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Why a Small Probability of Terror Generates a Large Macroeconomic Impact?*

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Abstract

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We develop a macroeconomic model with fear, represented as a higher level of probability inflation then expected by the cumulative prospect theory, and optimal level of direct anti-terrorism expenditures. The results show that a fairly in-efficient government that chooses to supply the public with a safety commodity may lead to a relatively high production lost, as was estimated by Eckstein and Tsiddon (2004) and Abadie and Gardeazabal (2003).

1. Introduction

Since 9/11 terror has become a central policy issue for all Western societies. It caused a large increase in defense expenditures in the US as well as in some other countries. The increase in defense expenditures comes as a response of policy makers trying to reduce the impact of terror on the welfare of the public. The joint impact of terror on life expectancy and the increase in defense expenditure cause a reduction in consumption, investment and trade, as it is predicted by a standard aggregate model with life uncertainty (Eckstein and Tsiddon [2004], Shieh, Chen, Chang and Lai [2005]).

In Eckstein and Tssidon (2004) and in Abadie and Gardeazabal (2003), among others, it is documented that terror activities had a substantial macroeconomic impact on GDP, consumption, investment and trade. Eckstein and Tsiddon (2004) claim that "had Israel not suffered from terror during the last three years (2001-2003), we estimate that output per capita would have been about 10 percent higher than it is today".

However, the impact of terror on life expectancy is low since the increase in the rate of death due to terrorist activity is small. For example, in Israel, 2002 was the year of the highest rate of terror activity ever. In that year the number of Israelis that died by these activities was 0.01 percent from the population (one hundredth of a percent) and was about the same as the annual car accidents rate. Common sense says that if one doubles the rate of car accidents one does not expect such a large impact on the economy.

In this paper we analyze the question, why a small probability of terror has a large macroeconomic impact? That is, we develop a macroeconomic model in which one can quantitatively show that the increase in the probability of death, due to terror as was observed in Israel during the period 2001 to 2004, is consistent with the change in economic activities, which is associated with the impact of terror as was documented.

It is common in the behavioral literature that followed the classic work of Kahneman and Tversky (1979, 1992) that many individuals provide excessive positive weights to rare events. That is, the standard events of a calm day get lower subjective probability than the subjective probability of an unexpected bad outcome. This is caused due to regular risk and ambiguity aversion, and is based on tests regarding financial issues. Fear is a psychological concept where different individuals evaluate reality in a different way that is subjective rather than objective terms. In this paper we assume that in the presence of fear, and especially fear of death, the overweighting of an undesired result is even higher then as the cumulative prospect theory predicts. This assumption follows Viscusi and Zackhauser (2003) presenting questioners' results which prove that the assessment of terrorist threat is falling to biases and anomalies identified in the risk and uncertainty literature.

Until now merely few papers considered the psychological feelings associated with terrorist threat in a theoretical framework (Frey, Luechinger and Stutzer [2004]). Among those who did are Naor (2006) claiming disutility emerges from untimely death, Becker and Rubinstein (2005) claiming that the fear associated with terror generates lost of utility and Sustein (2003) claiming probability neglect of terror, meaning people consider only the damage of the undesired outcome without taking the probability of such an outcome into account.

The remainder of this paper is organized as follows. Section 2 presents a theoretic framework of our analysis. Section 3 describes the simulation methods used. Section 4 shows the results of these simulations and section 5 concludes.

1. The Model

1.1. The Economy:

The setting of this model follows Ya'ari (1965), Shieh, Chen, Chang and Lai (2005)[1] and Naor (2006). We consider a Diamond (1965) OLG model of two periods, each cohort consist of *N* agents when born[2]. Once in each period terrorism attack strikes the economy. Without taking any security measures, this terrorism attack might kill part of the younger generation. The ratio of those who might die in the terrorism attack basically inflects the level of terror faced by this economy.

The government may produce a safety good which reduces the death ratio imposed by the terrorism attack. The production of this safety good is being financed by taxes paid by the younger generation. This is a common assumption in the public health literature (Bhattacharya and Qiao [2005], Chakraborty [2003]). Yet, regarding security expenditures, it should be dealt very carefully since Kaplan, Mintz and Mishal (2004) find that not all anti terrorism activities obtain lower levels of terrorism activity. Hence, we explore several levels of affectivity of the government security expenditure over the survival probability of the agent.

While young, the agent works in a firm she owns, producing a consumption commodity. From the wage she receives and the profits she may have from her ownership over the firm she consumes, pays their taxes and saves for consumption in the next period. The agents that survive the terror attack and reach elderly consume their savings.

[1] This paper is similar to the work presented here with two main differences: they are not assuming that the government expenditures on direct anti terrorism activities are determined optimally and do not use any fear mechanism.

