When Fear Disrupts Growth: Modeling the Economic Toll of Terror on Tourism

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Abstract

This paper develops a dynamic Ramsey-Cass-Koopmans (RCK) model to analyse the macroeconomic impact of terrorism-induced fear on tourism and growth. We introduce a behavioural mechanism where households' utility from tourism consumption is distorted by a time-varying security perception index, $\theta(t)$, which declines following terrorist attacks. This fear channel reduces savings and investment, slowing capital accumulation and long-run growth. Our model also incorporates government intervention through public safety investment aimed at restoring confidence. We evaluate three scenarios: i) one-time shock; ii) persistent fear; and iii) policy-driven recovery, and simulate their effects on capital, consumption, and welfare. Our results show that persistent fear leads to the greatest welfare loss, while rapid policy-driven recovery can paradoxically destabilize investment if not properly calibrated. Our paper highlights the trade-offs in post-terrorism policy design and offers new theoretical insights into how behavioural responses to insecurity can shape macroeconomic trajectories in tourism-dependent economies.

Keywords: tourism demand; Ramsey-Cass-Koopmans model; fear perception; government intervention

JEL Classifications: E13; E61; H56; L83; O41

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1. Introduction

Tourism has emerged as one of the fastest-growing and most economically significant sectors globally, accounting for over 10% of global GDP and supporting millions of jobs across both developed and developing nations. For many countries, particularly small island economies and developing regions, tourism represents a primary source of foreign exchange earnings, infrastructure investment, and socio-economic development. However, the industry is vulnerable to exogenous shocks: none more psychologically potent and economically disruptive than tourism. Acts of terror, even geographically isolated or limited in scope, can lead to disproportionate declines in international tourist arrivals due to fear-driven behavioural response. These events often result in long-lasting reputational damage, reduced investor confidence, and structural shifts in consumption patterns, particularly in sectors like hospitality, transport, and cultural services.

A large body of empirical literature has documented the adverse effects of terrorism on tourism flows. Enders and Sandler (1991) provided early evidence that tourist incidents in Spain led to significant reductions in tourist arrivals. Similar findings were documented Drakos and Kutan (2003), who documented that terrorism adversely affected regional tourism in Mediterranean countries. Neumayer (2004) used dynamic panel estimation techniques to show that political violence and terrorism have strong and persistent negative effects on international tourism across a wide set of countries. These impacts often extend beyond the immediate aftermath of attacks, as tourists adjust their perceptions of safety based on both direct threats and media portrayals.

Recent contributions have emphasized the psychological and behavioural dimensions of terrorism's economic toll. Sönmez and Graefe (1998) found that perceived risk and safety concerns significantly influence travel behaviour, often outweighing actual statistical probabilities of harm. Frey, Luechinger and Stutzer (2007) further argues that the fear induced by terrorism affects not only immediate consumer decisions but also shapes long-term expectations and utility, leading to broader macroeconomic consequences.

Despite these insights, most existing studies remain empirical or descriptive, with limited formal modelling of the dynamic interaction between fear, consumption, investment, and economic growth. We address this gap by developing a continuous-time Ramsey-Cass-Koopmans (RCK) model that incorporates behavioural security perceptions into the household utility function. We model tourism as a distinct consumption category whose marginal utility is distorted by perceived safety, represented by a time-varying index $\theta(t)$. A terrorism event induces a negative shock to $\theta(t)$, capturing the erosion of public confidence. Our model allows this perception to recover over time, either endogenously (via psychological adjustment) or through exogenous policy interventions, such as public safety investments, risk communication campaigns, or law enforcement efforts.

We explore three representative scenarios: i) a one-time shock with moderate recovery; ii) a persistent shock with prolonged fear; and iii) an intervention-based recovery driven by government policy. Through analytical derivations and numerical simulations, we show how different trajectories of perceived safety affect consumption allocation, capital accumulation, and long-term welfare. Our main findings are threefold. First, persistent terrorism-induced fear generates the largest long-run welfare losses by depressing both tourism and capital accumulation. Second, while government intervention can accelerate recovery, aggressive short-run stimulus to restore tourism may crowd out investment and trigger capital collapse if not properly timed. Third, optimal policy must balance between restoring confidence and maintaining investment incentive, avoiding excessive intertemporal shifts in consumption behaviour.

Our contribution lies in bridging behavioural macroeconomics and tourism economics by providing a formal theoretical model that captures the long-run economic implications of terrorism-induced fear. The findings have practical relevance for policymakers, particularly in designing post-crisis recovery strategies that align tourism promotion with sustainable economic growth.

