, despite the existing conflictual situation in Gaza.

Security restrictions on the movement and access of Palestinian goods and people dramatically hinder the economic growth process. Between 2000 and 2002, the economy contracted by 30-35% as noted by [5]. In 2005 unemployment levels reached 23%, whereas poverty level rose substantially with 47% of Palestinians living below the official poverty line of 2.1 USD per day [32]. This closure regime over time has had at least three major impacts [3], [32]:

- it denies Palestinian producers to access potential international, Israeli and domestic markets. Restrictions either delay or prevent the movement of goods, making it both expensive, unsafe, and insufficient to satisfy demand;
- it reduces the mobility of people both within and across Palestinian territories. This contracts the flexibility of Palestinian labor market increasing unemployment and reducing remittances, and discourages international investors;
- it restricts Palestinian access to chronically weak Palestinian markets only.

In 2008 there were over 550 impediments to movement such as road blocks, barriers or checkpoints, and Palestinian access to 1200 kilometers of road was also partially or wholly restricted (United Nations OCHA, various reports 2000-2009). This situation is unsustainable in the long run. Movement restrictions give rise to intra-Palestinian violence and to a higher risk of attacks against Israel. The Palestinian Authority needs to reform its large but poorly organized security services in order to ensure a vital level of security. To gain access to world markets, Palestinian enterprises face the challenge of moving within the West Bank itself in spite of high transportation costs limiting the possibility to capture scale economies. A pernicious effect of the closure regime is the uncertainty it creates. Because shippers cannot accurately predict how long it will take to move their goods, it is impossible to commit to delivery times and to enter export markets. It is estimated that, as a result of movement restrictions after the Second

Intifada, Palestinian internal trade has declined by 40% and its external overall trade decreased by 60%, with an estimated daily loss of about USD 1.9 million in exports [30].

Movement and access blocks affect mostly industries that rely heavily on transportation or whose transportation share in the selling price is relevant, such as vegetables, fruits and bakery and other primary goods with transportation and communication services accounting for an average share of 11% in the total West Bank GDP [20]. As a result, poverty rates in the West Bank are very high due to the *de-development* effect generated by the lack of trade and low exchange volumes between local communities. On the other hand, estimates of the population growth by the Palestinian Central Bureau of Statistics show that the Palestinian economy would need to generate over 500 thousand jobs by 2015 in order to maintain unemployment at pre-Intifada levels and to avoid the risk of a fiscal crisis. The physical damage resulting from the conflict was estimated to be USD 305 million in 2001 and to USD 930 million by the end of 2002 [29], resulting in a dramatic decrease in the stock of real productive capital.

On-field interviews taken to major Palestinian transport companies operating across the West Bank during June-November 2009, revealed that restrictions to movement are mostly implemented along North-South and East-West axes of the West Bank, and consist of inaccessible roads, controls at the Israeli checkpoints, resulting in long queuing times and delays in delivery. Palestinian drivers and vehicles can apply for special permits to pass through the fixed checkpoints on these roads, but "flying" checkpoints are routinely in operation and applied to most Palestinian vehicles. The present study identifies "good" and "bad" times in the available data series from 2000 up to 2009 and models how truck drivers choose the optimal route on three major itineraries, under a risky political situation in the West Bank. Our aim is to estimate an order of magnitude for time loss and travel costs increase caused by movement restrictions and political upheaval in order to predict the total cost supported by the entire Palestinian economy, when the level of turmoil increases. We calibrate a route-choice model with risk-averse users on three of the most important trade corridors in the West Bank: i) Jenin-Ramallah, ii) Ramallah-Ashdod, and iii) Jenin-Haifa. A map showing their location in the West Bank is enclosed in *figure 4*. These itineraries gather approximately 30% of total Palestinian traffic, both internal to the West Bank and directed to Israel. The two corridors i) and ii), develop mostly along the main roads 57 and 60 and represent important corridors for the intra-regional trade in the West Bank, together with the West-East corridor running from Ramallah to Allenby through Jericho, and with the Ramallah - Hebron corridor in direction South.

3 The Model

The theoretical model formalizes the relationship between the evolution of political turmoil with the number of flying checkpoints in West Bank and its impact on route choice and travel costs, which currently represent 35% of the selling price in this area, corresponding to more than three times the "benchmark" level of 10% practiced in the remaining Middle East countries [5]. Some of the specific terms used throughout the paper follow.

3.1 Definitions, notation and assumptions

The most common road blocks in the West Bank are the "fixed" or "permanent" military checkpoints and the "flying" or "random" checkpoints.

Definition 1. *"Fixed" checkpoints* are Israeli military control points composed of two elements: an infrastructure obstructing vehicular and pedestrian traffic, and the permanent presence of Israeli security personnel. Security personnel checks for the documentation of individuals or trucks crossing the checkpoint and conduct searches on their vehicles and their belongings [24].

A specific "coordination" procedure is required for the Palestinian trucks willing to pass through the fixed checkpoints.

Definition 2. *Coordination procedure.* It is an "announcement" procedure requested to Palestinian trucks willing to pass through the fixed checkpoints placed on the West Bank roads. Before their departure, truck drivers are supposed to announce by phone the military authorities at each fixed checkpoint along the trip, and claim their passage during a certain time schedule. This procedure is implemented by the Israeli Defense Force on a sporadic basis and it may take from 5 to 30 minutes, depending on the traffic conditions.

Definition 3. *"Flying" checkpoints* are made up of similar infrastructure as the fixed checkpoints, only that they are not permanently staffed. Frequently, the partial checkpoint is installed on roadsides and therefore does not directly obstruct the traffic. When staffed, partial checkpoints function as full checkpoints. When un-staffed, the traffic may flow easily along the route. The Israeli Defense Force erects dozens of random or "flying", checkpoints each week, mainly on side roads, depending on the socio-political context. Massive delays and queues lasting hours are routinely reported by field experts. In addition to staffed permanent and partial checkpoints, the army has also erected hundreds of physical obstructions, such as dirt piles, concrete blocks, boulders, trenches, fences, and iron gates, in order to block access to main roads and channel Palestinian traffic towards staffed checkpoints [24].

The definition of "safe" and "risky" routes is related to the time variability specific to each alternative route. "Safe" routes are usually main roads and they are characterized by the presence of fixed military checkpoints. Due to the fact that their presence is known to the truck-drivers traveling on those roads, travel times on these roads are deterministic. On the contrary, "risky" routes are usually off-roads and they are mostly characterized by the presence of flying checkpoints. Since the distribution of flying checkpoints on the roads is casual, and therefore, not known by the truck-drivers before their departure, travel times are not any more deterministic, but random.

Definition 4. *Safe route* is a route containing fixed checkpoints, being usually represented on geographical maps as a main road. *Risky route* is a route containing only flying checkpoints, being represented on geographical maps as a secondary road.

Definition 5. *Comprehensive Closure Days* represent the total number of days in which no passage is allowed throughout the fixed checkpoints [24].

Special control procedures are applied to cargo transports when passing through "Green Line" checkpoints, such as "back-to-back" controls.

Definition 6. *Back-to-back* cargo control is generally understood as the transfer of loose goods from one truck to another, made by positioning two trucks with their backs to one another. Primitive variants involve labor-intensive handling and placement of cargo on the ground during the transfer. This process is a required control procedure at the fixed checkpoints across West Bank, and it inflicts serious time delays and damage to perishable cargo.

Definition 7. *Bad time* is an indicator taking value 0 during peaceful periods, when the the level of political turmoil is considered to be "low", and it takes value 1 otherwise, i.e. during *bad times.* In order to define this indicator more accurately, we conduct a cluster analysis on data collected on a monthly basis, from January 2000 until December 2009 (for details on computation, see *section 4* below).

In our theoretical model, each variable depends on prior information captured by the set of factors $\Omega = \{\omega, \zeta, ...\}$, such as the good or bad political scenario, formalized by the two values of $\omega = \{g, b\}$, or on the weather conditions and the license type used for travels beyond the current boundaries of the West Bank, such as factors ζ, etc. In the following, such factors as ζ are ignored, to privilege the possible political scenarios. *Table 1* below summarizes the notation used throughout the paper:

Table 1: Notation

TT_I^z	total travel time on itinerary I of type z, sum of dist-related travel time, waiting at queues and checking;
TC_I^z	total travel cost equal to the monetary value of TT_I^z plus the transport tariff;
I	itinerary, represents a collection of routes.The 3 itineraries studied are: Jenin-Ramallah (JR), Jenin-Haifa (JH), Ramallah-Ashdod (RA);
$h = R, S$	route type: Risky, Safe;
$j = 1, ..., J$	index for links: l_j contains information on route type, between two nodes;
$z = x, y$	general index for checkpoints: x-fixed or y-flying;
$x = 1, ..., X$	fixed checkpoint index, associated to a link;
$y = 1, ..., Y$	flying checkpoint index, associated to a link;
$\widetilde{N_j^z}$	number of checkpoints on link j of type z, is a random variable;
cd_I	coordination time for the itinerary I;
tt_j	travel time on link number j;
$\widetilde{ck_j^z}$	control time in the checkpoint of type z on link l_j;
$\widetilde{q_j^z}$	queuing time at checkpoint of type z on link l_j depends on the number of vehicles ahead in the queue $\widetilde{m_j^z}$, random for $z = x$, and on the control time, $\widetilde{ck_j^z}$;
θ	type of decision makers. If $\theta = 1$, decision makers are risk-neutral. If $0 \leq \theta < 1$, agents are risk averse;
$U(TC, \theta)$	generic utility function;
$\omega = \{g, b\}$	states of the nature of factor $\omega \in \Omega$, $g = $ *good* and $b = $ *bad* political situation.

Remark 8. *Origin-Destination.* Each itinerary starts at origin O and finishes at destination D and it represents a collection of links of two types: *risky* routes, indexed by y, and *safe* routes, indexed by x. For the time being, we consider that $O - D$ trips are symmetric to $D - O$ trips.

