The Economics of Terror:
The Effect of Terror in the Framework of a Rational Choice Model.

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What is this project about?

- In this project we aim at explaining, within the framework of rational choice models, why low probability events such as the likelihood to be harmed by terror affect peoples' behavior so much.
- We put forward a theory incorporating into the expected utility theory situations in which the extreme consequences associated with consumption of risky goods affect persons' mental state, generate fear, and by that affect peoples' utility and well-being.
- Using data from the US and from Israel we: (i) provide empirical evidence to support our model, (ii) identify the effect of fear, and (iii) calibrate the risk and fear aversion parameters

Motivation:

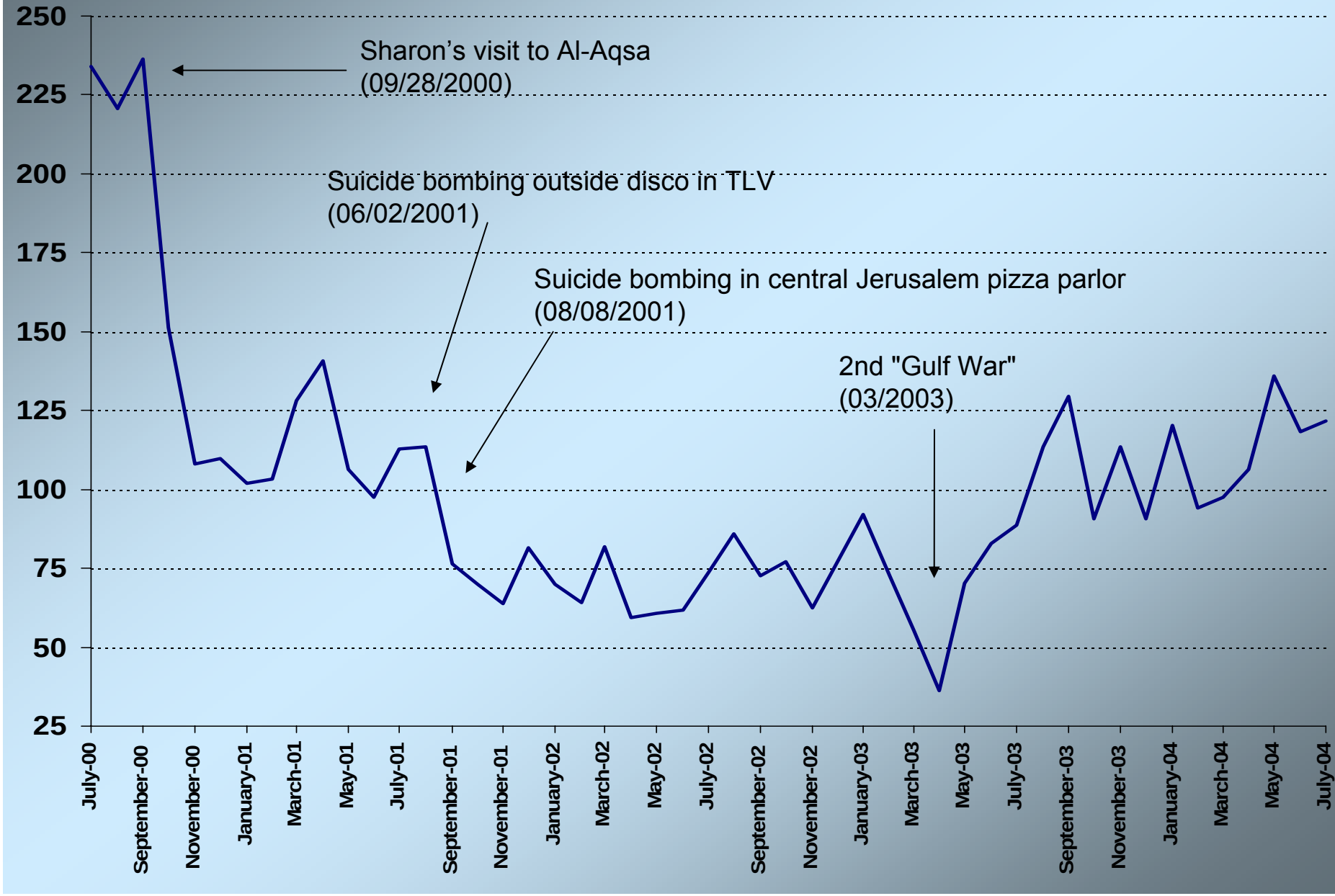
- In the aftermath of September 11, terror is no longer a phenomenon limited to particular areas of conflict.
- It is thus not surprising that understanding the causes and the consequences of terrorism, especially in its current form, is a challenge economists find hard to resist.
- Public opinion and the academic community focused mainly on: (i) understanding why young and educated people commit suicide, killing others in the name of “God”; (ii) estimating the causal effect of terror on aggregate outcomes.

Motivation – (Cont.):

However...