[2] This is not a strong assumption, and is made in order to prevent a situation in which the population diminishes. Every population growth rate which exceeds the terror rate achieves this goal, and this assumption is made only in order to simplify the mathematical calculations.

1.2. The agent's preferences:

In the economy there are two commodities which derive the agent with utility. The first one is a consumption good, c; and the second one is a safety commodity, g, which may reduce the death ratio, and is supplied solely by the government.

We specify the agent's instantaneous utility from consumption as a logarithmic utility function, and therefore the maximization target function is:

$$(1) \qquad \log(c_y^t) + \beta * \left(1 - \frac{\omega(d)}{f(g_t)}\right) * \log(c_o^t)$$

Where c_y^t represents the consumption of a member of the young generation born at time t; c_o^t represents the consumption of a member of the old generation born at time t; β represents the agent's time preferences; $f(g_t)$ represents the affectivity of the safety good in increasing the agent's survival probability and $\omega(d)$ represents the subjective terror level faced by the economy, meaning the decision weights of the terror level following the cumulative prospect theory.

The cumulative-prospect theory attempts to understand the way we perceive risk possibilities. When we confront a chance either of winning or of losing money in a game with known probabilities, we tend to act as if we estimate these probabilities inaccurately. Tests by Kahneman and Tversky (1979, 1992), Tversky and Fox (1995), Prelec (1998), and many others show that we tend to overweight low probabilities and underweight moderate and high probabilities. Therefore, the value of each outcome in a prospect is multiplied by a decision weight and not by the additive probability.

In view of these empirical tests, the decision weight function has the following properties: regressive, asymmetric, *S*-shaped,[1] and reflective.

Several algebraic functions have been constructed to describe the decision weights, $\omega(P)$, all of which are continuous in [0,1) and continuously differential in (0,1). These algebraic specifications were constructed using econometrics methods on the tests results regarding certainty equivalence.

We are using Perlec's (1998) specification:

[1] In which a sure \$30 is preferred over an 80% chance of obtaining \$45 even as a 20% chance of obtaining \$45 is preferred over a 25% chance of obtaining \$30. (Tversky and Fox [1995]).

(2) $\omega(d) = \exp(-\lambda(-\ln d)^{\gamma})$

Since the terror level is relatively small, using decision weight means sort of subjectively inflating the terror level faced by the economy.

Regarding the subjective terror level three different alternatives are analyzed:

1. Both the government and the agents use decision weights rather then the terror level in the expected survival probability.
2. While the agents are using decision weights, the government uses the actual terror level.
3. Both the government and the agents use the actual terror level. Meaning: $\omega(d)=d$.

These three different alternatives are used not only for the calculation of the quantitative effect of terror on the economy, but will play an important role in the further research.

When using the cumulative prospect theory in this model, we assumed that the agent use decision weights function over the initial terror level and not over the adjusted survival probability given the level of supplied safety good (meaning we used $\frac{\omega(d)}{f(g_t)}$ rather then $\omega\left(\frac{d}{f(g_t)}\right)$). This assumption was made in order to simplify the mathematical analysis but it *does* affect our results. According to the cumulative prospect theory the agent acts as if inflating the probability more, the smaller the initial probability is. Meaning, when applying this theory on the initial terror level and then consider the safety good effect over the survival probability we receive a higher survival probability then we should have. This means that our results regarding the terror affect are downward biased.

The government taxes the agent with two different taxes: lamp-sum tax, T_t, which finances the government expenditures in creating the safety good, and an income tax at a rate τ_t, which finances all the other government expenditures. Both taxes are collected only from the members of the young generation[1]. Therefore, the agent's budget constraint is:

(3) $$\begin{aligned} &(w_t + \pi_t)(1-\tau_t) - T_t = c_y^t + s_t \\ &c_o^t = s_t * (1 + r_{t+1}) \end{aligned}$$

[1] This assumption is made in order to simplify the mathematical computation.

Where w_t is the agent's gross wage from working in the firm; π_t is the agent's profit from the firm she owns; s_t is the savings of the young generation and r_{t+1} is returns she receives for her savings.

Since part of the young generation would not reach elderly due to terrorism activity, they would not consume their savings. We assume that the government inherits their savings and uses them to finance its expenditures (not including the production of the safety good).

1.3. Technology:

We assume that each agent owns one unit of labor, when young and that the labor is inelastically supplied. The firm acts competitively and its' production function is specified as a Cobb-Douglas:

(4) $$y_t = Ak_t^{\alpha}$$

Where y_t is the total production, A and α are the production parameters and k_t represents the capital used by the firm.

