Economic Implications of Terrorism Events: a rapid assessment approach

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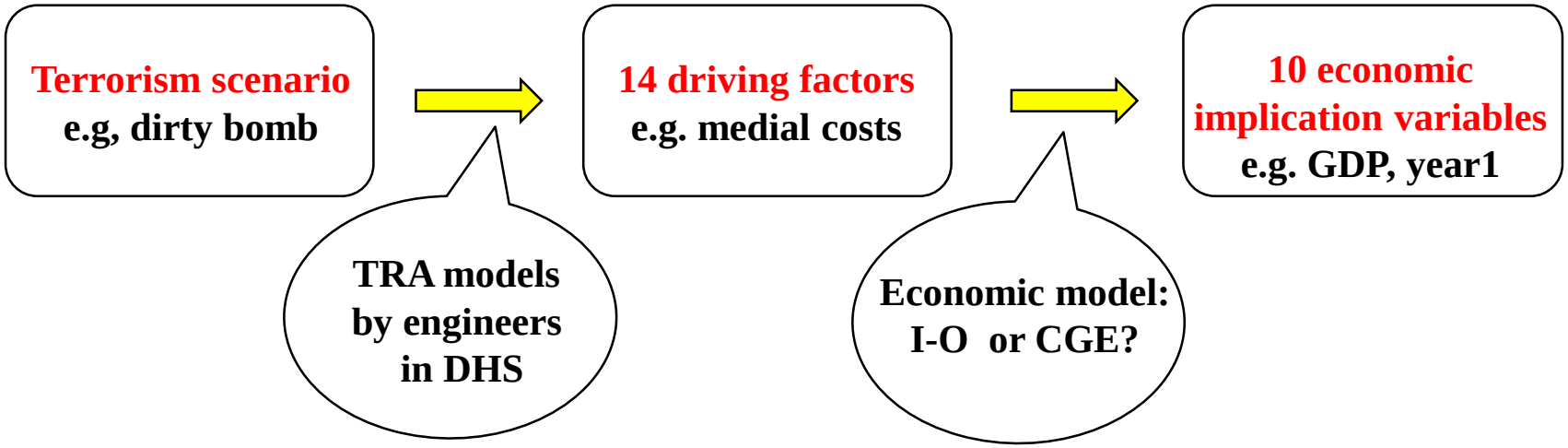
Terrorism Risk Assessment groups (TRAs) in the U.S. Department of Homeland Security assess economic implications of terrorism events

CoPS



Driving factors
(note regional dimension)

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1. Value of capital taken out of use in target region
2. Value of capital returned to use after 1 year in target region
3. Public expenditure in target city, cleanup
4. Public sector health expenditures
5. Accommodation expenses in target city
6. Accommodation expenses outside target city
7. Loss of foreign visitor expenditure in target city
8. Loss of foreign visitor expenditure outside target city
9. Loss of domestic traveler expenditure in target city
10. Loss of domestic traveler expenditure outside target city
11. Loss of food production in target state
12. Total loss of food production in U.S. including target state
13. Deaths & serious injuries, permanent removal from work
14. Aversion, per cent reduction in labor supply to target region

Economic implication variables
(note regional and dynamic dimension)

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1. national GDP in the event year (year 1)
2. national employment in the event year
3. GRP (gross regional product) in the target region in the event year
4. employment in the target region in the event year
5. national GDP in the long run (year 20)
6. national employment in the long run
7. present value of loss in economic welfare, discount rate 2%
8. present value of loss in economic welfare, discount rate 5%
9. GRP in the target region in the long run
10. employment in the target region in the long run

Measuring the welfare effects of a terrorism incident

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An event occurring in 2015 affects the future paths of economic variables. We measure the welfare effect of the event by looking at future effects on utility-generating private consumption and on terminal stocks of capital & net foreign liabilities. We make an additional allowance for pain and suffering associated with deaths.

$$PV_{2014}dWELFARE = \sum_{t=2015}^{2034} (1-DR)^{t-2014} * \left(\frac{C(t)}{CB(t)} - 1\right)$$
$$+ (1-DR)^{2035-2014} * KCRatio * \left(\frac{K(2035)}{KB(2035)} - 1\right)$$
$$- (1-DR)^{2035-2014} * GDPCRatio * \left(\frac{NFLGDP(2035)}{NFLGDPB(2035)} - 1\right)$$
$$- \frac{(1-DR)}{CB(2014)} * VLIFE * DTHS$$

Welfare measured as equivalent % loss in 2014 consumption

Why CGE not I-O?