2. Model

2.1 Set-up

In this section, we develop a Ramsey-Cass-Koopmans (RCK) model to analyse the dynamic effects of terrorism-induced fear on tourism demand and economic growth. We embed a behavioural security perception mechanism into a representative household's intertemporal optimisation problem, and explore the role of government intervention in restoring confidence and stabilising long-run welfare.

Time is continuous, $t \in [0, \infty)$. A representative infinitely-lived household derives utility from general consumption, denoted by $c(t)$, and from tourism-related consumption, denoted by $l(t)$. We assume the household faces security-related fear or anxiety that modifies the marginal utility of tourism. The instantaneous utility function is given by:

$$U = \int_0^\infty e^{-\rho t}[\ln c(t) + \theta(t) \ln l(t)]dt, \tag{1}$$

where $\rho > 0$ is the discount factor, and $\theta(t) \in [0,1]$ represents household's time-varying perception of safety in the context of tourism. When $\theta(t) = 0$, fear is extreme and no utility is derived from tourism; when $\theta(t) = 1$, tourism is perceived as fully safe.

Household allocates total income to consumption, tourism, and savings. Capital accumulation evolves according to:

$$\dot{k}(t) = f\big(k(t)\big) - c(t) - l(t) - \delta k(t), \tag{2}$$

where $k(t)$ denotes capital per capita, $\delta > 0$ is the depreciation rate.

We model terrorism as a negative psychological shock to tourism demand through the time-varying fear factor $\theta(t)$. In the absence of government action, we assume:

$$\theta(t) = \bar{\theta} - \phi X(t), \qquad \phi > 0$$

where $\bar{\theta} \in (0,1]$ represents baseline safety perception in the absence of terrorism; $X(t)$ stands for the terrorism intensity process (e.g., a Poisson shock), and ϕ captures the marginal disutility of fear. A higher $X(t)$ reduces $\theta(t)$, diminishing tourism utility and expenditure.

Firm's production function is Cobb-Douglas: $f(k) = Ak(t)^{\alpha}$, where $A > 0$ denotes total factor productivity (TFP), and $0 < \alpha < 1$ refers to output elasticity of capital. We introduce a policy function $G(t)$ representing public security investment to mitigate the effect of terrorism on tourism. Government spending improves public confidence, partially offsetting the fear shock. We assume:

$$\theta(t) = \bar{\theta} - \phi X(t) + \varphi G(t), \qquad \varphi > 0$$

where φ measures the effectiveness of government action in restoring perceived safety. In our setup, $G(t)$ acts as a confidence-restoring public good. Spending can be interpreted as law enforcement deployment, public communication, infrastructure investment, or tourist protection initiatives.

2.2 Household's problem

We now solve the household's optimization problem. The representative household chooses consumption $c(t)$ and tourism-related consumption $l(t)$ to maximize intertemporal utility subject to the capital accumulation constraint. Form the current-value Hamiltonian:

$$\mathcal{H} = \ln c(t) + \theta(t) \ln l(t) + \lambda(t)[f\big(k(t)\big) - c(t) - l(t) - \delta k(t)], \tag{3}$$

The first-order conditions (F.O.C) are:

$$\frac{\partial \mathcal{H}}{\partial c} = \frac{1}{c(t)} - \lambda(t) = 0 \qquad \Longrightarrow \qquad \lambda(t) = \frac{1}{c(t)} \tag{4}$$

$$\frac{\partial \mathcal{H}}{\partial l} = \frac{\theta(t)}{l(t)} - \lambda(t) = 0 \qquad \Longrightarrow \qquad l(t) = \theta(t) \cdot c(t) \tag{5}$$

$$\dot{\lambda}(t) = \rho \lambda(t) - \frac{\partial \mathcal{H}}{\partial k} = \lambda(t)\left(\rho + \delta - f'\big(k(t)\big)\right) \tag{6}$$

Substituting Equation (4), the consumption growth equation becomes:[1]

$$\frac{\dot{c}(t)}{c(t)} = f'\big(k(t)\big) - \delta - \rho$$

2.3 Steady-state

In the steady state, $\dot{c}(t) = \dot{k} = 0$ and $\theta(t) = \bar{\theta}$. The conditions simplify to:[2][3]

$$f'(k^*) = \delta + \rho \qquad \Rightarrow \qquad k^* = (\frac{\alpha A}{\delta + \rho})^{1/(1-\alpha)} \tag{7}$$

$$c^* = \frac{f(k^*) - \delta k^*}{1 + \bar{\theta}}, \qquad l^* = \bar{\theta} \cdot c^* \tag{8}$$