The government owns a technique that enables it to transpose production into a safety commodity. This safety commodity affects the survival probability as indicated earlier. The affectivity function needs to keep several requirements:

- The affectivity of zero safety good is one. Meaning if no safety good is being produced, the survival probability depends only on the initial terror level, ($f(0)=1$).
- The more safety good being produced, the survival probability is higher, .($f'(g)>0$)
- Decreasing marginal affectivity of the safety good, ($f''(g)<0$).

Following these requirements, the specification for the affectivity function is set in a logistic form:

(5) $$f(g_t) = \frac{\exp(\frac{g_t}{b})}{(1-a)+a\exp(\frac{g_t}{b})}$$

Where a and b are the parameters of the affectivity. Kaplan, Mintz and Mishal (2004) showed that not all of the government anti-terrorism activities in Israel during 2001-2003 actually lowered the number and size of suicide bombing. Following these results we do not make any assumption regarding the efficiency of the government and simulate the model for different values of these parameters.

1.4. The government:

The government is producing two different products: the first, g_t, is a safety good, meaning direct anti-terrorism expenditures; the other one, g'_t, is all the other government expenditures[1]. Setting G_t as the total government expenditures we receive:

(6) $$G_t = g_t + g'_t$$

We assume that the government is keeping the budget balanced for each of the products. Hence:

(7) $$\begin{aligned} g_t &= N * T_t \\ g'_t &= N * w_t * \tau_t + s_t * N * \frac{d}{f(g_t)} \end{aligned}$$

We assume that τ_t is a parameter and that T_t is the government choice variable. The government sets the lump-sum tax optimally according to the agent's preferences.

1.5. The equilibrium:

The equilibrium of the model must hold few properties:

[1] We do not assume that all the government expenditures are set optimally. Therefore, in order to simplify the model we assume that all the other government expenditures rather then direct anti-terrorism expenditures do not derive the agent with utility.

1. *Goods Market Equilibrium:*

The following resources constraint must be held:

(8) $$Y_t = Ak_t^{\alpha} = N * c_y^t + N * (1 - \frac{d}{f(g_{t-1})}) * c_o^{t-1} + G_t$$

We assume full depreciation, so that the capital follows the law of motion:

(9) $$\begin{aligned} k_{t+1} &= I_t \\ I_t &= N * s_t \end{aligned}$$

Where I_t is the investment in the economy, which is equal to the total savings of the entire young generation. Remind that the agent saves before the realization of the terror activity.

2. *Factor Market Equilibrium:*

Since we assume that the firm acts competitively the factors should equal the marginal productivity. Therefore the wage offered by the firm is the marginal productivity of labor - $w_t = (1-\alpha)Ak_t^{\alpha}$, and the interest rate is the marginal productivity of capital - $r_t = \alpha Ak_t^{\alpha-1}$. This assumption also implies that the firm has zero profits.

1.6. <u>First order condition</u>:

The agent maximizes her expected life time utility considering her budget constraint. The indirect utility function is therefore:

(10) $$V(s_t, g_t / \cdot) = \log\left((w_t + \pi_t) * (1-\tau) - T_t - s_t\right) + \beta\left(1 - \frac{\omega(d)}{f(g_t)}\right) * \log\left(s_t * (1 + r_{t+1})\right)$$

Differentiating equation (10) with respect to the savings leads to the optimal level of savings:

(11) $$s_t = \frac{\beta(1 - \frac{\omega(d)}{f(g_t)})((w_t + \pi_t) * (1 - \tau_t) - T_t)}{(1 + \beta(1 - \frac{\omega(d)}{f(g_t)}))}$$

Notice that $\beta(1 - \frac{\omega(d)}{f(g_t)})$ is the effective subjective discount rate, since the agent takes into account her survival probability as well as her subjective time preference. Also notice that $((w_t + \pi_t) * (1 - \tau_t) - T_t)$ is the agent net income. Therefore, the savings are economically identical to those of the regular O.L.G. model.

Using the optimal savings, the agent's indirect utility function and the budget constraint the government finds the optimal level of safety good. The first order condition regarding the safety good is[1]:

(12) $$\left(\frac{(-1+a)\omega(d)}{b}\log\left(\frac{(1+r_{t+1})\beta(N(w_t+\pi_t)(1-\tau) - \frac{g_t}{N})((1-a)\omega(d) - \exp(\frac{g_t}{b})(1 - a\omega(d))}{(1-a)N\beta\omega(d) - \exp(\frac{g_t}{b})N(1+\beta - a\beta\omega(d))}\right)\right) + \frac{1+\beta}{N(w_t+\pi_t)(1-\tau) - g_t} - \beta\exp(\frac{g_t}{b})\omega(d)\left(\frac{1 - a + a\exp(\frac{g_t}{b})}{N(w_t+\pi_t)(1-\tau) - g_t}\right) = 0$$

Equation (12) does not have a closed form solution so that in order to find the optimal level of safety good simulations must be used.