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The TRAs commissioned CoPS to investigate the practicality of replacing I-O with CGE as the link connecting driving factors with economic implication variables

Relative to I-O, CGE has improved the treatments of:

(a) resource constraints
(b) time (dynamics)
(c) variable coverage (both input and output variables)

CGE models can show welfare losses even when they show short-run gains in GDP and employment

How can the TRA groups use a GGE model?

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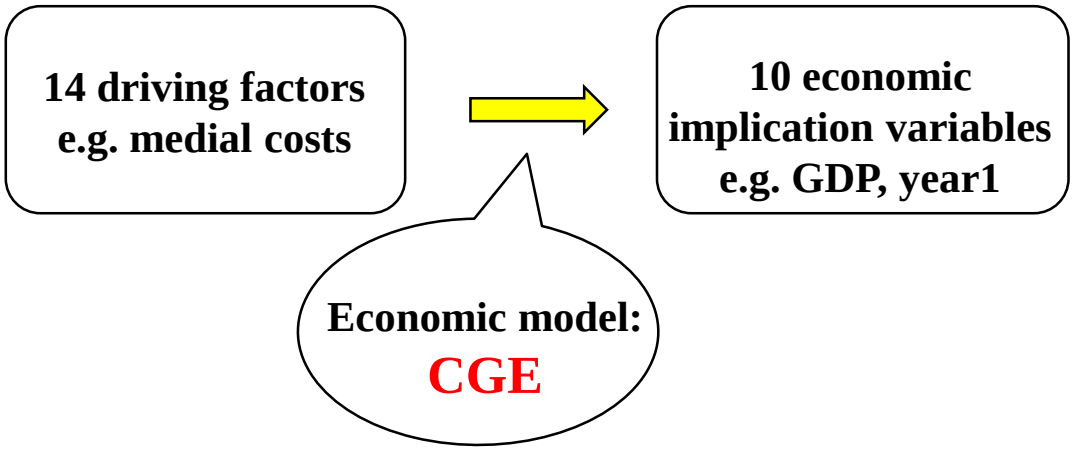
Problems: **Security and computation**



CoPS can't do the CGE computations because we are not allowed to know what DHS is worried about

DHS can't do the CGE computations because they don't have the specialist CGE skills and there are far too many scenarios

Solving the computational & security problems: the elasticity solution

Supply elasticity coefficients (E_A) for the equation

$$v_j = \sum_{s \in S} E_A(s, d_j, v) * s_j$$

Elasticity of implication variable v with respect to driving variable s for an event occurring in congressional district d_j (target region for scenario j) under macro assumption A

v_j and s_j are outcome for implication variable v and shock for driving factor s in scenario j

DHS can now compute implications for millions of scenarios j without involving CoPS

We use USAGE-TERM to calculate the coefficients E(s,d,v)

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We use USAGE-TERM to calculate the coefficients E(s,d,v)

Key features of USAGE-TERM

(a) Bottom-up regional

(b) Dynamic: baseline and perturbation runs

(c) Master database (436 *x* 120) and flexible aggregation

6. Estimating the elasticity coefficients, E(s,d,v), using USAGE-TERM

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Possible approaches:

1. **Set up a 436 region version of USAGE. Perform 14*x*168 *x*2 simulations**

   [14 shocks applied to each of the 168 Congressional districts in cities of interest under 2 macro assumptions]

   Record results for 10 implication variables from each simulation to reveal 47040 elasticities (=14*x*168*x*2*x*10).