The number of flying checkpoints on some link j of type R follows a Poisson distribution with parameter λ_j. Stated differently, the expected number of flying checkpoints on link j is λ_j. The total travel time associated to itinerary I of some type z is the sum over all routes of the coordination procedure duration, the distance-related pure travel time tt, and the queuing and checking times at all checkpoints:

$$TC_I^z = cd_I \cdot \mathbf{I}_{z=x} + \sum_{j \in I} \left(tt_j^x + \widetilde{q_j^z} \cdot \widetilde{N_j^z} + \widetilde{ck_j^z} \cdot \widetilde{N_j^z} \right), \tag{1}$$

in which $\mathbf{I}_{z=x}$ is the indicator function for the type of route, taking the value if the route is safe, or $z = x$, and value zero if the route is risky, $z = y$.

Remark 9. *Total Travel Time (TT) and Total Monetary Cost (TC).* Total travel time represent the sum over components of time such as: coordination, distance-related travel time, waiting in queues and checking time at checkpoints. Total travel cost is the monetary value of TT plus the transport tariff.

Computing total travel times on both routes of an itinerary, conditional on the political scenario ω, yields:

$$TT_I^S = cd_I + \sum_{j \in I} \left(tt_j^x + \widetilde{q_j^x} \cdot N_j^x + \widetilde{ck_j^x} \cdot N_j^x \right), \tag{2}$$

$$TT_I^R = \sum_{j \in I} \left(tt_j^y + \widetilde{q_j^y} \cdot \widetilde{N_j^y} + \widetilde{ck_j^y} \cdot \widetilde{N_j^y} \right). \tag{3}$$

Given the total travel time functions, the choice between safe and risky roads is made according to the travel cost minimization principle (Wardrop, 1952). Decision makers, according to the good or bad political situation and considering their aversion to risk, will choose the road with the lowest travel cost. In a simplified version, this travel cost consists of the distance-related travel time, queuing time before checkpoints along the road, and checking time due to inspection at checkpoints.

In order to obtain estimates of the economic cost at macroscopic level associated to the activity of transporting goods on these routes, let us consider an average monetary cost by truck. It has been estimated that this value is equal to EUR 7.5 for Israel, at 2005 prices (see [11]), therefore, we consider that using the value of 6 USD per hour for the West Bank is reasonable enough to the purpose of this analysis. In this first attempt, assuming an identical monetary travel cost for both routes, $\tau_R = \tau_S = \tau$, it yields the monetary equivalent of equation (4), TC_I^z:

$$TC_I^S = \tau + \left[cd_I + \sum_{j \in I} \left(tt_j^x + \widetilde{q_j^x} \cdot N_j^x + \widetilde{ck_j^x} \cdot N_j^x \right) \right] \cdot vot_S, \tag{4}$$

$$TC_I^R = \tau + \left[\sum_{j \in I} \left(tt_j^y + \widetilde{q_j^y} \cdot \widetilde{N_j^y} + \widetilde{ck_j^y} \cdot \widetilde{N_j^y} \right) \right] \cdot vot_R. \tag{5}$$

In the following analysis, we also assume that $vot_R = vot_S = vot$. Since the monetary values considered are identical for the risky and safe routes, we will furthermore compute analytical solutions based on functions TT only. Summing up these costs for all routes in the West Bank and multiplying them by the estimated number of trucks in good time and bad times, one obtains the value of cumulative monetary loss caused by the conflict. In the following section, we provide a simple representation of route choice solutions to be used in the numerical example.

4 Representation of Route Choice in Politically Risky Situations

Let us consider the existence of only one link on each route type, $j = 1$ on both risky and safe routes, and one fixed checkpoint on the safe route, $N_j^x = 1$. The checking time is deterministic $\overline{ck_j^z}$, conditional on the number of checkpoints on each route z. The variable denoting the number of flying checkpoints is conditionally distributed according to the following law, given that it depends on prior information contained in ω, such as *good* or *bad* time:

$$\widetilde{N_j^y} | \omega = \begin{cases} 1 & \text{prob.} \quad \lambda_j \\ \\ 0 & \text{prob.} \quad 1 - \lambda_j. \end{cases}$$

The value of λ_j may be interpreted as the probability of occurrence of bad time, in which the number of flying checkpoints is higher (i.e. equal to one) than in good times, when there are no flying checkpoints on the risky route. There is no traffic on either route, meaning that we assume there is no queuing time. This is equivalent to saying that queuing time is equal to zero, $\widetilde{q_j^x} = \widetilde{q_j^y} = 0$, such that the total costs on each of the two routes, are:

$$TT_I^S | \omega = cd_I + tt_j^x + \overline{ck_j^x}, \tag{6}$$

and the random total cost on the risky route is:

$$\widetilde{TT_I^R}|\omega = \begin{cases} tt_j^y + \overline{ck_j^y} & \text{prob.} \quad \lambda_j, \\ \\ tt_j^y & \text{prob.} \quad 1 - \lambda_j. \end{cases} \tag{7}$$

Once that costs are computed, we need to specify the travel demand on routes, demand which is originated by "trucks", based on the expected utility-maximizing behavior. This behavior follows the standard approach of expected total cost minimization for risk-neutral decision-makers and the approach of expected utility maximization for decision-making under risk. We provide a formal representation of both approaches in the following sub-section, for both risk-neutral and risk-averse decision-makers.

Drivers preferences are represented by a differentiable utility function $u(\cdot)$. The utility of an agent, $u(TT, \theta)$, depends on the total travel cost and on a risk aversion parameter θ, with values between zero and one, which reflects its attitude to a risky outcome.

4.1 Risk Neutral Agents

We consider that utility of risk neutral agents is linear in attributes, so that these users will select the route with the smallest expected travel cost. This implies that risk-neutral agents will prefer the safe route to the risky one only if $TT_I^S < E\left(\widetilde{TT_I^R}\right)$. In our example, this assumption formally implies:

$$S \succ R \iff TT_I^S < E\left(\widetilde{TT_I^R}\right), \tag{8}$$

$$\iff cd_I + tt_j^x + \overline{ck_j^x} < tt_j^y(1 - \lambda_j) + \left(tt_j^y + \overline{ck_j^y}\right) \cdot \lambda_j,$$

$$\iff \frac{cd_I - \overline{ck_j^x}}{\overline{ck_j^y}} + \frac{tt_j^x - tt_j^y}{\overline{ck_j^y}} < \lambda_j.$$

The threshold value for probability λ_j for the safe route to be chosen is:

$$\lambda_j^\star = \frac{cd_I - \overline{ck_j^x}}{\overline{ck_j^y}} + \frac{tt_j^x - tt_j^y}{\overline{ck_j^y}}.$$

This value states that for high enough probabilities of occurrence of one flying checkpoint on the risky route, thus for $\lambda_j^\star < \lambda_j$, drivers will choose the safe route. This result has as a special case the probability weighting case, in which the most pessimistic drivers choose the safe route. In the following sub-section, we present solutions to the route choice problem for risk-averse agents.

4.2 Risk-averse Agents with CARA Preferences

The Arrow-Pratt risk-aversion index we consider is $A = \frac{U''(TT;\theta)}{U'(TT;\theta)}$, (see [13]). The condition that A is constant leads to an ordinary differential equation, $U'' - b \cdot U' = 0$, with b whatever constant. The set of concave utility functions fulfilling this condition is given by:

$$U(TT;\theta) = \frac{1 - e^{\theta \cdot TT}}{\theta}; \ \theta > 0,$$

where $A = \theta$. These functions are known as Constant Absolute Risk Aversion functions, or *CARA*. Remark that $U' = -e^{\theta x} < 0$ and $U'' = -\theta e^{\theta x} < 0$. The limit value $\theta \to 0^+$ corresponds to risk-neutrality, for which, utility of choosing S assumes:

$$U\left(TT_I^S;0\right)_{x\to 0} \simeq -TT_I^S,$$

since, by the first order Taylor approximation, $e^x_{x\to 0} \simeq 1+x$, for whatever x. For the binary distribution of $\widetilde{TT_I^R}$, the expected utility on route R is given by:

$$E\left[U\left(\widetilde{TT_I^R};\theta\right)\right] = (1-\lambda_j)\,\frac{1-e^{\theta tt_j^y}}{\theta} + \lambda_j\frac{1-e^{\theta\left(tt_j^y+\overline{ck_j^y}\right)}}{\theta},$$

which, by rearranging terms yields:

$$E\left[U\left(\widetilde{TT_I^R};\theta\right)\right] = \frac{1-e^{\theta tt_j^y}}{\theta} + \lambda_j\left[\frac{e^{\theta tt_j^y} - e^{\theta\left(tt_j^y+\overline{ck_j^y}\right)}}{\theta}\right].$$

The utility of choosing S of the risk-averse agent is equal to:

$$U\left(TT_I^S;\theta\right) = \frac{1-e^{\theta\left(cd_I+tt_j^x+\overline{ck_j^x}\right)}}{\theta}.$$

Comparing the two outcomes, R and S, yields the probability threshold value:

$$S \succ R \iff U\left(TT_I^S;\theta\right) > E\left[U\left(\widetilde{TT_I^R};\theta\right)\right] \iff$$

$$\frac{1-e^{\theta\left(cd_I+tt_j^x+\overline{ck_j^x}\right)}}{\theta} > \frac{1-e^{\theta tt_j^y}}{\theta} + \lambda_j\left[\frac{e^{\theta tt_j^y} - e^{\theta\left(tt_j^y+\overline{ck_j^y}\right)}}{\theta}\right] \iff$$

$$\frac{1-e^{\theta\left(tt_j^x-tt_j^y+cd_I+\overline{ck_j^x}\right)}}{1-e^{\theta\overline{ck_j^y}}} > \lambda_j,$$

with:

$$\lambda_j^\star = \frac{1-e^{\theta\left(tt_j^x-tt_j^y+cd_I+\overline{ck_j^x}\right)}}{1-e^{\theta\overline{ck_j^y}}}.$$

This means that risk-averse agents will choose to travel on the safe route if there are high-enough probabilities of occurrence of one flying checkpoint on the risky route, thus for values $\lambda_j^\star < \lambda_j$.

This simple example illustrates the link between the probability of having one flying checkpoint on roads and the risk attitude of agents. However, more complex scenarios may be accounted for, based for example on the real distribution of flying checkpoints, when prior information is taken into account, in order to assess the route choice determinants and the time loss de to conflict. In this attempt, in the following section we describe the data used to explain the good and bad times, to estimate an order of magnitude for the "damage" in terms of travel time, generated by the military conflict.