[1] This is the first order condition when the government and the agents use the same level of terror level (alternatives 1 and 3). In the other alternative the first order condition is more complicated, and does not have an analytical solution as well.

2. The Solution Methods

The model is solved backwards. Meaning, first of all we understand the level of savings desired by the agent for every given level of taxes, and then we find the optimal level of the lump-sum tax desired by the government. It is important to emphasize that the model does not have a closed form solution and that we present here a numerical solution. The mechanism which we use to achieve the numerical solution can be used due to the specification of the instantaneous utility function. Using the logarithmic function we receive that the income effect and the substitution effect of the interest rate over the savings are exactly the same, so that it seems as if the interest rate does not affect the savings at all.

The simulations are built as follows: For a given initial level of capital in the economy, and given parameters, which are discussed soon, we can find the wage in the economy and the savings as a function of the lump-sum tax level, $s(T_t / \cdot)$. Substituting the savings in the indirect utility function and the government's budget constraint, we receive a function of the safety good and the future interest rate only. Deriving this indirect utility function with respect to the safety good, we receive an implicit function of the safety good and the future interest rate. We use the law of motion to replace the level of the next period capital in the interest rate and receive an implicit function of the safety good. This function can be numerically solved and we receive the optimal level of safety good supplied by the government, and the optimal level of lump-sum tax needed to finance it.

Given the optimal level of the lump-sum tax and the safety good, the savings are calculated. By using the law of motion we can also calculate the capital in the next period. We repeat this mechanism over and over until we reach the steady state. The steady state is characterized by equal levels of capital in two subsequent periods. Meaning kt+1=kt.

Before presenting our results we must announce the parameters that we used:

The size of the population, N, was normalized to 1. This assumption does not influence our results.

The production parameters - We set A, the productivity factor, to be 120[1] and α, the production elasticity with respect to capital, to be 0.3.

The agent's preferences parameters - β, the subjective time preference, is set to be 0.97, and λ, one of the decision weights parameter, is set to be 1, following Perlec (1998). Regarding the other parameter, γ, we should elaborate more. Perlec (1998) estimated γ as 0.7; it can be shown that when γ is 1, the decision weight is the actual probability. Our discussion is focused on relatively small initial probabilities (smaller then 1/e), in this case, and following equation (2) one can observe that the lower is γ the higher is the decision weights for low probabilities are. In our simulations we used several levels of γ and not only the value that was estimated by Perlec (1998). We are doing so, in order to specifically account for the fear associated with terror. While the basic cumulative prospect theory deals with financial prospects, and is based on the questioned response regarding their certainty equivalence value, c, of a prospect that would give x USD in a probability p and zero otherwise. The decision weights were calculated as $\omega(p) = \frac{c}{x}$. These prospects were not dealing with any sort of fear, rather pure risk aversion. Thus the parameters which were estimated by these prospects do not indicate fear. One of the qualities of fear is higher probabilities associated with the undesired results, in this case pre-time death. Asking a frightened person what is the probability of her dying in a terror activity at a certain place is assumed here to lead to a higher probability then expected by the cumulative prospect theory. We assume that the any drop in the level of γ below 0.7 is related directly with the subjective fear associated with the terror. Viscusi and Chesson (1999) found that fear of ambiguity (when the level of risk is not clear) creates higher decision weights then those created by pure risk. Segal and Stein (2006) used these higher decision weights dealing with criminal process. Viscusi and Zeckhauser (2003) found that terrorism risk produced the kind of risk that is likely to be severely misestimated. Hence, our logic is as follows:

The government's parameters - we set τ, the income tax, to be 0.3. We must emphasize again that all the other government expenditures, g't, rather then direct anti-terrorism expenditures, are not assumed to be set optimally. Regarding the affectivity parameters a and b

[1] Estimations such as Cohen and Hsein (2003) found that *A* is from 1 to 1.5 per year. Since in the OLG model each period accounts for 30 years, 120 means 1.17 per year.

e simulated the model for a large number of combination. For every given level of safety good the logistic function operates on g_t / b. So that the smaller is b the more efficient the government is, and we must demand b to be positive. Regarding a, it effects the slop of the affectivity function (the higher is a the steeper is the affectivity function) and defines an average between 1 and $\exp(\frac{g_t}{b})$. Therefore, due to its role, we demand that it would be between zero and 1.

We also simulate the model for different levels of initial terror activity. One must notice that the observed survival probability results from equilibrium, meaning after considering the government expenditures for direct anti-terrorism activities. The initial terror level faced by the country may certainly be higher. We follow the data from 2002 in Israel to consider the adjusted death ratio as 0.0001 (one hundredth of one percent).