- Ignoring the issue of why terrorism generates such a large influence on peoples' behavior.
- The large aggregate effects were often attributed to peoples' "ignorance" of the objective probabilities using Tversky and Kahneman (1979) prospect theory
- The popular argument is that the perceived impact on the probability to die may be larger than the actual one.

Tourist Arrivals to Israel by Year and Month



The "Effect" of Terror on the Cost of a One Week Visit To Israel using the Value of a Statistical Life

∆ Cost = ∆ Prob (bad=1) * "Value of a Statistical Life"

"Budget Item"	"Values"
The number of casualties during the "worst" month (March 2002)	130
Effective population	5000000
The "probability" to be killed by terror during a one week visit	0.0007%
Value of a statistical life (upper bound on the VSL: Ashenfelter & Greenstone, 2004)	$1,540,000
The effective cost	**$10**
Flight ticket + other cost (living at your relatives)	**$1,000**
The % change in the cost of visiting Israel	***1%***

Question:

- Is it possible to explain such phenomena using a rational choice model?

Answer:

- Yes.
- Contrary to the alternative explanations, we argue that it is possible to explain large reactions by very small changes in the states of nature objective probabilities using the framework of a rational choice model.

The Argument: introduction

The state of the art...

- In the standard state-dependent utility model:

  Uncertainty agents face is with respect to the states of nature.

  However, when consumption eventually takes place, the state of nature is already known.
- We argue that this view misrepresents the "agents' problem" if consumption takes place ***prior to the resolution of uncertainty***.
- Therefore, the standard state-dependent expected utility model understates the effect of uncertainty on the expected utility.

Our argument:

Our argument is based on two corner stones:

First:

The likelihood to be harmed affects persons' utility in all states of nature.

Second:

Persons can handle their fears. They do so by accumulating mental capital.

Like other investments in human capital it is not a *"free-lunch"* and it does not pay back to everyone.

Those who are more likely to benefit from the risky activity will invest and overcome their fears while others will substitute other consumption or production plans.

The Overall Effect of Risk

An exogenous shock to the underlying probabilities affect agents' choices via two different channels:

- ***The risk channel:*** a change in the underlying probabilities keeping utility in each state unchanged.
- ***The fear channel:*** a change in the underlying probabilities also determines agents' optimal choice by affecting the utility ***in each state***.

The Model in Brief

The Economy:

- The economy consists of two consumption goods: “risky” good (c_1) and “risk-less” good (c_2).
- Consumption plans determine DM probability to survive ($\pi(c_1)$)
- Fear, measured by *F*, is determined by consumption and investment plans.
- Agents maximize their expected utility.

The Model in Brief– (Cont.):

Fear and Mental Capital:

- People can handle their fears. They do so by accumulating mental capital.
- Investment in mental skills, like other investments in human capital, is not a free-lunch.
- Let ***M*** stand for the monetary resources agents invest in mental skills.
- Then ***F*** is a function of:

  (2)

  $$F=F(S,\gamma,M),$$

  where $1\leq F\leq\infty$.

The Model in Brief– (Cont.):

Preferences:

- Fear is good dependent, meaning that consumption of risk-less goods generates no fear.
- The utility function W_i has a good additive representation that exhibits the following form:

(3)

$$W_{i,t} = \beta^{t-1} \cdot (\alpha_i U(c_{1,t}) F^{-1} + V(c_{2,t})),$$

where:

α_i is a taste parameter and β is the discount factor. We assume that $U(\cdot)$ and $V(\cdot)$ are concave and increase with c_1 and c_2 respectively.

The Model in Brief – (Cont.):

Agents problem:

- Agents maximize expected utility (c, M) subject to investment and consumption constraints:

(5)

$$\text{Max} \sum \pi_t \cdot \beta^{t-1} \pi_{t-1} W_{i,t},$$

s.t.:

$$\pi_1 \sum \pi_{t-1} \beta^{t-1} ((p_1 c_{1,t} + p_2 c_{2,t} + M_t) \leq I$$

Main Results and Testable Implications – in Brief:

Results:

- Risk affects peoples' choices via the ***risk*** and the ***fear*** channels.
- The higher the consumption from the risky good, the more worthwhile it is to invest in mental capacities.
- Borrowing Adam Smith's phrase, the "extra" effect of risk via the fear channel is limited by the extent of economic incentives to overcome it.

Implications:

- If overcoming fear is "technically" feasible, we expect:

  (i) people who had previously consumed large quantitative of what turned to be a risky good, to ***invest, overcome fear***, and practically keep their consumption plans unchanged, especially for cases in which γ is negligible.

  (ii) others will substitute the risky activity by other consumption plans, ***falsely appearing*** as if they overstate the objective probability to be harmed.