The steady-state level of capital, consumption, and tourism are fully determined by fundamentals and the perceived security level $\bar{\theta}$. Our model dynamics can be represented by a two-dimensional differential equation system in (k, c) space:

$$\begin{cases} \dot{c} = c[f'(k) - \delta - \rho] \\ \dot{k} = f(k) - \big(1 + \theta(t)\big)c - \delta k \end{cases}$$

Figure 1 shows the phase diagram. The equation for blue dashed line is: $f(k) = (1 + \theta)c + \delta k$, which refers to $\dot{k} = 0$ (i.e., capital no-change condition). That is, at any point along this curve, capital neither increases nor decreases. In the upper-left region, $\dot{k} < 0$ (i.e., capital decreasing), while in the lower right region $\dot{k} > 0$ (i.e., capital increasing). The equation for red dash-dot line is: $f'(k) = \delta + \rho \Rightarrow k^* = (\frac{\alpha A}{\delta+\rho})^{\frac{1}{1-\alpha}}$. It is a vertical line, representing the golden rule level of capital. In the left region, $\dot{c} < 0$ (i.e., consumption decreasing), while in the right region $\dot{c} > 0$ (i.e., consumption increasing).

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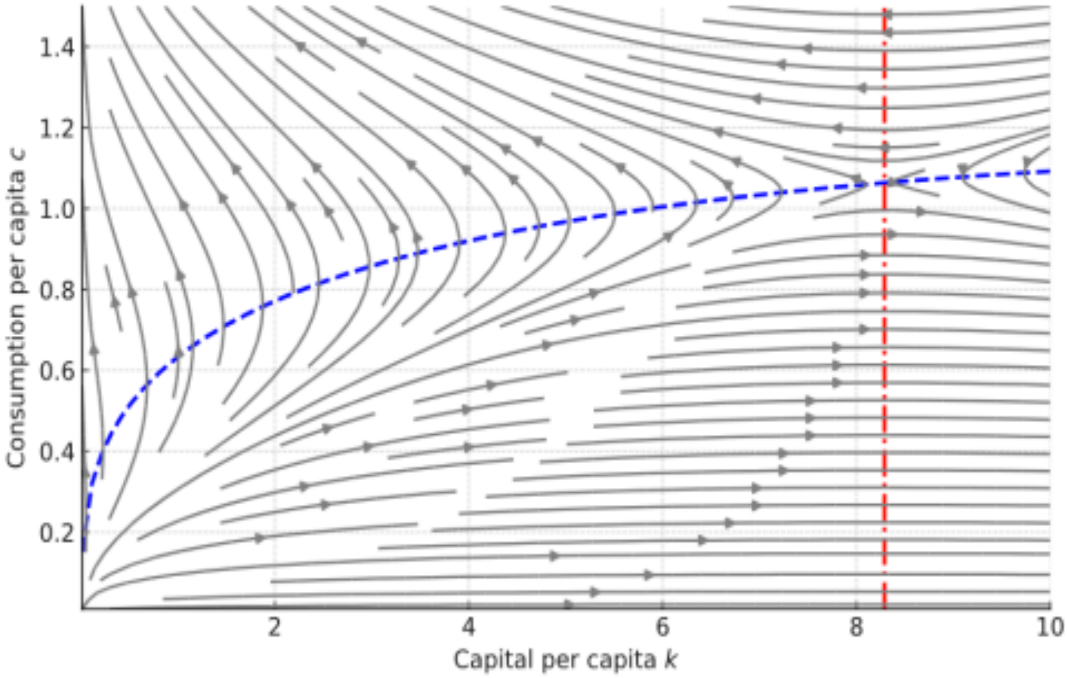
[1] We derive the consumption growth equation by differentiating the co-state variable $\lambda(t)$ with respect to time. From the first-order condition with respect to consumption: $\lambda(t) = \frac{1}{c(t)}$, differentiate both sides with respect to time, we get: $\dot{\lambda}(t) = \lambda(t)\left(\rho + \delta - f'\big(k(t)\big)\right)$. Now use the costate equation: $\dot{\lambda}(t) = \lambda(t)\left(\rho + \delta - f'\big(k(t)\big)\right)$. Substitute $\lambda(t) = \frac{1}{c(t)}$ and $\dot{\lambda}(t) = -\frac{\dot{c}(t)}{c(t)^2}$ into the costate equation, we have: $= -\frac{\dot{c}(t)}{c(t)^2} = \frac{1}{c(t)}\left(\rho + \delta - f'\big(k(t)\big)\right)$. Multiply both sides by $c(t)^2$ to eliminate dominators, we have: -$c(t)^2 = c(t)\left(\rho + \delta - f'\big(k(t)\big)\right)$. Divide both sides by $c(t)$, finally we can get: $\frac{\dot{c}(t)}{c(t)} = f'\big(k(t)\big) - \delta - \rho$.