5 Data

Based on several data-sources, we collect information concerning the monthly evolution of socio-political and economic indicators in Israel and West Bank and Gaza during the past ten years (January 2000 to December 2010) for a total of 120 observations. On one side, the political indicators describe the events on the Israeli-Palestinian political scene, such as: the evolution in the number of military flying checkpoints across the West Bank, the number of declared curfew hours, the number of injuries and deaths during open conflicts, the number of Israeli settlers in the West Bank [10], the number of Palestinian ruined residences and the effective homeless people, the media coverage intended as the number of articles published on the Israeli-Palestinian conflict issue. The number of articles published in "The New York Times" journal was chosen as a proxy to the media coverage concerning the Israeli-Palestinian issue. On the other side, economic indicators describe: the evolution of trade between the two parties and their share of trade with other countries from their own total trade (such as the trade with United States), the evolution of Gross Domestic Product (GDP) and the Consumer Price Index (CPI), the Foreign Direct Investments (FDI), the value of food production and the level of crops for both entities.

Summary statistics of the entire data-set, conditional on the political scenario classified according to the variable PA, as from *section 1*, are presented in *tables 3, 4, 5*, and *6*. Remark that, in bad times, the number of flying checkpoints in the West Bank increases from 313 to 584 on average per month. In particular, at north and south of West Bank, it more than doubles (from 126 to 264) or almost doubles in a month (from 134 to 219). In the central governorates the number of flying checkpoints remains roughly the same, on average 76 per month. We compute the number of checkpoints for the three itineraries, Jenin-Ramallah, Jenin-Haifa and Ramallah-Ashdod, from the total number of flying checkpoints corresponding to the governorates crossed by each itinerary and scaled by a factor of route network density equal to 30 for JR and JH itineraries and equal to 60 for the itinerary RA. Remark that there is a substantial increase of checkpoints for the two first itineraries in bad times compared to good times, and a lower increase in bad times on the last itinerary. From *table 4* it emerges that the number of Palestinian victims of war increases sharply, with the average number of fatalities per month increasing from 44 to 54 and the average number of injuries multiply by a factor of 2.48 in bad times compared to good times. In bad times, international journals, such as the New York Times Journal, write on average 68% more articles on the Israeli-Palestinian issue, compared to good times.

In terms of economic indicators, bad times impact dramatically on the output and the trade power of both economies: the Palestinian yearly GDP decreases by 18% and the Israeli GDP decreases by 6% in bad time compared to good time (see *table 5*). The trade between West Bank and Israel is blocked, with Israel importing 53% less from the West Bank, while switching towards other alternative partners, such as the United States (the West Bank exports towards US, even if marginal, increased by 68%). Computing the number of trucks that move the trade flows between Israel and West Bank, with an average value of 12,000 USD per truck, we observe that the number of incoming trucks in the West Bank decreases by 8% only, whereas the number of outgoing trucks decreases by almost 57% in bad times. From a simple regression to explain the number of outgoing trucks from the West Bank (see *table 6*), we observe that it is strongly and positively correlated with variables such as: the own consumer price index; the GDP of the trading partner- Israel and negatively correlated with Israel's total exports; the value of crops collected and food produced by Palestinians; negatively correlated with the journal publications concerning the Israeli-Palestinian issue, and the number of flying checkpoints located at north of the West Bank. Remark that the number of flying checkpoints located in the center of the region, since it remains roughly the same between good and bad times (see *table 3*), it has a less significant effect on trade which, instead, is positively correlated to the number of flying checkpoints at South. This positive correlation may be due to the fact that the density of Israeli settlements is higher in the central and southern regions of West Bank, and trade flows, from our data, are not separated by the receiver's nationalities; trade data is only available for two different directions, West Bank and Israel respectively.

In the following section we present the numerical experiment designed with the purpose to estimate time loss and monetary costs in bad time, compared to good time, at the truck level and totals at the West Bank level.

6 Simulation Results

We designed a numerical experiment for each of the three itineraries, in order to estimate route choice, time loss and monetary costs increase due to the conflict between Israeli and Palestinians. The ingredients of the numerical model are the parameters and variables that appear in the model presented in *sections 3* and *4*: average number and percentile distribution of flying checkpoints, the number of fixed checkpoints, travel time, coordination duration, queuing and checking time at checkpoints, assuming particular values in good time and bad time, for each of the three itineraries. The parameters used in the numerical experiment are obtained from the political turmoil data-set - the number and distribution of checkpoints in good and bad time - and from on-field interviews. Parameter values for the three itineraries are enclosed in *table 7.* During the "good" months of April and June 2009, we conducted interviews with the truck-drivers and managers of five representative shipment companies that deliver goods throughout the West Bank and in Israel, of two Israeli customs agencies and freight forwarders, and with several international representatives located in Israel and the West Bank. The interview came after a preliminary test phase in which specific terms were identified and defined, finalized with the indication of traffic conditions on the most frequently chosen routes when traveling from O to D in good and bad times, for each route, safe and risky, composing the three itineraries, Jenin-Ramallah, Jenin-Haifa and Ramallah-Ashdod (see *figure 4* for a schematic representation of the routes and itineraries). Then, the interview consisted of 20 questions about 5 recent shipments of goods directed to other regions in the West Bank or directed to Israel, using the three itineraries. The information collected concerned the type of goods transported, load characteristics such as weight and volume, chosen route, monetary costs of transport, as well as the number of fixed checkpoints, the travel time of their trip, coordination duration, queuing and checking time and indications about how these values change in bad time, in percentage. The average values of these variables for risky and safe routes in good time were used in the numerical experiment (see *table 8*). The values of these variables in bad time were calibrated according to percent-changes of actual values, as they were indicated by the respondents conditional on their prior experience, in which "bad" times were associated to the months around the Second Intifada.

For instance, in optimal conditions, without the presence of checkpoints, it would take 1 hour and 40 minutes to travel from Jenin to Ramallah on the safe route covering a distance of 89 kilometers, and 2 hours on the risky route which is of a lower quality and longer - 105 kilometers. In reality, on the safe route, there are always 2 fixed checkpoints with an average waiting time at queues of 30 minutes per truck at each checkpoint and checking duration of 10 minutes per truck at each checkpoint. These delays "inflate" the total travel duration of a trip. These waiting times double during bad time and contribute to an additional increase of the total travel time. On the risky route, passing through off-roads, there may be on average 1 flying checkpoint in good times and 3 flying checkpoints in bad times, characterized by the same waiting times as the fixed checkpoints on the safe route. Since there are no fixed checkpoints on off-roads, no coordination procedure is required on the risky routes. The monetary cost of moving an average truck transporting goods in value of 12,000 USD on this itinerary is 420 USD and the value of time, identical to all itineraries and routes, is of 6 USD per hour.

We compute total travel times on each itinerary for each route, according to equations (2) and (3), considering the ten-percentile distribution of flying checkpoints calibrated from the political turmoil data-set (see *table 9*), in order to simulate the choice of route by different types of truck drivers. These results are represented graphically in *figures 5* to *13.* For instance, on the Jenin-Ramallah itinerary, the trucks will choose with probability 75% the risky route in good time (having 1.09 flying checkpoints on average), since the travel time on this route in good time is much lower than the time spent on the safe route, with 2 fixed checkpoints. Nevertheless, they will only prefer with probability 24% the same route in bad time, switching to the safe route when the average number of flying checkpoints is 2.63 (see *figure 5*). Moreover, risk-neutral agents will prefer the risky route whenever the probability of bad time is higher or equal than 0.6 (see *figure 6*). The risk-averse agents with CARA preferences ($0 < \theta \leq 1$), will always get higher expected utility from traveling on the safe route compared to the risky alternative on this itinerary (see *figure 7*).

Interesting results are also obtained for the other two itineraries. In particular, the trucks traveling between Jenin and Haifa will always choose the much shorter risky route at north, indicating this route as the most natural alternative linking the two cities (53 kilometers compared to 198 kilometers of the safe route getting around the West Bank through Ramallah). It is preferred either in good time and bad time (see *figures 8* and *9*) since the shorter travel times (1 hour and 45 minutes compared to almost 6 hours on the safe route in good time) and the low presence of flying checkpoints at north of the West Bank render it convenient. Risk-averse agents traveling on this itinerary will get similar expected utilities from traveling on the safe route and the risky one (see *figure 10*). The route choice on the itinerary Ramallah-Ashdod are more similar to the results obtained on the itinerary Jenin-Ramallah (see *figures 11* to *13*) rather than the results obtained for users traveling between Jenin and Haifa.

Furthermore, at the truck level, on each itinerary and route, we compute the losses due to bad times, in terms of delays - time loss - and convert them into monetary costs, as indicated in equations (4) and (5). The results are presented in the *table 10*. On the safe routes, it is estimated that the travel time increases in bad time compared to good time by 41% between Jenin and Ramallah, by 22% between Jenin and Haifa, and by 45% between Ramallah and Ashdod. The risky routes account for much more deterioration in terms of travel time during situations of political turmoil, with similar time losses of 91%, 37% and 86% respectively. Monetary cost per truck is estimated to increase more on the risky routes rather than on the safe ones, in bad times compared to good time by 14 USD/truck between Jenin and Ramallah, by 5 USD/truck between Jenin and Haifa, and by 53 USD/truck between Ramallah and Ashdod. Remark that these differences are computed on the “good” time basis, which also corresponds to a situation of “military occupation” of the West Bank, even if less turbulent.

Finally, by averaging these costs to obtain one unit monetary value for safe routes and another value for risky routes, then multiplying the obtained values by the monthly number of incoming and outgoing trucks from the West Bank, and adding them to the value of “lost trade” due to bad times, when the movement of trucks is restricted, we obtain the total costs incurred by the conflict (see *table 11*). The estimated total costs due to the existing conflict, for all the generated traffic in the West Bank, amounts to 8.64 million USD per month, or to 103.78 million USD per year. Given that the transportation services amount for 11% of the West Bank total GDP in 2008, the total costs due to conflict for the entire economy are estimated as 28.90% of the total GDP. Remark that the estimated value represents the difference of costs between bad and good times, where “good” time is itself a situation of “military occupation”, but with less severe rules concerning the transports. Therefore, the estimated costs must be considered as a “low bound” for the actual costs generated by the political turmoil. In fact, it may be the case that the actual costs incurred by the occupation are much higher than the estimated value above.