The econometric approach

Briefly in words:

- We identify the ***effect*** of fear and ***calibrate*** risk and fear aversion parameters by comparing the effect of terror on the economic behavior of people who, according to our model, will not invest in eliminating fear with those who will.
- Our analysis rests on two (main) identifying assumptions:

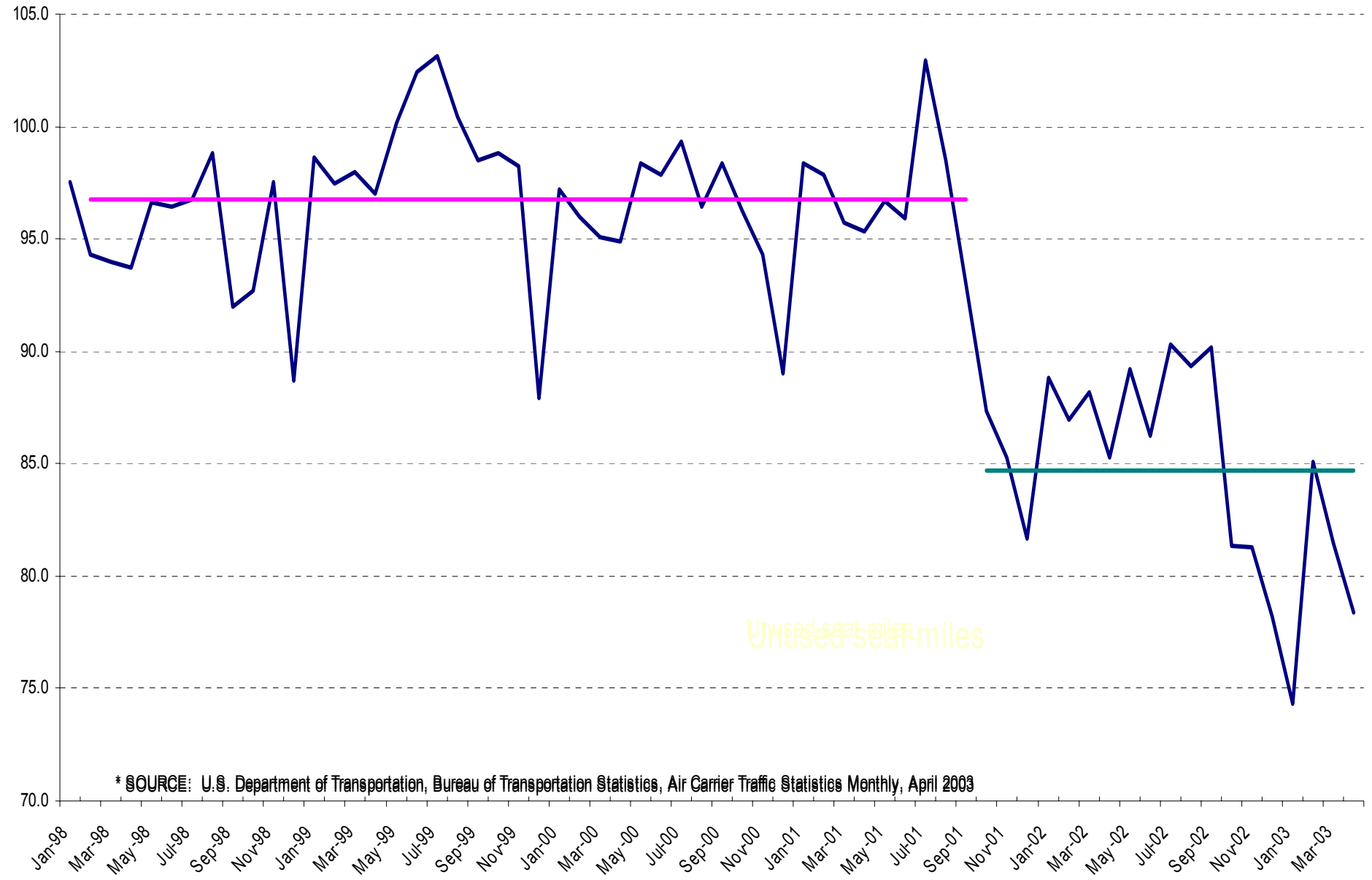
  (i) Terror incidents are exogenous to measured outcomes.

  (ii) People can be classified into "investors" and "others".

Data Source

- Terror incidents, casualties etc., self collected.
- Israeli Labor Force Surveys for the years 2000 to 2003
- Israeli Income Surveys for the years 2000 to 2003.
- Israeli Expenditure Surveys for the years 1999 to 2003
- The Israeli Central of Bureau Statistics data sets on tourism and transportation.
- Current Population Surveys, Monthly Files.
- U.S. Department of Transportation, Bureau of Transportation Statistics, Air Carrier Traffic Statistics Monthly, April 2003

Figure 3.USA:
Domestic Flights: Index of Air Passengers Air Freight Ratios
Domestic Air Seat and Passenger Miles and Air Freight Ton-Miles (monthly data, not seasonally adjusted)
January 1997 = 100.0



* SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Air Carrier Traffic Statistics Monthly, April 2003

Figure 2.ISR:
The Number Suicide Bomber Attacks and Fatalities by Month: Overall and Carried Out on Buses
Israel, January 2000 through April 2003