While simulating the model we considered the three different alternatives regarding the basic probability both during the convergence of the economy to the steady state and between different steady states depending on different levels of initial terror threat and other parameters.

3. Results

3.1. <u>The dynamics:</u>

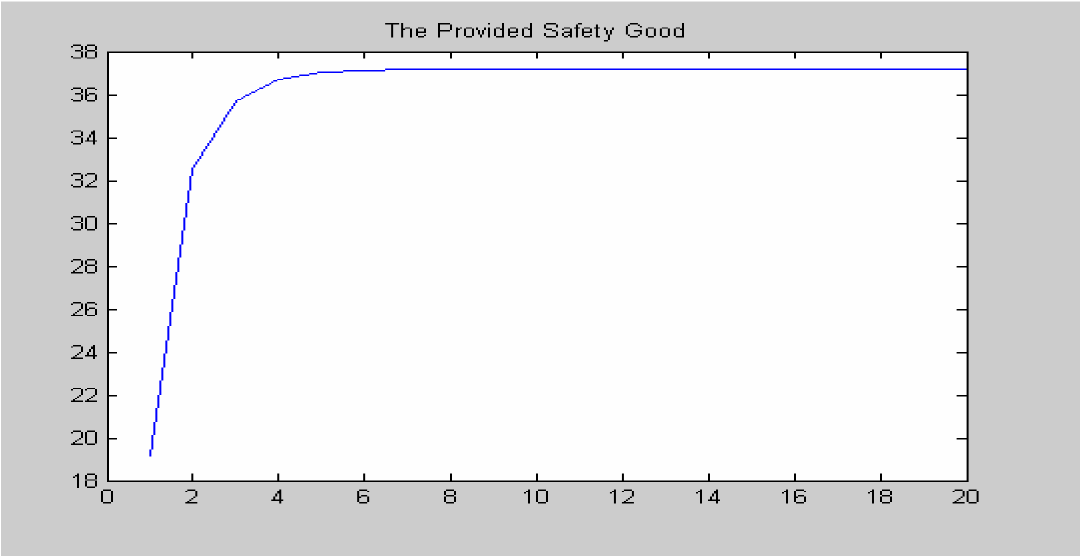
In the next sub-section we show that not all levels of terrorism threat and government affectivity in reducing this threat lead to government direct anti-terrorism expenditures. In this section we describe only the results that do involve direct anti-terrorism expenditures. When no safety good is being supplied at all, the convergence to the steady state is similar to the one described in Naor (2006).

We set a relatively low value of initial capital in order to make sure that we follow the economy on its growth path. The simulations show that given the government optimal level of anti-terrorism expenditures, all the economic variables in interest behave as in the regular OLG model. Meaning, as the capital grows so do the wage, the consumption and the savings.

Regarding the safety good, the simulations show that the supplied amount grows along the growth path. Figure 11 shows the safety good production as a function of the time.

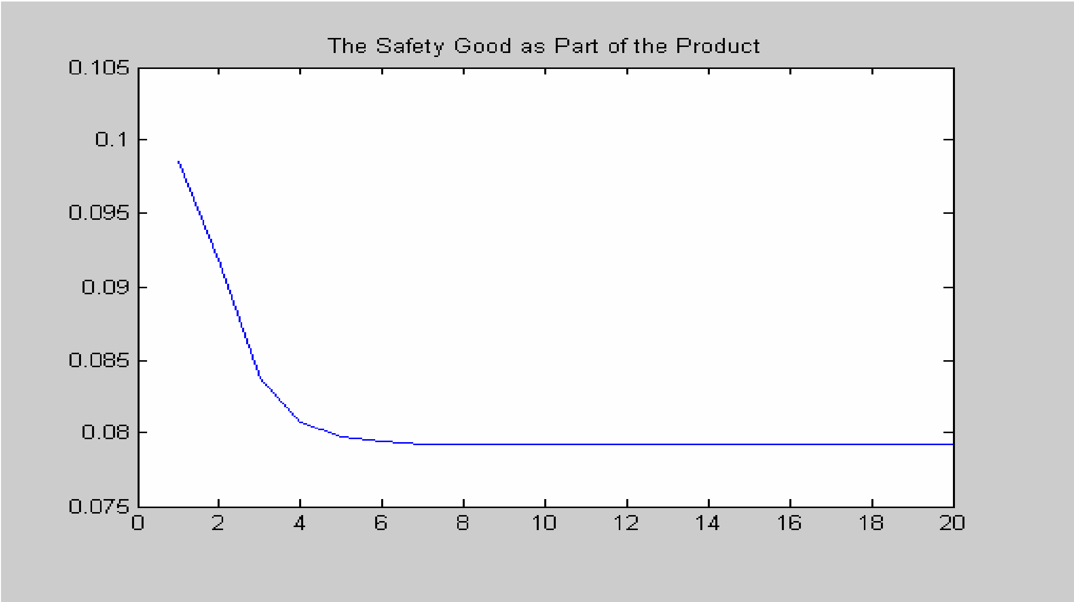
[1] The simulation results presented in this section are on the case in which both the government and the agent are using decision weight, and the parameters are those which explain 4.75% lost of production between the initial steady state to the new one (b=19; a=0.01). The simulation for the other sets of parameters, which leads the government to produce safety commodity, is qualitatively the same.