7 Conclusions

This paper reported estimates on the order of magnitude of time and economic loss generated by restrictions imposed on the movement of goods within and beyond Palestinian boundaries, restrictions caused by the politically unstable scenario. A disaggregated itinerary choice analysis undertaken for three of the most used itineraries connecting major locations in the West Bank and Israel: Jenin-Ramallah, Jenin-Haifa and Ramallah-Ashdod, and for two political scenarios, “good” time and “bad” on two alternative routes, "risky" and "safe" showed that risk-neutral agents prefer the “risky” alternative: i) whenever the probability of “good” time is lower than 0.4, for trips between Jenin and Ramallah and between Ramallah and Ashdod, ii) it is always preferred by agents traveling between Jenin and Haifa. Using a numerical experiment calibrated on data collected through on-field interviews, we estimate that the politically unstable situation generates on average 36% additional travel time loss on the “safe” routes and 71% additional time loss on the “risky” routes in “bad” times compared to “good” times. Finally, the estimated total cost difference in “bad” times compared to “good” times, for all the West Bank road traffic amounts to more than 103 million USD per year. Thus, the equivalent cost for the entire economy is estimated to 28.90% of the West Bank GDP in 2008.

Future research concerns theoretical and empirical developments on this subject, with the aim to provide estimates of the peace dividends gained by both parties, under a “counter-aggressive” and “pro-development” policy-making in the Near Middle East.

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Tables:

Table 2: Latent Cluster Analysis: Results

Axes	Description	Axes
pa_3	Categories$^{a)}$: 1=agreements, 2=political events	√
	3=suicide bombs, occupation or inciting behavior	
pa**(1 to 6)**	Six dummies$^{a)}$ with values 0-1for the following events: agreement consensus,	
	no agreement consensus, election times, death of politician,	
	inciting behavior, suicide bombs and occupation	
pa_6	Categories$^{a)}$: 1=agreement consensus 2=no agreement consensus	
	3=election times 4=death of politician, 5=inciting behavior	
	6=suicide bombs and occupation	
prelig	Dummy for Palestinian religious feasts$^{a)}$	√
irelig	Dummy for Israeli religious feasts$^{a)}$	√
flywb	Total no.of flying checkpoints in the West Bank$^{b)}$	√
fly (0 to 10)	No.of flying checkpoints for eleven governorates in the West Bank$^{b)}$	√
Results:	Number of groups using latent groups method	2
	Dissimilarity between groups (dendrogram of latent gr.method)	$5 \cdot 10^6$
	No.of Calinski-Harabasz Clusters (corresponding to max.F-test)	2
	Value of Calinski-Harabasz F-test	151.35
PA:	resulting cluster variable with values **0=good time**, **1=bad time**.	

$^{a)}$ *Data sources: [22] and [18];* $^{b)}$ *Data source: [25].*

Table 3: Military Flying Checkpoints[a)]: Summary Statistics for *Good* and *Bad* Time

Var.	Monthly data 01/2000-12/2009, No.Obs: 120. Definition of variables	Mean *Good time* *(PA=0)*	*Bad time* *(PA=1)*	Mean *Full data*
flyWB	No.of flying checkpoints in WestBank	313.24	584.82	453.55
		(60.69)	*(126.26)*	*(168.84)*
flyN	No.of flying checkpoints North of WestBank	126.13	264.51	197.63
		(47.47)	*(80.49)*	*(96.03)*
flyC	No.of flying checkpoints Center of WestBank	75.05	77.33	76.23
		(38.73)	*(30.09)*	*(34.41)*
flyS	No.of flying checkpoints South of WestBank	134.77	219.03	178.30
		(49.40)	*(76.76)*	*(77.31)*
fly0	No.of flying checkpoints,Jerusalem governorate	9.86	26.61	18.51
		(9.21)	*(21.91)*	*(18.90)*
fly1	No.of flying checkpoints,Nablus governorate	30.48	46.72	38.87
		(30.44)	*(28.07)*	*(30.23)*
fly2	No.of flying checkpoints,Jenin governorate	19.50	78.69	50.08
		(18.57)	*(41.00)*	*(43.69)*
fly3	No.of flying checkpoints,Tubas governorate	13.93	18.66	16.37
		(6.66)	*(12.06)*	*(10.07)*
fly4	No.of flying checkpoints,Qalqilya governorate	62.22	120.43	92.30
		(20.46)	*(41.41)*	*(43.96)*
fly5	No.of flying checkpoints,Salfit governorate	19.55	27.11	23.45
		(10.94)	*(13.78)*	*(13.00)*
fly6	No.of flying checkpoints,Ramallah governorate	13.41	15.54	14.51
		(15.38)	*(17.99)*	*(16.74)*
fly7	No.of flying checkpoints,Hebron governorate	83.51	106.38	95.33
		(39.79)	*(34.19)*	*(38.59)*
fly8	No.of flying checkpoints,Jericho governorate	3.00	4.06	3.55
		(4.15)	*(7.28)*	*(5.98)*
fly9	No.of flying checkpoints,Bethlehem governorate	41.39	86.03	64.45
		(13.17)	*(36.73)*	*(35.72)*
fly10	No.of flying checkpoints,Tulkarm governorate	42.08	34.67	38.25
		(30.90)	*(15.71)*	*(24.45)*
flyJR	No.of flying checkpoints on Jenin-Ramallah route,	1.09	3.14	2.15
	calibrated as (**fly2**+**fly6**)/30	*(0.67)*	*(1.38)*	*(1.49)*
flyJH	No.of flying checkpoints on Jenin-Haifa route,	1.20	1.35	1.28
	calibrated as (**fly0**+**fly10**)/60	*(0.97)*	*(0.54)*	*(0.78)*
flyRA	No.of flying checkpoints Ramallah-Ashdod route,	2.08	3.20	2.66
	calibrated as (**fly7**+**fly9**)/60	*(0.80)*	*(1.15)*	*(1.14)*

[a)] *Data source: [25].*

Standard Deviation is in parentheses.

Table 4: Casualties[c)]: Summary Statistics for *Good* and *Bad* Time

Var.	Monthly Data 01/2000-12/2009, No.Obs: 120. Definition of variables	Mean *Good time* *(PA=0)*	*Bad time* *(PA=1)*	Mean *Full dataset*
curfew	No.of declared curfew hours in WestBank	138.65	89.91	113.47
		(108.73)	*(112.55)*	*(112.93)*
pfatw	No.of Palestinian deaths in open conflict in WestBank	44.67	54.27	49.63
		(29.68)	*(51.92)*	*(42.74)*
ifatw	No.of Israeli deaths in open conflict in WestBank	1.87	2.70	2.30
		(2.52)	*(3.39)*	*(3.02)*
injurp	No.of Palestinian injuries in WestBankGaza	170.12	422.75	298.57
		(125.19)	*(896.68)*	*(652.38)*
settli	No.of Israeli settlers in WestBank, thousands	130.12	153.62	142.26
		(78.12)	*(153.77)*	*(123.22)*
pruin	No.of house demolitions in WestBank	10.17	17.64	14.04
		(12.26)	*(15.07)*	*(14.23)*
homeless	No.of Palestinian homeless in WestBankGaza	51.60	91.91	72.43
		(48.90)	*(127.25)*	*(99.27)*
media	No.of articles published inTheNewYorkTimesJournal	13.32	19.58	16.55
	concerning Israeli-Palestinian conflict	*(6.50)*	*(11.89)*	*(10.06)*

[c)] *Data sources: [4], [23], [2], [10] and [19].*
Standard Deviation is in parentheses.

Table 5: Economic Indicators[d)]: Summary Statistics for *Good* and *Bad* Time

Var.	Monthly Data 01/2000-12/2009, No.Obs: 120. Definition of variables	Mean Good time (PA=0)	Bad time (PA=1)	Mean Full Dataset
igdp	Israel's Gross Domestic Product, bil.USD/year	152.28	142.34	147.14
		(38.02)	*(30.17)*	*(34.41)*
pgdp	WestBankGaza Gross Domestic Prod.,bil.USD/year	4.15	4.09	4.12
		(0.33)	*(0.53)*	*(0.44)*
isrcpi	Israel Consumer Price Index, base=2002	102.40	103.62	103.03
		(2.41)	*(2.94)*	*(2.78)*
palcpi	WestBankGaza Consumer Price Index, base=2002	145.70	142.12	143.85
		(14.44)	*(14.00)*	*(14.27)*
wbcpi	WestBank Consumer Price Index, base=2002	146.71	142.92	144.75
		(15.03)	*(13.66)*	*(14.40)*
wbcpitr	WestBank Transport Price Index, base=2002	194.42	190.56	192.42
		(31.36)	*(32.17)*	*(31.71)*
palunemp	WestBank unemployment rate/year	25.29	23.54	24.39
		(4.99)	*(4.29)*	*(4.70)*
palexp	WestBankGaza total exports, bil.USD/year	0.73	0.72	0.72
		(0.13)	*(0.17)*	*(0.15)*
palexpUS	WestBankGaza exports to United States,bil.USD	0.19	0.32	0.26
		(0.61)	*(0.81)*	*(0.72)*
palimptot	WestBankGaza total imports,bil.USD/year	2.79	2.36	2.57
		(0.97)	*(0.58)*	*(0.82)*
palimpUS	WestBankGaza imports United States,bil.USD	0.11	0.16	0.14
		(0.19)	*(0.20)*	*(0.20)*
palinvest	WestBankGaza Foreign Investments,bil.USD/year	0.09	0.21	0.15
		(0.15)	*(0.14)*	*(0.16)*
isrexptot	Israel total exports, bil.USD/year	3054.10	2873.04	2961.28
		(845.15)	*(710.86)*	*(781.17)*
isrexpUS	Israel exports to United States, bil.USD	829.48	771.66	799.61
		(254.67)	*(199.36)*	*(228.65)*
isrexpWB	Israel exports to WestBank, bil.USD	3.38	3.00	3.19
		(4.51)	*(4.13)*	*(4.30)*
isrimptot	Israel total imports, bil.USD/year	3092.63	2858.04	2972.38
		(946.80)	*(707.91)*	*(837.67)*
isrimpUS	Israel imports from United States, bil.USD	1357.44	1351.61	1354.42
		(361.12)	*(324.40)*	*(341.20)*
isrimpWB	Israel imports fromWestBank, bil.USD	1.67	0.72	1.18
		(4.70)	*(0.45)*	*(3.31)*
isrinvest	Israel Foreign Investments, bil.USD/year	4.62	5.39	5.02
		(3.20)	*(5.21)*	*(4.35)*
arabpopIS	Arab population living in Israel, thousands	1388.30	1366.94	1377.40
		(81.43)	*(90.34)*	*(86.31)*
palfood	WestBankGaza food production, USD/year	457219	469216	464218
		(26035.87)	*(27603.74)*	*(27473.09)*
palcrops	WestBankGaza crops, USD/year	271601	279456	279483
		(18080.39)	*(19807.68)*	*(19403.69)*
isrcrop	Israel crops, USD/year	914620	917937	916555
		(61868.07)	*(47916.33)*	*(53882.33)*
truckin	No.of trucks entering the West Bank	5579	5118	5341
	(calibrated as **isrexpWB**/12 000 USD)	*(7944.65)*	*(7037.01)*	*(7461.24)*
truckout	No.of trucks out from the WestBank	2888	1246	2039
	(calibrated as **isrimpWB**/12 000 USD)	*(8172.55)*	*(862.35)*	*(5749.14)*

[d)] *Data sources:[12],[17][20], and [4].*
Standard Deviation is in parentheses.