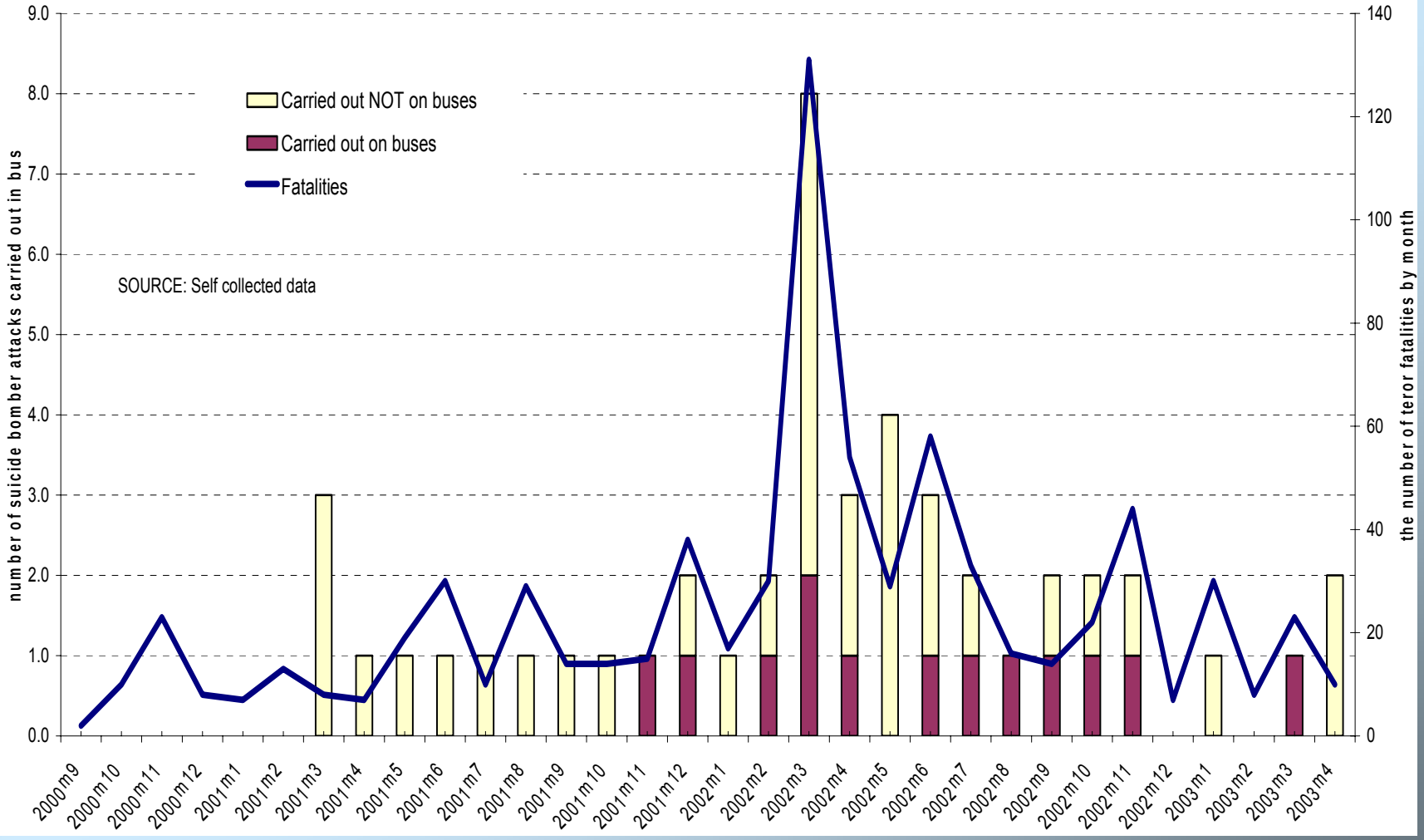


Table 1.ISR:
The Effect of Suicide Bombers on the Number of Passengers in Regular Bus Lines
Israel, October 2001 to April 2003
Dependent variable: the ratio of passegers in regular lines to passengers in special lines (in logs)

Variables	(i)	(ii)	(iii)	(iv)	(vii)
Num. of suicide bomber events - on buses only - this month	**-0.191**			**-0.168**	**-0.219**
	(0.054)			**(0.059)**	**(0.089)**
Num. of suicide bomber events this month NOT on buses		-0.053		-0.023	-0.046
		(0.026)		(0.025)	(0.043)
Fatal incidets			-0.008		-0.002
			(0.007)		(0.011)
Fatal incidents with 1967 borders					0.034
					(0.025)
Num people killed by terror action this month					0.004
					(0.005)
Num. people wounded					-0.001
					(0.001)
Months / observations	28	28	28	28	28
Adj R-Square	0.2998	0.1076	0.0228	0.2958	0.2627

Note:
Sources:
1. Public transportation data is based on Israeli Central of Bureau Statistics datasets
2. Data on the type of the terror events, casualties (killed, wounded) and location was collected by the authors
( ) Standard errors in parenthesis