Figure 1



Yet, in percentages (either from the production or from the wage), the safety good is dropping, meaning it does not grow as fast as the capital does. This leads to higher net income, both since the wage is increasing (due to higher level of capital per capita) and since the lump-sum tax is less costly to the agent (in percentages of her income). Figure 2 shows the simulation results regarding the safety good share in the product as a function of the time. Remind that this is since the production grows over time as well.

Figure 2



The increase of the safety good along the growth path leads also to a higher survival probability. This enables the economy to reach a steady state that involves more capital, since the agent is saving a bigger share of his gross income, which is also bigger since the wage grows. Notice that this is leading to real growth and not to higher growth rate, which is dropping as we get closer to the steady state. So that two countries differing only by their capital per capita would reach eventually to the same steady state. There is no poverty trap.

As in every OLG model, what derives the growth is the accumulation of capital, which is caused by higher savings. Here, the savings rise due to three reasons: higher gross wage, relatively lower lump-sum tax and a higher survival probability leading to lower present preference.

One more interesting analyze of this economy is comparing the pre-terrorism steady state to the post-terrorism one. This is done in the next sub-section.

3.2. Comparative Statics:

Before presenting the results we turn to a short explanation of the model's intuition. When the government interferes in the economy by producing a safety good it causes two different effects on the savings, and therefore the capital, at the same time. First it lowers the net income of the agent, since she must pay more taxes in order to finance the production of the safety good. This is called an income effect. Second, it raises the agent's survival probability and therefore her incentive to save; this is called the substitution effect. These two effects are opposite, so that one can not say clearly what happens to the savings once the government interfere. In the agent's view, the income effect can be referred as the cost, and the substitution effect as the benefit of the safety good.

As can be seen from equation (11) the savings depends on the net wage of the agent. If a certain generation saves less this leads to lower level of capital in the next period and consequently lower gross wage for the workers of the subsequent generation. Obviously, having earned less, the next generation is able to save less. Meaning that in the steady state the reduction in the savings also creates a reduction in the wage.

We simulate the three different alternatives and analyze these two effects. In all the three alternatives we reach to a steady state with a lower capital per capita then the pre-terrorism one. This is caused by a reduction in the savings due to lower survival probability and hence higher present preferences.

An interesting point is comparing the steady state with the golden rule. The golden rule determines the maximum level of consumption, but does not determine the mechanism which shifts the economy to this level. According to the golden rule the level of savings in the economy is too low if the marginal productivity of capital (the interest rate) is higher then the sum of population growth and the depreciation rate (the total depreciation of capital per capita)[1]. In this model even the pre-terrorism economy suffers from too low capital per capita. So that all the three alternatives that lead to lower levels of savings shift the economy further away from the golden rule.

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[1] $r_t > n + \delta \rightarrow k_{ss} < k_{GR}$

The First Alternative - Both the Government and the Agents Use Decision Weights Rather then the Terror Level in the Expected Survival Probability.

This case clearly explains why a small probability of terror has a large macroeconomic impact. The intuition is as follows: Since both the agent and the government use decision weights rather then the actual terror level, the government invest a lot in producing the safety good. This safety good maintains higher survival probability and by that helps to raise the savings of the agent's, but the cost of producing it is rather high.

Intuitively, as the level of initial terror threat faced by the economy is higher, the government spends more resources on security (even as a share in the product). Therefore, the net income of the agent is lower, allowing her to both consume and save less. This leads to lower levels of capital, production and wage, and higher level of interest rate.