[2] For Equation (7), we begin with the Cobb-Douglas production function: $f(k) = Ak^\alpha$. Its marginal product is: $f'(k) = \frac{d}{dk}(Ak^\alpha) = \alpha A k^{\alpha-1}$. At the steady state, the consumption Euler equation implies: $\frac{\dot{c}(t)}{c(t)} = f'(k) - \delta - \rho = 0 \Rightarrow f'(k) = \delta + \rho$. Substituting the expression for $f'(k)$ into the steady-state condition, can get: $\alpha A k^{\alpha-1} = \delta + \rho$. Solving for k^*, we rearrange: $(k^*)^{\alpha-1} = \frac{\delta+\rho}{\alpha A}$. Taking both sides to the power $\frac{1}{\alpha-1} = \frac{-1}{1-\alpha}$, we obtain: $k^* = (\frac{\alpha A}{\delta+\rho})^{\frac{1}{1-\alpha}}$.

[3] For Equation (8), we derive the steady-state values of consumption c^* from the capital accumulation equation. Start with the law of motion for capital: $\dot{k}(t) = f\big(k(t)\big) - c(t) - l(t) - \delta k(t)$. At steady state, $\dot{k} = 0$, thus: $f(k^*) - c^* - l^* - \delta k^* = 0$. Rewriting this, we obtain the resource constraint: $c^* + l^* = f(k^*) - \delta k^*$. From the first-order condition with respect to $l(t)$, we have: $l(t) = \theta(t) \cdot c(t) \Rightarrow l^* = \bar{\theta} \cdot c^*$. Substituting this equation into the resource constraint, we get: $c^* + \bar{\theta} \cdot c^* = f(k^*) - \delta k^*$. Factoring c^* on the left-hand side: $(1 + \bar{\theta})c^* = f(k^*) - \delta k^*$. Then solving for $c^* = \frac{f(k^*)-\delta k^*}{1+\bar{\theta}}$.

The intersection of the two curves is the steady-state equilibrium. We can see clearly that the unique saddle-path equilibrium converges to the steady state. Moreover, a positive security (e.g., a reduction in terrorism or an increase in government safety investment increases) $\theta(t)$, reduces the required consumption share devoted to tourism, and encourages faster capital accumulation. Conversely, a persistent decline in $\theta(t)$ can trap the system in a low-growth regime with suppressed tourism demand and underinvestment.