Table ISR.17:
The Effect of Suicide Bomber Attacks Carried Out on Buses on the Use of Public Bus Transportation
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on public bus rides

Variables	Location: All (i)	All (ii)	Metro Cities(&) (iii)	Metro Cities(&) (iv)	Others(&&) (v)	Others(&&) (vi)
(1) Suicide bomber attacks curried out on a bus^	**-0.310 (0.108)****		**-0.427 (0.120)****		**-0.065 (0.231)**	
(2) Suicide bomber attacks curried out not on a bus^		-0.069 (0.046)		-0.069 (0.046)		-0.125 (0.099)
Personal characteristics:						
(3) School years completed	0.088 (0.016)**	0.088 (0.016)**	0.052 (0.018)**	0.088 (0.016)**	0.133 (0.034)**	0.134 (0.034)**
(4) Income (in logs)^^	-1.336 -(0.101)**	-1.337 (0.101)**	-1.505 (0.114)**	-1.337 (0.101)**	-1.102 (0.222)**	-1.099 (0.222)**
(5) Age^^^	0.035 (0.004)**	0.035 (0.005)**	0.023 (0.005)**	0.035 (0.005)**	0.073 (0.011)**	0.073 (0.011)**
(6) Female^^^	0.311 (0.124)*	0.298 (0.124)*	0.082 (0.137)	0.298 (0.124)*	0.668 (0.272)*	0.672 (0.271)*
(6) Family size	0.228 (0.036)**	0.228 (0.035)**	0.381 (0.042)**	0.228 (0.035)**	0.245 (0.071)**	0.245 (0.071)**
(6) Recent immigrant^^^^^	1.328 (0.153)**	1.342 (0.153)**	0.805 (0.162)**	1.342 (0.153)**	2.388 (0.390)**	2.375 (0.389)**
(7) Observations	9811	9811	6566	6566	3245	3245

Table ISR.17:
The Effect of Suicide Bomber Attacks Carried Out on Buses on the Use of Public Bus Transportation
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on public bus rides

Variables	Location					
	All		Metro Cities (&)		Others (&&)	
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
(1) Suicde bomber attacks carried out on a bus^	**-0.31 (0.108)****		**-0.427 (0.120)****		**-0.065 (0.231)**	
(2) Suicde bomber attacks carried out NOT on a bus^		-0.069 (0.046)		-0.069 (0.046)		-0.125 (0.099)

Table ISR.18:
The Effect of Suicide Bomber Attacks Carried Out on Buses on the Use of Taxi Services
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on taxi services

Variables	Location		
	All	Metro Cities (&)	Others (&&)
	(i)	(ii)	(iii)
(1) Suicde bomber attacks carried out on a bus^	-0.085 (0.158)	**0.758** **(0.342)***	-0.314 (0.179)

Table ISR.19:
The Effect of Suicide Bomber Attacks Carried Out on Buses
on the Use of Public Bus Transportation
Consumption by Daily Tickets Vs. Consumption by Multiple-Rides ticket or Monthly Passes
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on public bus rides

Variables	Daily	Multiple-Rides / Monthly
	(i)	(ii)
(1) Suicde bomber attacks carried out on a bus^	**0.758**	-0.085
	(0.342)*	(0.158)

Table ISR.20:
The Effect of Suicide Bomber Attacks Carried Out on Buses on the Use of Public Bus Transportation
Daily Rides by Family Income
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on public bus rides

Variables	Income Level		
	All	5k to 10k	10k to 20k
	(i)	(ii)	(iii)
(1) Suicde bomber attacks carried out on a bus^	-0.499 (0.171)**	-0.552 (0.242)*	-0.483 (0.241)*