We start the simulation using the decision weight parameter suggested by Perlec (1998) meaning γ=0.7. Given this, we simulate the model for several combinations of the affectivity parameters a and b. The simulation show that we can only explain 0.75% lost of production in the economy relative to the pre-terrorism steady state. This is a considerably high level of production lost, meaning that in this case by interfering the government enlarge the impact of terror. If the government is less efficient in producing the safety good (higher b) it chooses to supply less safety good, even though this lowers the survival probability the reduction in the tax burden is significant and leads to actual higher level of savings; If the government is more efficient (lower b) it needs to collect less taxes in order to maintain the level of safety good supplied. Regarding a, the second parameter of the affectivity function, as it gets higher a lower amount of safety good is needed to create the same reduction in the terror threat level. When looking for the maximum lost of production, it is always achieved in relatively low levels of a, which lead to flatter affectivity function. In this case the maximum lost of production is achieved when the government supplies the public with safety good but in a relatively non-efficient manner.

We also receive a threshold level of efficiency needed in order to produce a safety good at all. The choice whether to produce the safety good or not depends mainly on the level of b.

Meaning, any government which is able to transfer production into a reduction in the death ratio less efficiently (very high b) chooses not to produce the safety good at all (in the levels of threat in interest); the more efficient governments produce it. Given that b is low enough so that the government chooses not to supply the public with safety good at all, the level of a is irrelevant. This is because a determines a weighted average between 1 and $\exp(\frac{g_t}{b})$. Given that g_t is zero, every a, which satisfied our condition, delivers the same result. In this case, the threshold level is higher then the one that maximizes the lost of production. This is true since we are observing the adjusted survival probability, which is achieved for different levels of initial terror threat, depending on the affectivity function parameters.

As explained above, we do not restrict ourselves only to the decision weight parameter, γ, estimated by Perlec (1998). Allowing γ to become smaller, and by that capturing the fear associated with terror, we can explain higher levels of production lost.

As γ gets smaller the threshold level of the efficiency parameter, b, from which the government starts to produce the safety good get higher. Meaning, if the government and the public experience higher levels of fear associated with terror, even a less efficient government spent production on direct anti-terrorism activities. In this case, the maximum lost of production also takes place given a less efficient government. This result is consistent with Sunstein (2003) claiming that if the government cannot ease the fear associated with terror in any other way, it should try to ease the level of risk.

Every reduction in γ, leads to a drastic drop in the maximum lost of production. So that if γ=0.4, we can explain 4.75% production lost between the two steady states. This maximum lost of production is achieved for higher levels of b. This means that as the public and government experience higher levels of fear a less efficient government causes more damage, since it find need to produce the safety good even though it is costly to produce.

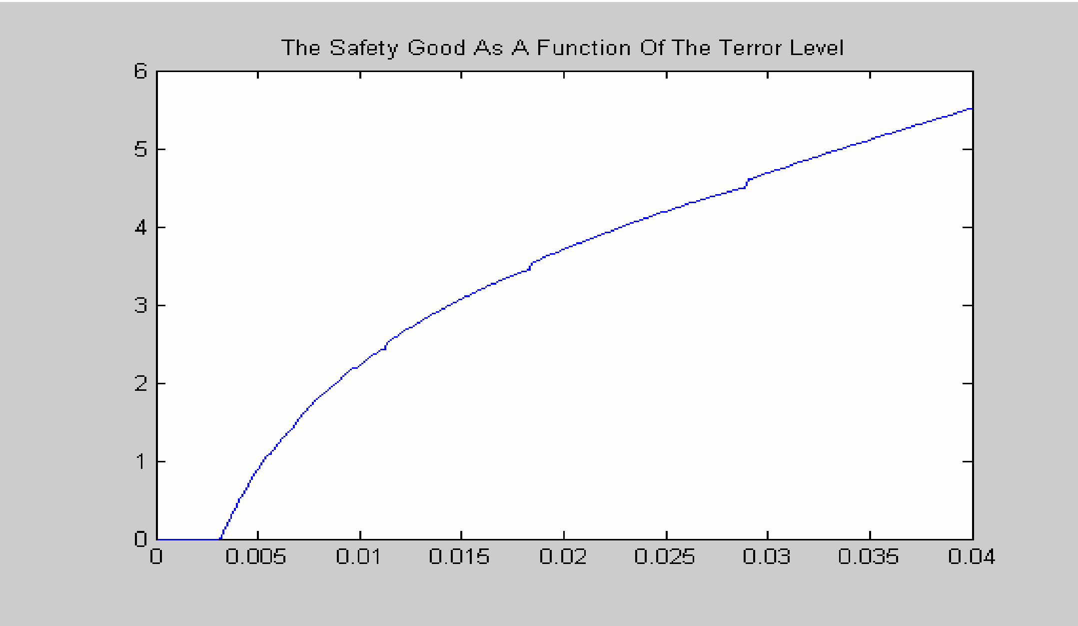
The Second Alternative - While the Government Uses the Actual Terror Level the Agent Uses Decision Weights

The idea of this part of the model is as follows. The government is aware that the agent's savings are based on decision weights. Yet, after substituting the savings into the indirect utility function the government uses the *actual survival probability* associated with the terror level faced by the economy rather then inflated one.