Figure 1: Phase diagram in (k, c) space under $\theta = 0.5$

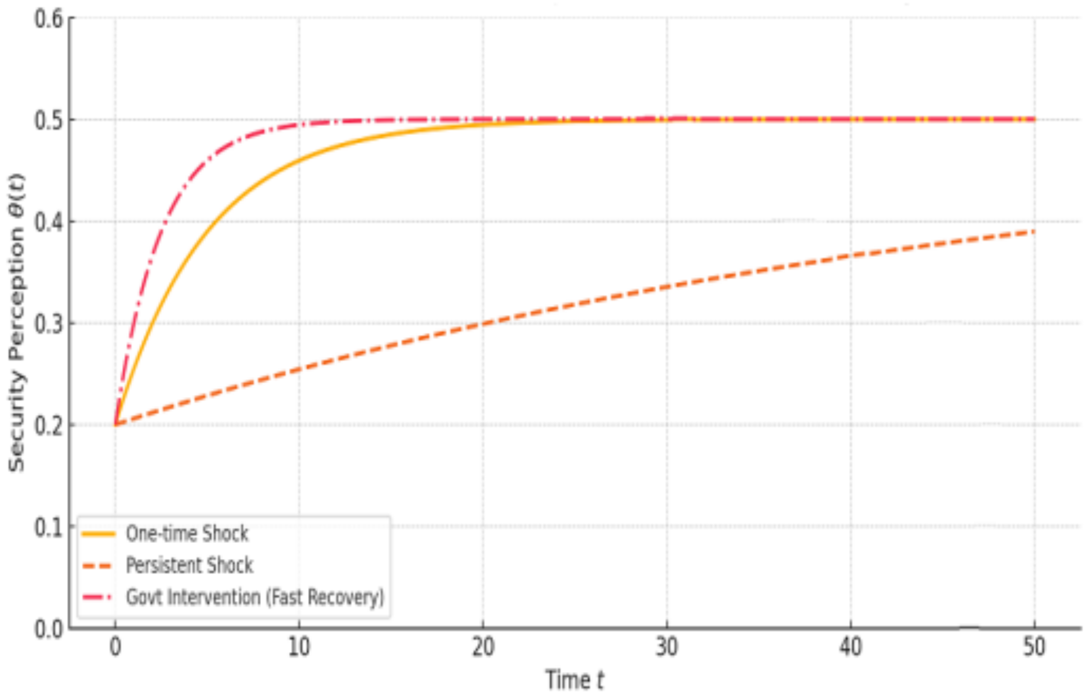


2.4 Simulation

We first simulate the dynamic adjustment of the security perception index $\theta(t)$ following a terrorism shock under three different scenarios. Figure 2 illustrates the simulated dynamic paths of $\theta(t)$ under three different post-terrorism scenarios. Specifically, we consider the following three trajectories of $\theta(t)$: i) one-time shock: temporary decline in security perception, modelled as an exponential decay function: $\theta(t) = \bar{\theta} - 0.3e^{-0.2t}$; ii) persistent shock: a long-lasting fear response where confidence recovers slowly: $\theta(t) = \bar{\theta} - 0.3e^{-0.02t}$; and iii) government intervention: public investment restores confidence more rapidly: $\theta(t) = \bar{\theta} - 0.3e^{-0.4t}$. In all cases, the shock initially reduces perceived safety from its baseline level $\bar{\theta} = 0.5$ to $\theta = 0.2$, capturing a sudden loss in public confidence following an attack.

The one-time shock scenario (solid yellow curve) models an exponentially decaying fear response, where public confidence gradually returns in the absence of follow-up attacks. This case captures a typical psychological recovery from a single event. The persistent shock scenario (dashed orange curve) assumes a much slower recovery process, mimicking situations where repeated minor threats, prolonged media exposure, or structural fear inhibit the restoration of perceived safety. In this case, $\theta(t)$ remains significantly below its pre-shock level for an extended period, implying a sustained drag on tourism demand and economic performance. In contrast, the government intervention scenario (dash-dotted red curve) introduces a policy-induced recovery mechanism, where public spending and confidence-building efforts accelerate the rebound of $\theta(t)$. This results in a steeper and earlier convergence back to the baseline. Figure 2 highlights the central role of behavioural fear dynamics and the potential for timely public policy to mitigate long-term macroeconomic damage from terrorist events.

Figure 2: Dynamic paths of security perception $\theta(t)$ under terror shock



Next, to assess the quantitative implications of terrorism-induced fear on tourism and macroeconomic dynamics, we again simulate the model under three distinct scenarios for the evolution of $\theta(t)$. All scenarios begin with an identical magnitude of fear shock (30% drop), but differ in recovery speed. $\bar{\theta}$ is normalized to 0.5 across simulations. We numerically solve the nonlinear system consisting of:

$$\frac{\dot{c}(t)}{c(t)} = f'\big(k(t)\big) - \delta - \rho, \qquad \dot{k}(t) = f\big(k(t)\big) - (1 + \theta(t))c(t) - \delta k(t)$$

Using a forward-shooting method over a 50-year horizon, initializing from $k_0 = 2$ and $c_0 = 0.5$, the resulting trajectories $k(t)$ and $c(t)$ exhibit distinct dynamics.

Figure 3 shows the dynamic evolution of capital per capita $k(t)$ over a 50-period horizon under three distinct security scenarios corresponding to different trajectories of $\theta(t)$. In the one-time shock scenario (orange curve), confidence gradually returns to normal, allowing the economy to maintain a positive savings rate. As a result, capital accumulation continues, albeit at a slower pace than in the steady-state path without shocks. In contrast, the persistent shock scenario (yellow curve) features a prolonged fear environment where $\theta(t)$ recovers very slowly. This sustained anxiety depresses consumption-adjusted saving, but the economy still manages to accumulate capital over time, albeit more sluggishly. The most striking outcomes arises in the government intervention scenario (red curve), where confidence is restored rapidly due to public safety policies. Surprisingly, capital collapses after a temporary rise. This counterintuitive result stems from the fact that rebound in $\theta(t)$ increases the household's effective marginal utility from tourism consumption so sharply that optimal consumption surges, crowding out investment. Once capital drops below a certain threshold, depreciation outweighs output, triggering a downward spiral and collapse toward a capital-poor steady state. This demonstrates a potential policy pitfall: if demand is overstimulated before productive capacity has recovered, the economy may overshoot its short-term consumption potential, leading to unsustainable trajectories.