   Conceptually simple but computationally impractical

2. **Create 168 four-region models each identifying a Congressional district (target region), Rest of city, Rest of state and Rest of US. Perform 14*x*2 simulations with each of the 168 models and record results for 10 variables in each simulation to reveal 14x168x2x10 elasticities.**

   Avoids having a model with an impractical number of regions. Still computationally unwieldy and doesn't facilitate understanding of properties/realism of the elasticities

3. **Create 4 four-region models. Perform 14*x*2 simulations with each of the 4 models and record results for 10 variables in each of simulation. Work out how to generalize the results by combining them with data from the 436 Congressional districts to reveal 14*x*168 *x*2*x*10 elasticities.**

   Conceptually tricky. Computationally feasible and facilitates understanding of properties/realism of the elasticities

Approach 3: using proportionality variables to estimate 14x168x2x10 elasticities from a small number of regional computations

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Approach 3 depends on defining and evaluating proportionality variables [PV(s,r,q)] from the 436-region database such that elasticities can be evaluated according to:

$$E_A(s,d,v) = C_A(s,v) * PV(s,d,v)$$

47040 280

where

$C_A(s,v)$ is a coefficient of proportionality, independent of d.

If we know that E_A(s,d,v) for given s and v is proportional to PV(s,d,v) then we have:

(a) a computationally feasible way of estimating all of the elasticities from a small number of four-region models, and

(b) an identification of what explains differences across regions (d) in the elasticities E_A(s,d,v). This is important in assessing the realism of the elasticities

Selected elasticities: Target region FL24, Neoclassical assumptions

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Implication variables / Driving variables	Year 1		Year 20		
	National GDP	Target region employment	National employment	Accumulated welfare (DR=0.02)	Target region employment
1. Value of capital taken out of use in target region	-0.0013	-0.6386	0.0000	-0.0076	0.0076
3. Public expenditure in target city, cleanup ($158m)	0.0007	0.0352	0.0000	-0.0006 (-$58m)	-0.0005
13. Deaths & serious injuries, permanent removal from work (people)	-0.2100	-34.2437	-1.0060	-231.6000	-2.0572
14. Aversion, per cent reduction in labor supply to target region	0.0000	-0.2486	0.0000	0.0000	-0.9025

Selected elasticities: Target region FL24, Keynesian assumptions

CoPS

Implication variables / Driving variables	Year 1		Year 20		
	National GDP	Target region employment	National employment	Accumulated welfare (0.02)	Target region employment
1. Value of capital taken out of use in target region	-0.0013	-0.6386	0.0000	-0.0076	0.0076
3. Public expenditure in target city, cleanup	0.0017	0.0902	0.0000	0.0000	-0.0002
13. Deaths & serious injuries, permanent removal from work (people)	-0.5600	-57.0728	-1.0130	-231.7000	-1.9993
14. Aversion, per cent reduction in labor supply to target region	0.0000	-0.4810	0.0000	0.0000	-0.9019

3 example scenarios

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Driving factors	S1 Epidemic	S3w: Dirty bomb	S5: Food loss
1. Value of capital taken out of use in target region ($m)	0	2622	0
2. Value of capital returned to use after 1yr in target region ($m)	0	2622	0
3. Public expenditure in target city, cleanup ($m)	393	62691	49
4. Public sector health expenditures ($m)	3068	128	65
5. Accommodation expenses in target city ($m)	0	215	0
6. Accommodation expenses outside target city ($m)	0	215	0
7. Loss of foreign visitor expenditure in target city ($m)	8837	5848	3570
8. Loss of foreign visitor expenditure outside target city ($m)	46099	22180	18624
9. Loss of domestic traveler expenditure in target city ($m)	15	1653	6
10. Loss of domestic traveler expenditure outside target city ($m)	0	0	0
11. Loss of food production in target state ($m)	0	0	210
12. Total loss of food production in U.S. including target state ($m)	0	0	210
13. Deaths & serious injuries, permanent removal from work (people)	38181	1645	493
14. Aversion, per cent reduction in labor supply to target region	0	10	0

3 example scenarios in percentage changes, FL24

CoPS

Driving factors	S1 Epidemic	S3w: Dirty bomb	S5: Food loss
1. Value of capital taken out of use in target region	0	2.9	0
2. Value of capital returned to use after 1yr in target region	0	2.9	0
3. Public expenditure in target city, cleanup	2.5	397.7	0.3
4. Public sector health expenditures	244.4	10.2	5.2
5. Accommodation expenses in target city	0	7.9	0
6. Accommodation expenses outside target city	0.0	0.0	0
7. Loss of foreign visitor expenditure in target city	50.7	33.6	20.5
8. Loss of foreign visitor expenditure outside target city	25.4	12.2	10.3
9. Loss of domestic traveler expenditure in target city	0.1	8.8	0.03
10. Loss of domestic traveler expenditure outside target city	0.0	0	0
11. Loss of food production in target state	0.0	0	1.4
12. Total loss of food production in U.S. including target state	0.0	0	0.02
13. Deaths & serious injuries, permanent removal from work	0.012	0.001	0.0002
14. Aversion, per cent reduction in labor supply to target region	0.0	10	0