In order to assume this assumption, we need to introduce a model that explains why people tend to use the cumulative prospect theory. Gayer (2005) showed that when an agent is trying to understand a certain probability she uses similarities to probabilities that she already faced before. The level of similarity drops as the new probability is farther then those she knows. Thus, when evaluating a small probability, most of the knowledge regarding previous probabilities involves higher probabilities and leads to higher decision weights. The more probabilities accumulated in the agent's knowledge, the less inflated these decision weights would be. Using this theory in our model, and assuming that the government has acquired more knowledge then the representative agent, leads us to this case.

The simulations show that the threshold level of terror that would lead the government to supply the public with safety good is higher once the agent is using decision weight rather then the actual death ratio imposed by terror and the government is using the actual one. This is since a relatively non-efficient government that in the presence of fear chooses to produce a safety good, finds it less desirable once it itself is not influenced by fear. In this case, as well as in the previous one, the threshold level is lower the lower is the decision weight's parameter, γ. Figure 3 shows the supplied safety good in the steady state as a function of the initial level terror activity.

Figure 3



The main result of this part of the model is rather intuitive. If the government uses the actual terror level it supplies less safety good to the public, and therefore less production is lost to the economy. This is true both since the in the previous case the government is over investing in direct anti-terrorism activity, and since the adjusted surviving probability that we use reflects now a lower level of terror.

Another interesting result that evokes from the simulation is the level of efficiency that leads to the highest level of production lost. It turns out that in this case, inefficient government that chooses not to produce safety good at all leads to more production lost then an efficient one who chooses to produce it. This is true since the agent uses decision weights, and therefore the lack of anti-terrorism activity affects her savings strongly. This does not mean that it is optimal to produce the safety good in this case, and is a direct reaction to the different target function used by the government and the agent.

Also in this case, we first simulate the model using the decision weight parameter that was estimated by Perlec (1998). The maximum level of production lost that could be achieved in this case is 0.19%. In this case only a government that can multiply the production it uses in the safety good affectivity function by 6 (meaning b is lower then 0.15) chooses to supply the public with safety good, and by that saves the economy from even a larger production lost.

In this case as well, allowing for lower levels of γ creates larger maximum production lost which is in the case when the government supplies the public with no safety good at all. The level of b which drives the government to choose not to produce this safety commodity is higher then in the pervious one. For each level of γ the maximum lost of production is lower then in the previous case, when both the government and the agent inflate the death ratio imposed by terror. This is basically true since this case involves no direct anti-terrorism expenditures at all and therefore the agent prefers to consume more in the first period of his life.

The Third Alternative - Both the Government and the Agent Use the Actual Terror Level

While simulating this model we reached a non trivial result. For the initial terror threat (0.0001) the optimal level of safety good is zero for every set of parameters of the affectivity function. Meaning, the production is falling due to a lower incentive of the agent to save. She thinks that future is less likely and therefore her incentive to save drops. If the economy is in its' steady state before any terror activity has been experienced, this reduction in the incentive to save leads to lower level of savings and capital and therefore for lower production in the economy. Yet, this reduction is very small (0.0023% from the production between the two steady states).

In this case, the government starts to supply safety good for the population only given relatively high levels of terror threat. The level of terror threat that would lead the government to provide the public with a positive level of safety good depends, as in the previous cases, mainly on the efficiency parameter b. As the government is more efficient (b is lower) it may supply safety good which influences on the survival probability of the agent relatively cheap, and therefore it chooses to do so. Thus, the government supplies the public with relatively low levels of safety good even for relatively low level of terror faced by the economy (which is still higher then level in interest).

4. Conclusions

This paper provides an explanation to a macroeconomic puzzle - why a small probability of terror generates a large macroeconomic impact. Our explanation to this puzzle is divided to two. First, we allow for a government intervention in the economy by supplying the public with a safety good that reduces the death ratio imposed by terrorism activities. Since the safety good in financed through taxes, it lowers the net income of the agent. Second, we assume the Cumulative Prospect Theory based on Kahneman and Tversky (1979, 1992), asserting use of decision weights rather then probabilities. According to this theory, people tend to overweight small probabilities, such as the death ratio associated with terror activity, and underweight high probabilities. We allow for higher levels of overweighting probabilities due to emotional feeling associated with terror such as fear.

Using these tools, we can numerically achieve the same behavior of the macroeconomic variables as is empirically described in Eckstein and Tsiddon (2004) for Israel data during the second Intifada (2002-2003) and in Abadie and Gardeazabal (2003) for the Basque Country data during 1968 till the late 90's.

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