Table 6: Linear regression results to explain the number of outgoing trucks from the West Bank (Jan.2000 - Dec 2009, No.Obs. 120)

Number of outgoing trucks from the West Bank			
R2=0.43	**Coefficient**		*(Std.Dev.)*
Monthly no.of flying checkpoints, North of West Bank	-2.40	**	*(1.20)*
Monthly no.of flying checkpoints, Center of West Bank	3.74	*	*(2.23)*
Monthly no.of flying checkpoints, South of West Bank	2.94	**	*(2.12)*
Monthly Consumer Price Index in West Bank, base=2002	30.30	***	*(12.03)*
Monthly no.of articles published in"New York Times" on Israeli-Palestinian issue	-17.63	***	*(6.77)*
Israel Gross Domestic Product, bil.USD/year	64.22	***	*(18.40)*
Palestinian Crops, USD/year	-0.08	***	*(0.02)*
Palestinian food production, USD/year	0.05	***	*(0.01)*
Israel total exports, bil.USD/year	-82.04	***	*(28.57)*
Monthly no.of Palestinian deaths in open conflict	3.25	**	(1.66)
Constant	-11095	***	*(2248)*

*Significant at:***1% **5%; *10%.*

Table 7: Calibration of Numerical Experiment: Parameters$^{e)}$

Param.	**Definition**	Good Time	Bad Time
		Jenin >	**>Ramallah**
n_y	average no.of flying checkpoints$^{f)}$ (risky route)	1.09	3.14
n_x	no.of fixed checkpoints (safe route)	2	2
vot	value of time$^{g)}$ in USD/hour (identical for all routes,all itineraries)	6	6
τ_z	average monetary cost USD/truck (itinerary-specific)	420	420
		Jenin >	**>Haifa**
n_y	average no.of flying checkpoints$^{f)}$ (risky route)	1.20	1.35
n_x	no.of fixed checkpoints (safe route)	2	2
vot	value of time$^{g)}$ in USD/hour (identical for all routes,all itineraries)	6	6
τ_z	average monetary cost USD/truck (itinerary-specific)	260	260
		Ramallah >	**>Ashdod**
n_y	average no.of flying checkpoints$^{f)}$ (risky route)	2.08	3.20
n_x	no.of fixed checkpoints (safe route)	2	2
vot	value of time$^{g)}$ in USD/hour (identical for all routes,all itineraries)	6	6
τ_z	average monetary cost USD/truck (itinerary-specific)	120	120

$^{e)}$ *Values indicated by Palestinian truck drivers during on-field interviews taken in April and June 2009;* $^{f)}$ *Value from table 3.*
$^{g)}$ *Reference value for Middle East countries, see [5].*

Table 8: Calibration of Numerical Experiment: Variables$^{e)}$

Var.	**Definition (in minutes)**	Good Time	Bad Time	Good Time	Bad Time
			Jenin >	**>Ramallah**	
		Safe	*(89km)*	*Risky*	*(105km)*
tt_1	pure travel time,without inspection time	100	100	120	120
q_1	queue time before checkpoints	30	60	30	60
ci_1	coordination time	15	15	0	0
ck_1	average check time per checkpoint	10	20	10	20
			Jenin >	**>Haifa**	
		Safe	*(198km)*	*Risky*	*(53km)*
tt_2	pure travel time, without inspection time	240	240	120	120
q_2	queue time before checkpoints	30	60	30	60
ci_2	coordination time	30	30	0	0
ck_2	average check time per checkpoint	10	20	10	20
			Ramallah >	**>Ashdod**	
		Safe	*(95km)*	*Risky*	*(110km)*
tt_3	pure travel time,without inspection time	120	120	160	160
q_3	queue time before checkpoints	30	60	30	60
ci_3	coordination time	50	50	0	0
ck_3	average check time per checkpoint	40	80	40	80

$^{e)}$ *Values indicated by Palestinian truck drivers at on-field interviews (April-June 2009).*

Table 9: Percentiles of Flying Checkpoints in Good vs. Bad Times$^{h)}$

	Number of flying	checkpoints	by route:			
	Jenin	**- Ramallah**	**Jenin**	**- Haifa**	**Ramallah**	**-Ashdod**
Perc.	*Good*	*Bad*	*Good*	*Bad*	*Good*	*Bad*
1%	0.20	0.26	0.38	0.25	1.00	0.96
5%	0.26	0.33	0.43	0.51	1.05	1.33
10%	0.46	0.96	0.53	0.73	1.26	1.58
25%	0.60	2.63	0.63	0.93	1.56	2.31
50%	0.83	3.16	0.86	1.26	1.90	3.26
75%	1.73	3.76	1.13	1.76	2.38	4.36
90%	2.23	4.60	2.18	2.10	3.53	4.85
95%	2.36	4.96	4.00	2.13	3.60	5.10
99%	2.50	7.03	4.03	2.16	4.51	5.16

$^{e)}$*See variables from table 3.*

Table 10: Per Truck: Time Loss and Economic Cost, in *Good* and *Bad* Times

#	**Definition**	**Time**	**Jenin >**	**Ramallah**	**Jenin>**	**Haifa**	**Ramallah>**	**Ashdod**
			Safe	*Risky*	*Safe*	*Risky*	*Safe*	*Risky*
1'	Distance, in kilometers		89	105	198	53	95	110
1	Avg.Travel Time (TT) in good time, minutes$^{h)}$	*Good*	195	156.06	350	135.09	310	286.08
2	*Idem.*	*Bad*	275	299.43	430	186.17	450	533
3	Time difference in minutes: (2)-(1)		80	143.37	80	51.08	140	246.92
4	Time increase in percentage: (3)/(1)		+41%	+91%	+22%	+37%	+45%	+86%
5	Value of time (VOT), USD/hour$^{i)}$		6	6	6	6	6	6
6	Avg.monetary cost in good/bad time, USD/truck$^{j)}$		540	532	950	220	450	160
7	Total cost (TT*vot), USD/truck: (5)+(4)*(1)	*Good*	559.50	547.61	985	233.51	481	188.61
8	*Idem.*	*Bad*	567.50	561.94	993	238.62	495	213.30
9	Total cost difference, USD/truck: (7)-(6)		+8	+14.34	+8	+5.11	+14	+24.69
10	Cost difference, USD/truck/kilometer: [(7)-(6)]/(1')		+0.09	+0.14	+0.04	+0.10	+0.15	+0.22

$^{h)}$*Simulation results.*

$^{i)}$*Ref. value for Middle East countries, see [5].*

$^{j)}$*Values indicated by Palestinian truck drivers at on-field interviews (April-June 2009).*

Table 11: Monthly Totals for West Bank: Time Loss and Economic Cost, in *Good* and *Bad* Times

#	Description	Time	Value
1	Average number of trucks per month, incoming+outgoing$^{m)}$	*Good*	8,467
1'	*Idem.*	*Bad*	6,364
3	Number of trucks choosing *Safe* routes$^{n)}$	*Good*	6,773.60
3'	*Idem.*	*Bad*	5,091.20
4	Number of trucks choosing *Risky* routes$^{o)}$	*Good*	1693.4
4'	*Idem.*	*Bad*	1,272.80
5	Average monetary cost per truck on *Safe* route, USD/truck/km$^{p)}$	*Good*	5.44
5'	*Idem.*	*Bad*	5.53
6	Average monetary cost per truck on *Risky* route, USD/truck/km$^{p)}$	*Good*	3.78
6'	*Idem.*	*Bad*	3.93
7	Kilometers by month per truck$^{q)}$		13,000
8	Trade loss on *Safe* routes due to conflict, USD/month: [(3)-(3')]*(7)*(5)		119,011,567.78
9	Trade loss on *Risky* routes due to conflict, USD/month: [(4)-(4')]*(7)*(6)		20,660,526.30
10	Total cost on the *Safe* routes, USD/month: (3)*(5)*(7)	*Good*	479,158,794.28
10'	*Idem:* (3')*(5')*(7)+(8)	*Bad*	570,989,672.27
11	Total cost on the *Risky* routes, USD/month: (4)*(6)*(7)	*Good*	83,182,442.32
11'	*Idem:* (4')*(6')*(7)+(9)	*Bad*	85,705,177.85
12	Total costs of traffic due to conflict, USD/month: (11')-(11)+(10')-(10)		8,648,435.68
12'	**Total costs of traffic due to conflict, USD/year:**		**103,781,228.12**
13	Perc.of *transportation and communication* services (TCS) in the West Bank GDP$^{s)}$		11 %
14	**Total economic costs imposed by conflict, USD/year$^{s)}$:**		**943,465,710.23**
15	**Total economic costs as percentage in West Bank GDP 2008$^{s)}$:**		**28.90 %**

$^{m)}$ Value from table 3;$^{n)}$ 80%=Value obtained from on-field interviews with Palestinian truck drivers during June 2009;$^{o)}$ 20%=Value obtained as n); $^{p)}$ Value obtained as average of 3-routes costs in table 11; $^{q)}$ Reference value; $^{s)}$ Source:[20]. West Bank GDP for 2008 at constant prices is 3,264.2 mil.USD.