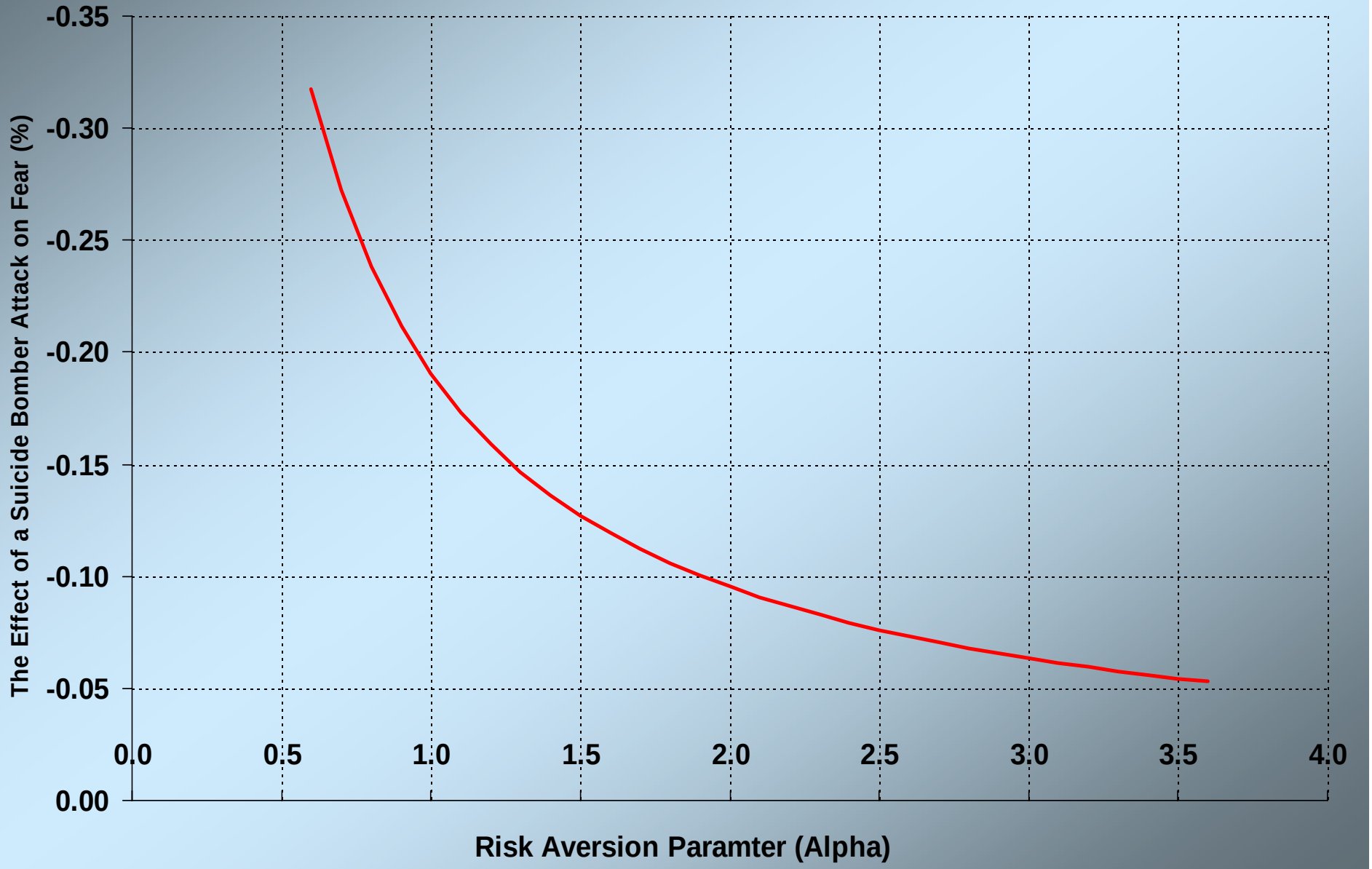
Table ISR.21:
The Effect of Terror Fatalities and Suicide Bomber Attacks Carried Out on Buses on Coffee Shops Consumption
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) in Coffee Shops

Variables	Location		
	All	Metro Cities (&)	Others (&&)
	(i)	(ii)	(iii)
(1) Suicde bomber attacks carried out on a bus^	0.076	0.276	-0.018
	(0.191)	(0.358)	(0.224)
(2) Fatalities^^	-0.011	**-0.02**	-0.008
	(0.005)*	**(0.009)***	(0.005)

Table ISR.22:
The Effect of Suicide Bomber Attacks Carried Out NOT on Buses on Coffee Shops Consumption by Marital Status
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) in Coffee Shops

Variables	Marital Status			
	Married, No Children		Singles	
	(i)	(ii)	(iii)	(iv)
(1) Suicde bomber attacks carried out NOT on a bus^	**-0.276**	**-0.797**	0.035	0.356
	(0.081)**	(0.364)*	(0.12)	(0.245)
Age	All	22-35	All	22-35

Figure 5:
Back of the Envelope Calculation for the Effect of Suicide Bomber Attacks
Carried out on Buses on Agents' Marginal Utility and the Degree of Risk Aversion



In Detail

If time allows…see next slides

Table 1.USA:
The Effect of September 11th 2001 on the Number of Domestic Air Passengers in the US
Dependent variable: the ratio of air passengers miles to air Freight ton-miles
USA, January 1995 to April 2003

Variables	(i)	(ii)	(iii)	(iv)	(v)
September 2001 April 2003	-0.147 (0.011)	-0.100 (0.014)			-0.105 (0.014)
Linear time trend		-0.001 (0.000)	-0.002 (0.000)		-0.001 (0.000)
September 2001			0.030 (0.051)	-0.029 (0.075)	0.085 (0.041)
Months / observations	100	100	100	100	100
Adj R-Square	0.6318	0.6993	0.5444	-0.009	0.7091

Note:
* SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics, Air Carrier Traffic Statistics Monthly, April 2003
( ) Standard errors in parenthesis

Table FRC.1:
The Effect of Stock on Changes in the Demand for Quality
Source: Adda (2001)

Variable	Before Crisis	During Crisis
Stock [20%,40%]	**-0.410**	**1.89**
	(0.513)	(0.995)
Stock [40%,60%]	**0.280**	**1.92**
	(0.467)	(0.960)
Stock [60%,80%]	**-0.210**	**0.37**
	(0.420)	(0.925)

Notes:
Adda Jerome (2001):
Behavior Towards Health Risks: An Empirical Study Using the CJD Crisis as an Experiment"
Heteroscedastic corrected standard errors were computed.
Regression also controls for lagged changes in quality, region of living, size
of city, occupation, education, family size and income.