Figure 3: Capital dynamics $k(t)$ under different security scenarios

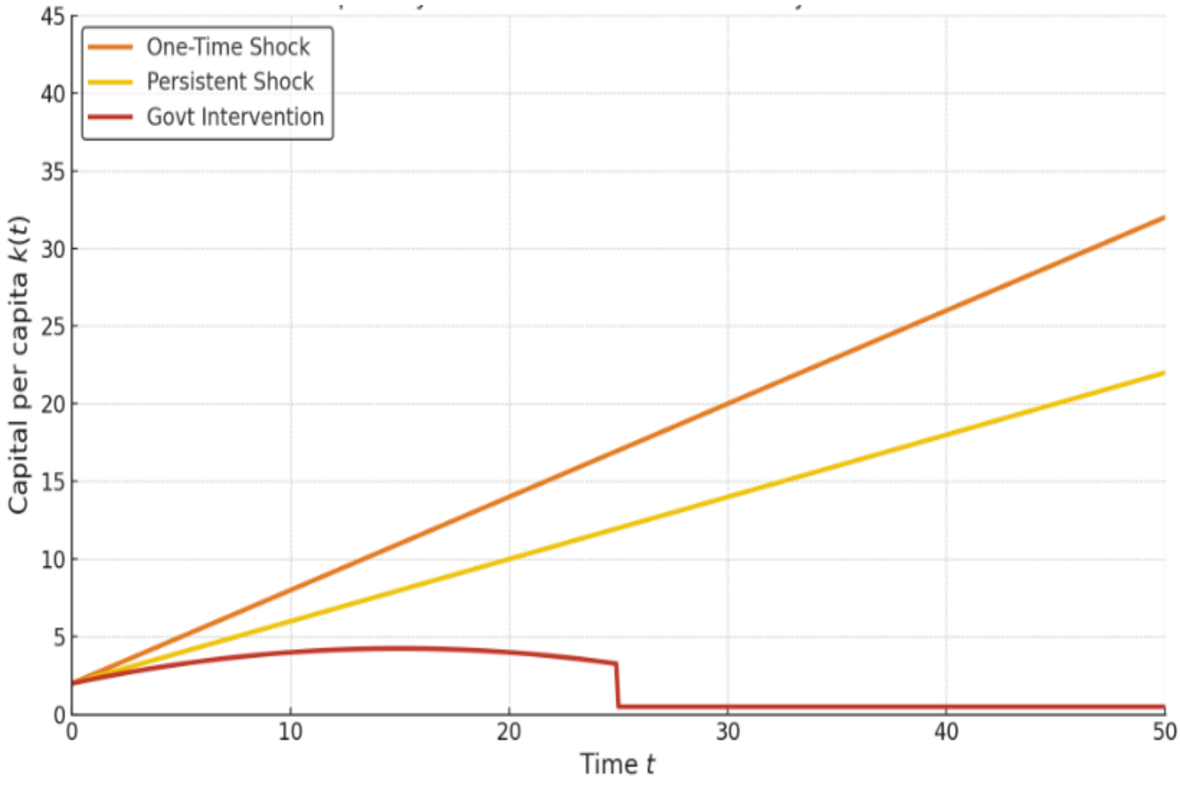
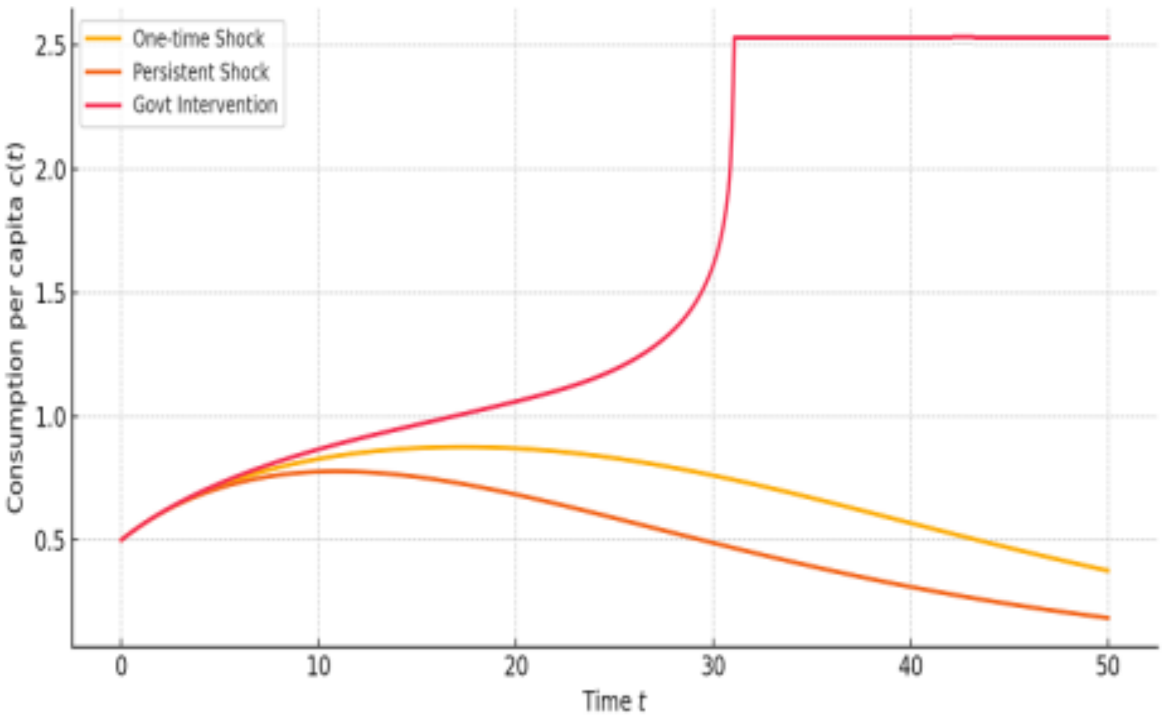