Figures:

Figure 1: OCHA map (2007) with the location of fixed barriers to movement in West Bank. Green circles signal the location of the main fixed checkpoints for freight passage outside West Bank

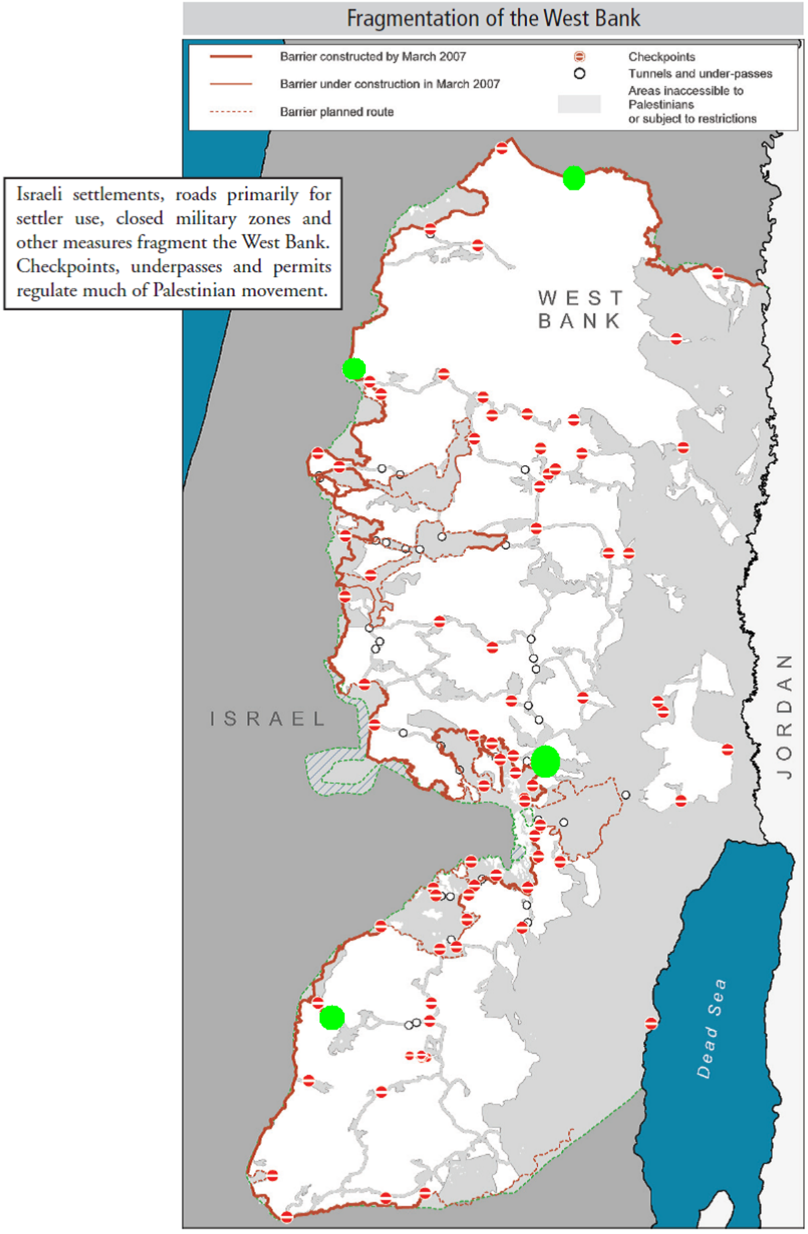
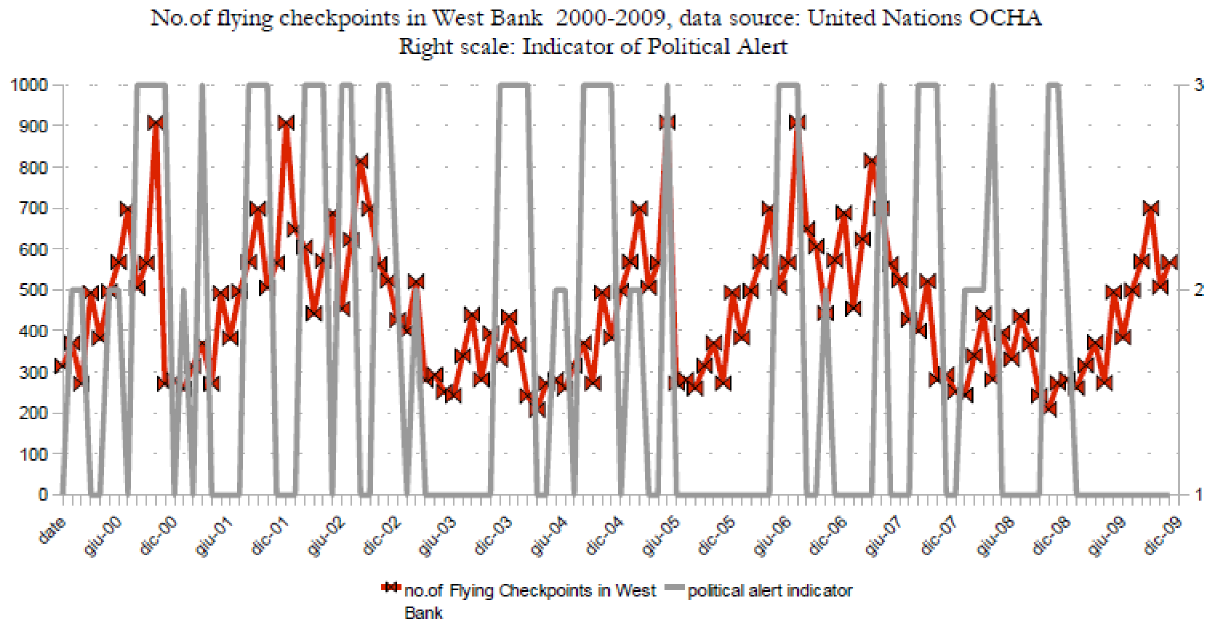


Figure 2: Relationship between the "Political Alert Index" and the number of flying checkpoints in West Bank (monthly data, 2000-2009)

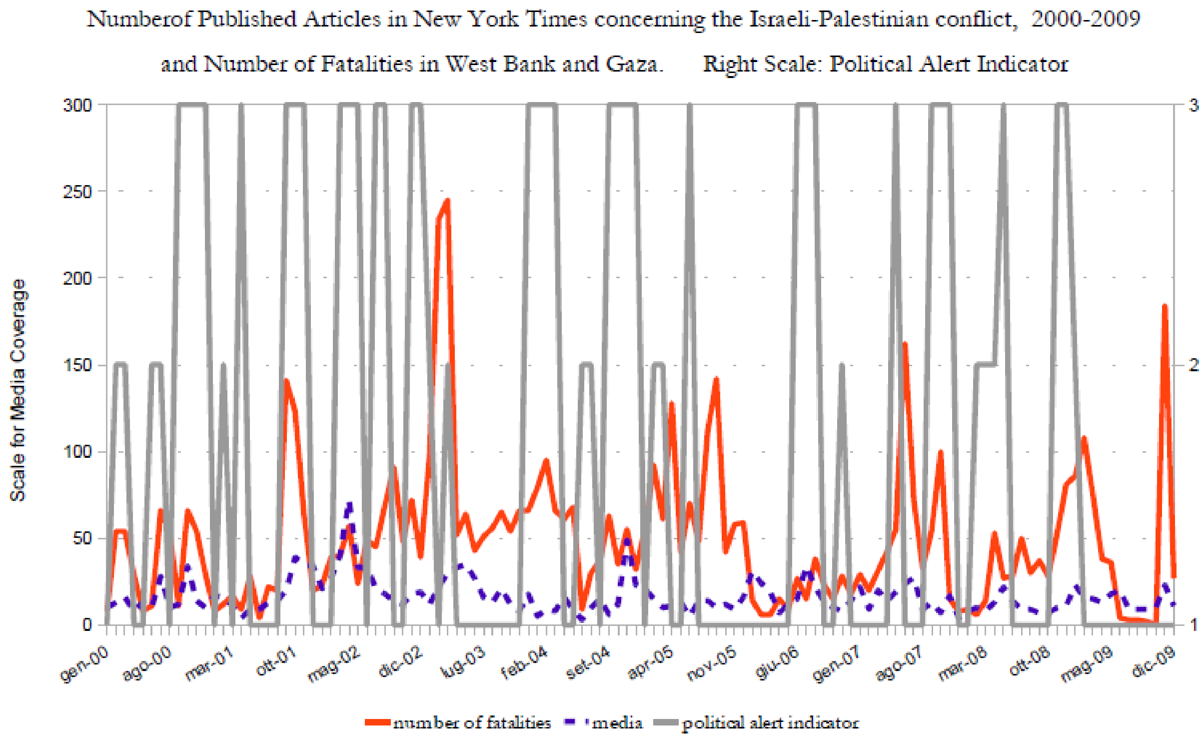


Key to the figure:

Date:	**Selected events*taking value 3 on the scale of political alert** ($pa_3 = 3$)** :
sept – 2000	Palestinians start riots after Ariel Sharon's visit to Temple Mount;
oct – 2000	Second Intifada starts;
sept – 2001	Terror attacks on U.S. World Trade Center (Al-Qaida);
mar – 2002	Israel starts "defensive shield operation"in West Bank;
apr – 2002	Jenin battle;
may – 2002	Church of Nativity in Bethlehem sieged;
nov – 2004	P.A.Presid.Yasser Arafat dies;
jun – 2005	Violence flares in Gaza;
jul – 2006	Hezbollah attacks on Israel (in Haifa);
feb – 2008	Suicide bombers and rockets from Gaza;
dec – 2008	Gaza War, operation "Cast Lead" started;

**Data source: see tab.4 "Summary Statistics"; **Definition of pa_3 is given in tab.4.*

Figure 3: Relationship between the "Political Alert Index", the number of fatalities and the number of articles published in "New York Times Journal", proxy for media coverage concerning the Israel-Palestinian issue (monthly data, 2000-2009)



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sept – 2000	Palestinians start riots after Ariel Sharon's visit to Temple Mount;
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feb – 2008	Suicide bombers and rockets from Gaza;
dec – 2008	Gaza War, operation "Cast Lead" started;

**Data source: see tab.4"Summary Statistics"*; ***Definition of* pa_3 *is given in tab.4.*

Figure 4: Three main trade corridors for cargo movement: Jenin-Ramallah (darkblue), Jenin-Haifa (magenta) and Ramallah-Ashdod (lightblue). Safe routes are represented by continuous lines; risky routes are represented by dashed lines.