Table ISR.18:
The Effect of Suicide Bomber Attacks Carried Out on Buses on the Use of Taxi Services
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on taxi services

Variables	Location: All (i)	Metro Cities(&) (ii)	Others(&&) (iii)
(1) Suicide bomber attacks curried out on a bus^	**-0.085** (0.158)	**0.758** (0.342)*	**-0.314** (0.179)
Personal characteristics:			
(2) School years completed	0.016 (0.023)	0.194 (0.045)**	-0.062 (0.028)*
(3) Income (in logs)^^	-1.132 (0.150)**	-1.072 (0.283)**	-1.076 (0.177)**
(4) Age^^^	-0.016 (0.007)*	-0.019 (0.014)	-0.018 (0.008)*
(5) Female^^^	0.420 (0.183)*	-0.129 (0.401)	0.592 (0.205)**
(6) Family size	0.107 (0.052)*	0.036 (0.107)	0.130 (0.060)*
(7) Recent immigrant^^^^^	0.463 (0.227)*	-0.428 (0.516)	0.777 (0.254)**
(8) Observations	9811	1898	7913

Table ISR.19:
The Effect of Suicide Bomber Attacks Carried Out on Buses on the Use of Public Bus Transportation
Daily Vs. Weekly/Monthly Tickets
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on public bus rides

Variables	Daily (i)	Monthly (ii)
(1) Suicide bomber attacks curried out on a bus^	**-0.390** (0.125)**	**-0.007** (0.279)
Personal characteristics:		
(3) School years completed	0.032 (0.019)	0.115 (0.044)**
(4) Income (in logs)^^	-1.462 (0.122)**	-1.541 (0.279)**
(5) Age^^^	0.025 (0.005)**	0.033 (0.013)*
(6) Female^^^	0.345 (0.148)*	0.541 (0.338)
(6) Family size	0.300 (0.044)**	0.883 (0.099)**
(6) Recent immigrant^^^^^	0.624 (0.185)**	2.562 (0.409)**
(7) Observations	8416	8416

Table ISR.20:
The Effect of Suicide Bomber Attacks Carried Out on Buses on the Use of Public Bus Transportation
Daily Rides by Family Income
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) on public bus rides

Variables	Income level		
	All	5 to 10K	10 to 20K
	(i)	(ii)	(ii)
(1) Suicide bomber attacks curried out on a bus^	**-0.499**	**-0.552**	**-0.483**
	(0.171)**	(0.242)*	(0.241)*
Personal characteristics:			
(2) School years completed	0.005	-0.005	-0.014
	(0.029)	(0.041)	(0.040)
(3) Income (in logs)^^	-1.124	-0.917	-1.314
	(0.299)**	(0.546)	(0.650)*
(4) Age^^^	0.032	0.015	0.050
	(0.008)**	(0.012)	(0.013)**
(5) Female^^^	0.304	-0.283	0.807
	(0.205)	(0.294)	(0.288)**
(6) Family size	0.281	0.217	0.332
	(0.061)**	(0.086)*	(0.088)**
(7) Recent immigrant^^^^^	0.893	0.764	0.952
	(0.251)**	(0.343)*	(0.371)*
(8) Observations	4757	2209	2548

Table ISR.21:
The Effect of Terror Fatalities and Suicide Bomber Attacks Carried Out on Buses on Coffee Shops Consumptio
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) in Coffee Shops

Variables	Location: All (i)	Metro Cities(&) (ii)	Others(&&) (iii)
(1) Suicide bomber attacks curried out on a bus^	**0.076** (0.191)	**0.276** (0.358)	**-0.018** (0.224)
(2) Fatalities^^	**-0.011** (0.005)*	**-0.020** (0.009)*	**-0.008** (0.005)
Personal characteristics:			
(3) School years completed	0.141 (0.021)**	0.139 (0.037)**	0.112 (0.025)**
(4) Income (in logs)^^^	2.223 (0.130)**	1.907 (0.216)**	2.423 (0.161)**
(5) Age^^^^	-0.066 (0.006)**	-0.083 (0.011)**	-0.058 (0.007)**
(6) Female^^^^	0.355 (0.152)*	0.558 (0.290)	0.301 (0.178)
(7) Family size	-0.717 (0.049)**	-0.710 (0.093)**	-0.630 (0.058)**
(8) Recent immigrant^^^^^^	-1.386 (0.216)**	-2.029 (0.434)**	-1.037 (0.249)**
(9) Observations	9811	1898	7913