Computing the effects of the 3 scenarios for the 10 implication variables

$$v_j = \sum_{s \in S} E_A(s, d_j, v) * s_j$$

Welfare effects measured as percent loss of a year's consumption (discount rate 2%)

CoPS

Target region & macro assumption	S1: Epidemic	S3w: Dirty bomb	S5: Food loss
FL24 (Miami)			
Keynesian	-3.0264	-0.2580	-0.1589
Neoclassical	-2.9020	-0.4123	-0.1033
NY14 (New York)			
Keynesian	-3.0264	-0.2580	-0.1586
Neoclassical	-2.9020	-0.4123	-0.1031
CA34 (Los Angeles)			
Keynesian	-3.0264	-0.2580	-0.1588
Neoclassical	-2.9020	-0.4123	-0.1032

- Target region makes almost no difference for given set of $ shocks
- Keynesian versus Neoclassical - only moderately important
- Epidemic scenario is much worse that the other two. Why?

Decomposition of welfare effects, 3 scenarios with target region FL24

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Driving factors	S1: Epidemic		S3w: Dirty bomb		S5: Food contamination	
	Keynes	Neoclass	Keynes	Neoclass	Keynes	Neoclass
1. Value of capital taken out of use in target region	0.0000	0.0000	-0.0220	-0.0220	0.0000	0.0000
2. Value of capital returned to use after 1yr in target region	0.0000	0.0000	0.0210	0.0210	0.0000	0.0000
3. Public expenditure in target city, cleanup	0.0000	-0.0014	0.0000	-0.2230	0.0000	-0.0002
4. Public sector health expenditures	0.0018	-0.0091	0.0001	-0.0004	0.0000	-0.0002
5. Accommodation expenses in target city	0.0000	0.0000	-0.0007	-0.0011	0.0000	0.0000
6. Accommodation expenses outside target city	0.0000	0.0000	-0.0007	-0.0011	0.0000	0.0000
7. Loss of foreign visitor expenditure in target city	-0.0524	-0.0262	-0.0347	-0.0173	-0.0212	-0.0106
8. Loss of foreign visitor expenditure outside target city	-0.2186	-0.1093	-0.1052	-0.0526	-0.0883	-0.0442
9. Loss of domestic traveler expenditure in target city	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10. Loss of domestic traveler expenditure outside target city	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
11. Loss of food production in target state	0.0000	0.0000	0.0000	0.0000	-0.0012	-0.0005
12. Total loss of food production in U.S. including target state	0.0000	0.0000	0.0000	0.0000	-0.0020	-0.0013
13. Deaths & serious injuries, permanent removal from work	-2.7572	-2.7560	-0.1159	-0.1158	-0.0463	-0.0463
14. Aversion, per cent reduction in labor supply to target region	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	-3.0264	-2.9020	-0.2580	-0.4123	-0.1589	-0.1033

Project shows that CGE is practical for TRA purposes

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Main results so far:

1) **In ranking terrorism events in terms of damage, a welfare metric is likely to lead to different conclusions than a GDP metric**
2) **With life valued at $9.6m, death is the dominant driving factor in welfare**
3) **For scenarios with the same $ shocks and deaths, the target region is unimportant in determining *national* outcomes**
4) **Short-run *regional* outcomes depend crucially on the target region**
5) **The only shocks with significant long-run implications for GDP and national employment are loss of life**
6) **The only shocks with significant long-run regional implications are aversion**

7) **Short and long-run regional implications for employment can differ sharply**

8) **The state of the economy (recessed or non-recessed) can have a significant bearing on the short-run implications of a given scenario for both national and regional variables**

9) **The state of the economy in year 1 has almost no bearing on long-run implications for GDP and employment, but has moderate consequences for welfare**