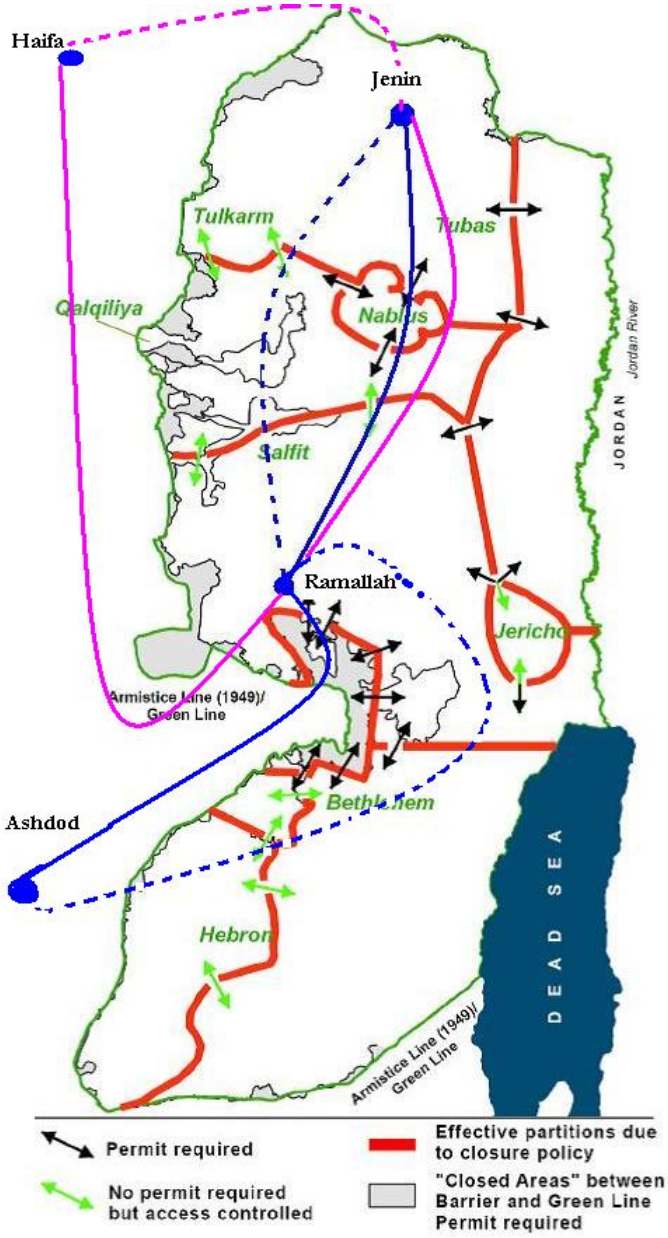

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Figure 5: Simulation Results