Table ISR.22:
The Effect of Suicide Bomber Attacks Carried Out NOT on Buses on Coffee Shops Consumption by Marital Status
Family Expenditure Surveys, 1999 through 2002
Dependent variable: family expenditures (in logs) in Coffee Shops

Variables	Marital Status			
	Married, no children		No married	
	(i)	(ii)	(iii)	(iv)
(1) Suicide bomber attacks curried out NOT on a bus^	**-0.276** (0.081)**	**-0.797** (0.364)*	**0.035** (0.120)	**0.356** (0.245)
Personal characteristics:				
(2) School years completed	0.111 (0.030)**	0.016 (0.155)	0.210 (0.046)**	0.063 (0.130)
(3) Income (in logs)^^	3.060 (0.199)**	0.734 (0.606)	1.364 (0.261)**	-0.131 (0.462)
(4) Age^^^	-0.056 (0.009)**	0.293 (0.129)*	-0.084 (0.012)**	0.220 (0.095)*
(5) Female^^^^	0.429 (0.224)	0.711 (0.849)	-0.236 (0.332)	1.106 (0.655)
(6) Family size	-0.517 (0.073)**		-0.185 (0.140)	
(7) Recent immigrant^^^^^^	-1.386 (0.319)**	-1.445 (1.171)	-1.705 (0.410)**	-1.779 (0.910)
Age	All	22-35	All	22-35
(8) Observations	6346	291	2070	327

The Model

The economy:

- An endowment economy where individuals live for T=2 periods.
- At each period they can borrow or lend with no restrictions at a fixed rate r.
- The economy consists of two consumption goods:

  (a) “risky” good (c_1).

  (b) “risk-less” good (c_2).
- Consumption plans determine DM probability to survive ($\pi(c_1)$)
- Agents maximize their expected utility.

The Model – (Cont.):

Technology

- The probability to survive is solely determined by agents' consumption plans.
- To simplify, and without loosing generality, we assume that:

(1)

$$\pi(c_1)=\exp(-\gamma c_1)$$

where $0>\gamma_1$.

Note that the hazard rate equals $-\gamma_1$.

The Model – (Cont.):

Fear and mental human capital:

- Fear, measured by *F*, is determined endogenously by consumption and investment plans. It is also affected by γ as well as by the extent at which extreme consequences associated with consumption of risky goods turn into a salient phenomenon measured by S.

The Model – (Cont.):

Preferences

- We assume additive separable preferences over goods and time.
- We allow for heterogeneity in individuals' taste.
- Fear is good dependent, meaning that consumption of risk-less goods generates no fear.
- The utility function W_i has a good additive representation that exhibits the following form:

(3)

$$W_{i,t} = \beta^{t-1} \cdot (\alpha_i U(c_{1,t}) F^{-1} + V(c_{2,t})),$$

where:

α_i is a taste parameter and β is the discount factor. We assume that $U(\cdot)$ and $V(\cdot)$ are concave and increase with c_1 and c_2 respectively.

The Model – (Cont.):

- People can handle their fears. They do so by accumulating mental capital.
- Investment in mental skills, like other investments in human capital, is not a free-lunch.
- Let ***M*** stand for the monetary resources agents invest in mental skills.
- Then ***F*** is a function of:

  (2)

$$F=F(S,\gamma,M),$$

  where $1 \le F \le \infty$.

  We assume that ***F*** is increasing concave in S, γ and decreasing and convex in ***M*** for any γ>0. We further assume that $F_{M,\gamma} < 0$ and $F_{M,s} < 0$ (for any γ>0).

The Model – (Cont.):

Budget constraints:

We assume:

- Perfect capital market and a full actuarially fair annuity system.
- Prices do not vary over time and normalize the price of investment in each period to equal 1
- The budget constraint can be written as:

  (4)

  $$\pi_1((p_1 c_{1,1}+p_2 c_{2,1}+M_1)+\pi_2 \beta(p_1 c_{1,2}+p_2 c_{2,2}+M_2))\leq I,$$

  where:

  the discount factor β equal 1/(1+r).

The Model – (Cont.):

Agents problem:

- Agents maximize expected utility (c, M) subject to investment and consumption constraints:

(5)

$$\text{Max} \sum \pi_t \cdot \beta^{t-1} \pi_{t-1} W_{i,t},$$

s.t.:

$$\pi_1 \sum \pi_{t-1} \beta^{t-1} ((p_1 c_{1,t} + p_2 c_{2,t} + M_t) \leq I$$

The Model – (Cont.):

- From the F.O.C. we receive that the MRS between c_1 and c_2 consists of three components:

  (6)

  $$a_i((Uc_1/(Vc_2)) - a_i(Uc_1/Vc_2)(1-F^{-1}) - \gamma \cdot (W_i^*-\lambda I^*)/(Vc_2)$$

where:
$W_i^*-\lambda I^*$= consumer's surplus.

Identifying treatment effects

- Take from the pdf file

Identifying risk and fear aversion parameters using CRRA utility function

- Take from the pdf file