Figure 4 illustrates the simulated time paths of consumption per capita $c(t)$ over a 50-period horizon, under three distinct trajectories of $\theta(t)$. The figure reveals sharp differences in consumption dynamics depending on the speed and persistence of the security shock. In one-time shock scenario (yellow curve), consumption initially rises as investment gradually recovers, but then declines in later periods due to the compounding effects of diminished capital accumulation. The persistent shock scenario (orange curve) results in an even more pronounced long-run decline in $c(t)$, reflecting sluggish recovery of public confidence and a sustained drag on both savings and output. By contrast, the government intervention scenario (red curve) produces a dramatically different outcome: consumption increases rapidly as confidence is restored and the perceived utility from tourism rebounds. However, the rise in consumption becomes unsustainable as it outpaces capital growth, eventually hitting an imposed cap in the simulation (reflecting resource constraints). This pattern illustrates how aggressive stimulus to tourism-related utility can shift preferences toward immediate consumption, which—if not matched by productive capacity—risks depleting capital and destabilizing the long-run growth path.

Figure 4: Consumption dynamics $c(t)$ under different security scenarios



Overall, Figure 4 emphasizes that faster recovery of perceived safety boosts short-run consumption, but the macroeconomic effects depend critically on the interplay between behavioural responses, capital formation, and sustainability constraints. Policymakers must calibrate interventions not only to restore confidence, but to avoid excessive intertemporal shifts in household behaviour that could undermine long-term economic resilience.

2.5 Welfare comparison and losses

Figure 5 shows the welfare losses associated with three different trajectories of $\theta(t)$, following a simulated terrorism shock. We first numerically solve the RCK model under each $\theta(t)$ scenario, as described earlier, and compute the lifetime utility of the representative household: $W = \int_0^T e^{-\rho t}[\ln c(t) + \theta(t) \ln l(t)]dt$, where $T = 50$ is the planning horizon. Welfare loss are then measured as the percentage reduction in total utility relative to the best-performing scenario—government intervention—where confidence recovers rapidly.[4]