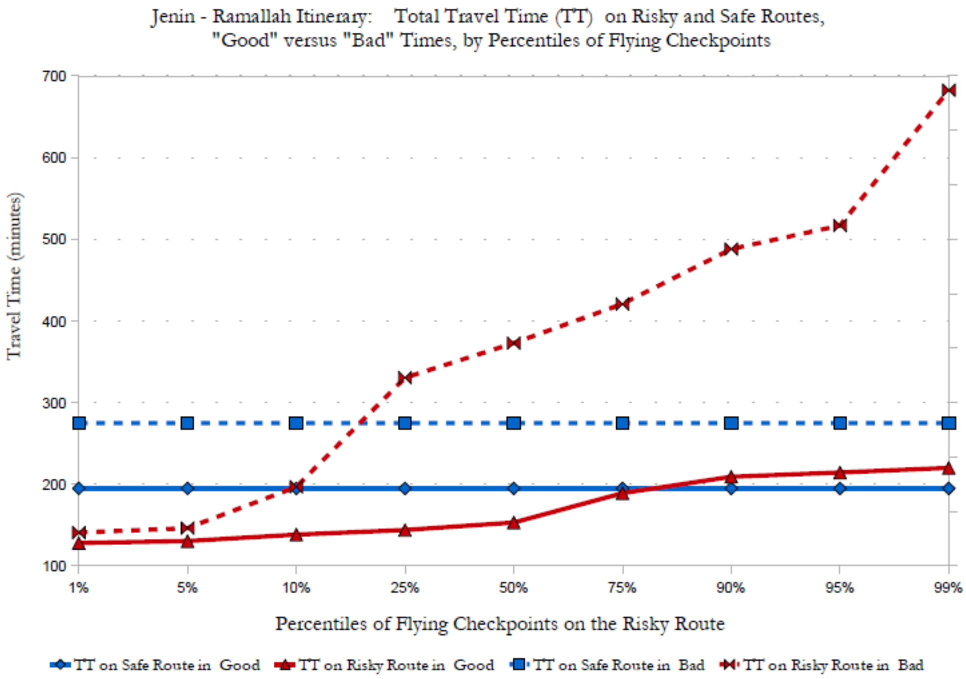

Figure 6: Simulation Results

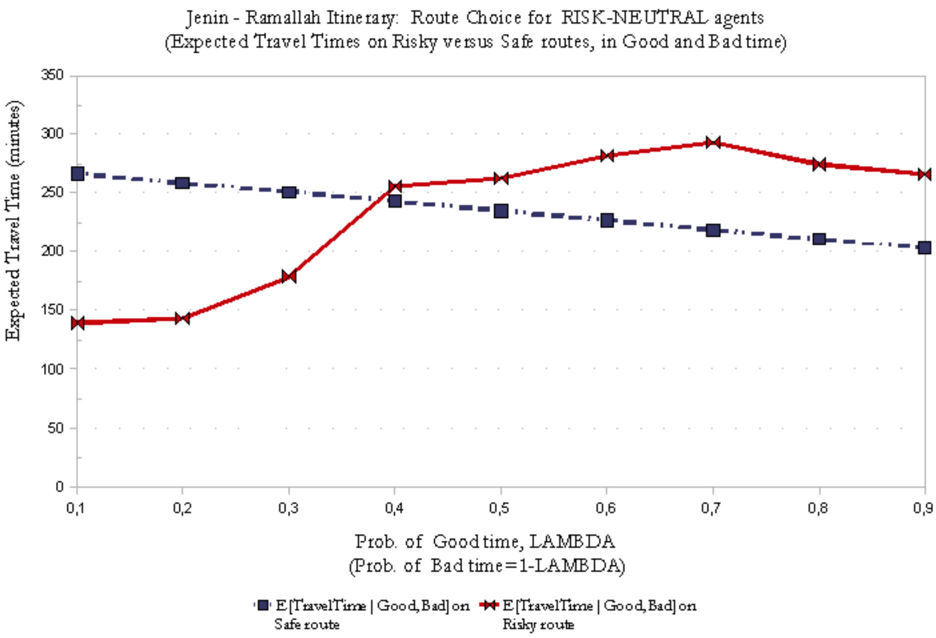

Figure 7: Simulation Results

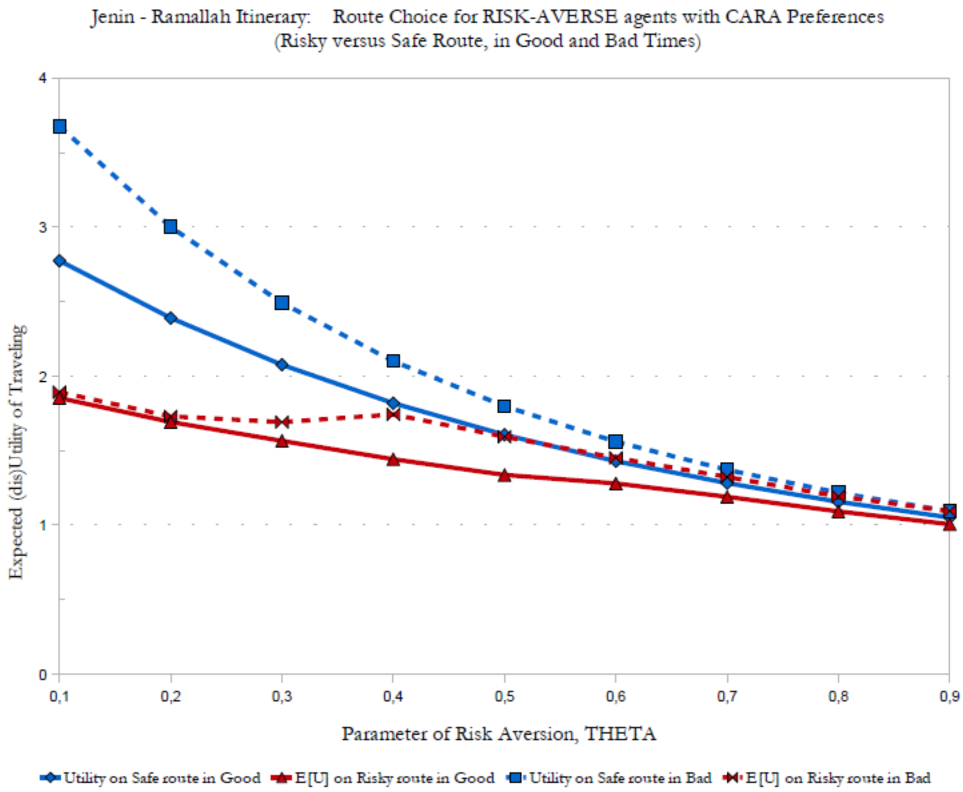

Figure 8: Simulation Results

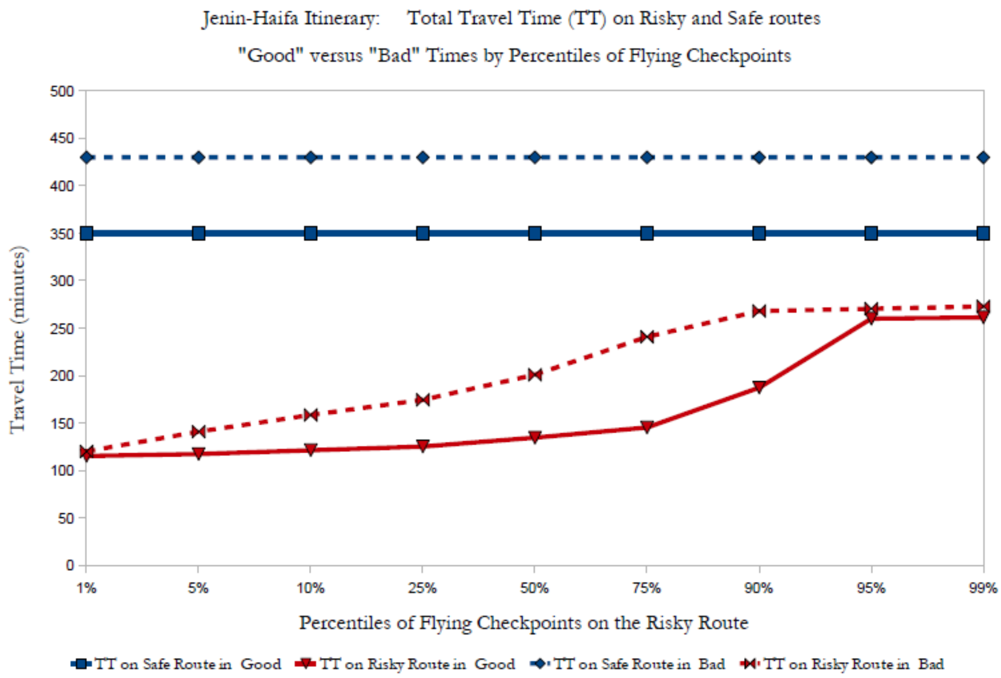

Figure 9: Simulation Results

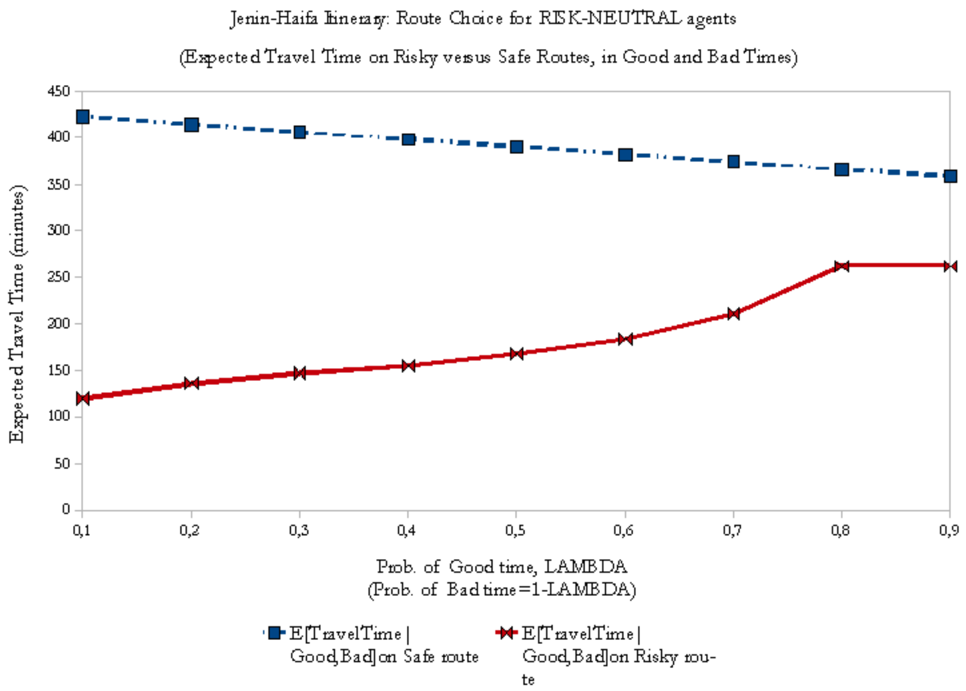

Figure 10: Simulation Results

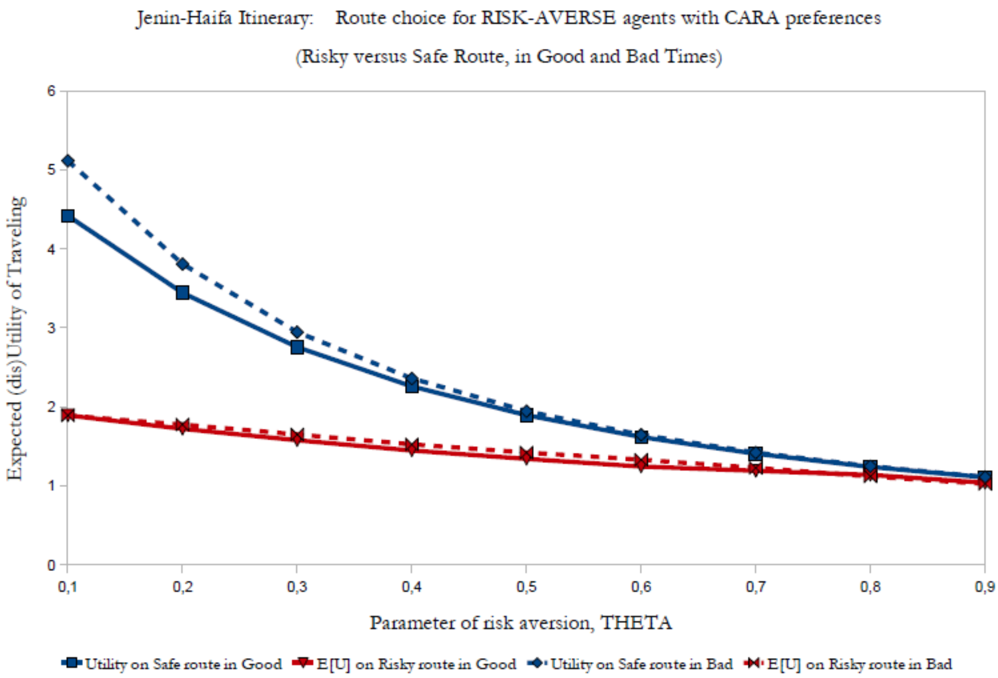

Figure 11: Simulation Results

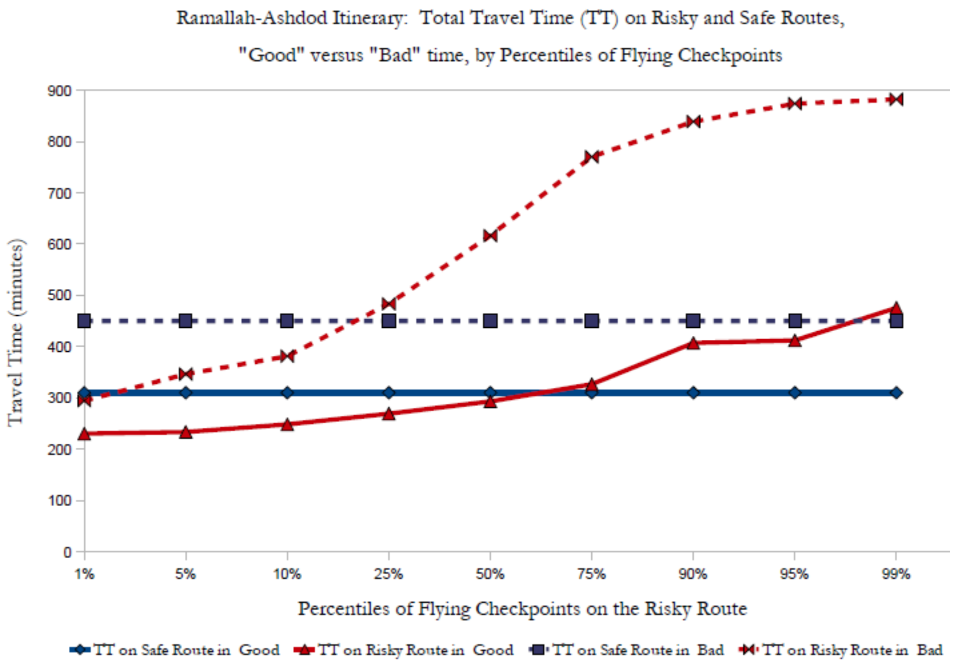

Figure 12: Simulation Results

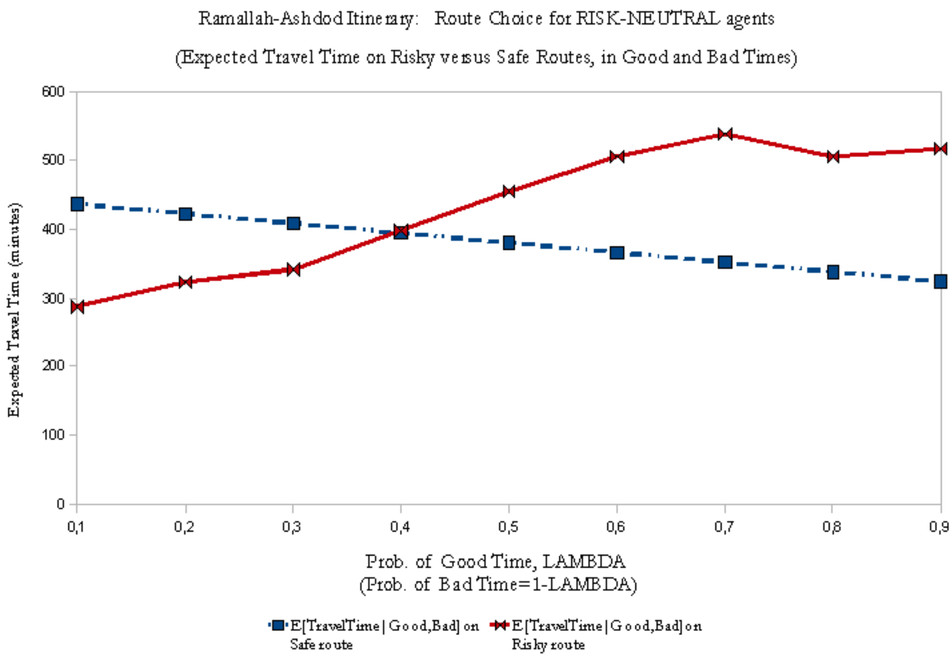

Figure 13: Simulation Results