Figure 5: Welfare loss under different $\theta(t)$ scenarios

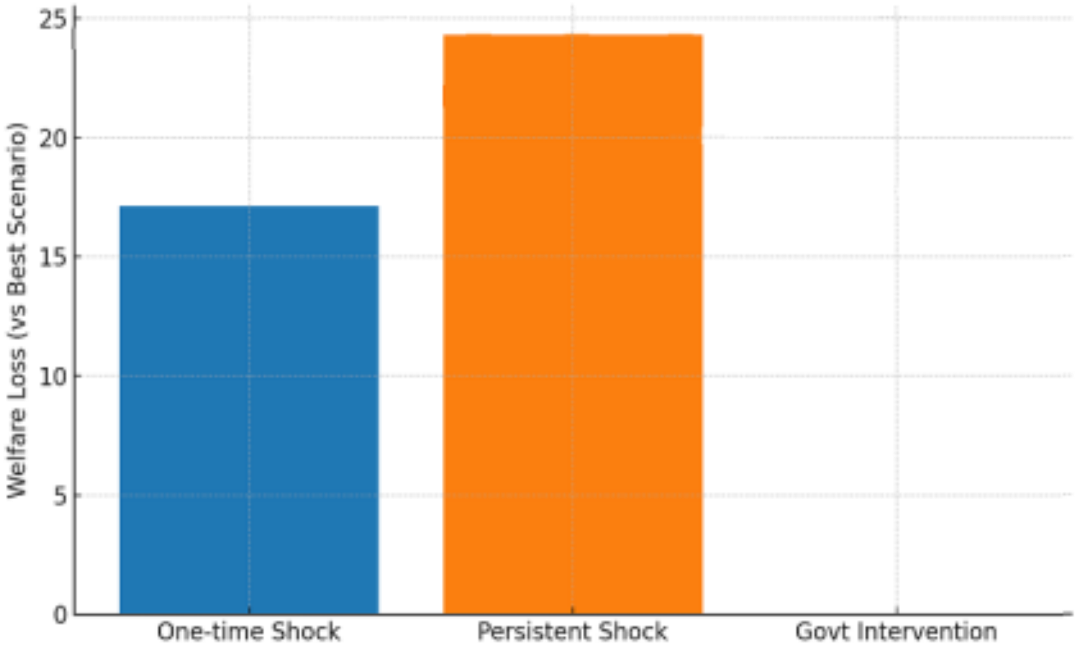


Figure 5 reveals that the persistent shock (orange bar) yields the highest welfare loss, amounting to nearly 25 utility units below the best-case outcome. This reflects the prolonged period of reduced perceived safety, which depresses both direct utility from tourism and investment-driven growth. The one-time shock (blue bar) performs moderately better, but still exhibits substantial welfare loss due to the slower economic rebound in the absence of policy intervention. As expected, the government intervention results in no welfare loss by construction, since it serves as the benchmark.

In summary, the figure underscores the macroeconomic cost of fear persistence, and highlights the powerful welfare-enhancing role of timely and effective government action. While even a temporary confidence shock can reduce long-term welfare, persistent uncertainty exerts particularly damaging and irreversible effects.

3. Conclusion

This paper develops a dynamic macroeconomic framework to analyse the long-run effects of tourism-induced fear on tourism and growth. By embedding a time-varying perception of security into a RCK model, we formally incorporate the behavioural distortions that arise when fear alters the marginal utility of tourism consumption. Our

[4] For full numerical results and lifetime utility values by scenario, see Table A1 in Appendix.

model captures how tourism shocks, though non-economic in origin, can trigger substantial and persistent economic disruptions through changes in consumption, savings, and capital accumulation.

Our analysis shows that the fear channel operates as a behavioural wedge that depresses tourism demand, reduces effective saving rates, and impedes long-term capital formation. This distortion, if left unaddressed, can push the economy toward a low-growth trajectory characterized by underinvestment and declining welfare. Our model also reveals that the recovery path of perceived safety—whether fast, slow, or policy-induced—critically determines the severity and persistence of macroeconomic losses.

Simulation results across three fear trajectories highlight the nonlinear and often counterintuitive dynamics of post-terror recovery. A one-time shock with natural fear decay leads to moderate welfare loss, while persistent fear results in the most severe long-run consequences. Interestingly, our model cautions against overly aggressive government intervention aimed at rapidly restoring tourism demand. If public policies stimulate tourism-related consumption before productive capacity has recovered, the resulting shift away from savings can induce capital collapse, undermining long-run growth and stability. Our findings thus call for calibrated, rather than purely reactive, post-crisis tourism and security policies—ones that rebuild confidence while preserving macroeconomic resilience.

Future research can extend the model in several directions. One promising avenue is to endogenize government behaviour, allowing public investment in security to be determined optimally in response to shock size and economic conditions. Another is to incorporate international spillovers—where tourism in one country affects tourism demand in neighbouring regions—within a multi-country general equilibrium framework.

Ultimately, our work underscores that while terrorism is a physical act of violence, its most enduring economic damage often arises from fear—and that managing this fear is as much an economic challenge as a psychological one.

Disclosure statement:

No potential conflict of interest was reported by the author(s).

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Appendix

Table A1: Raw welfare values and losses under different $\theta(t)$ scenarios

Scenario	Lifetime utility W	Welfare loss (vs. benchmark)
One-time shock	125.3	17.0
Persistent shock	117.8	24.5
Govt intervention (benchmark)	142.3	0.0