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Abstract

We explore the supply side of the market for suicide bombers. While the strategic edge of suicide attacks for certain terrorist organizations has been thoroughly explored, the motivation of the suppliers remains quite mysterious. Following a review of existing theoretical approaches and empirical findings we develop a model of the supply of suicide bombing, the motivation of which is expressive but time inconsistent. The model implies terrorist organizations to provide a commitment device in exchange for the ``services'' of those suicide bombers' that do not suffer from any mental or physical burden of life. By contrast, suicide attackers that do suffer from some sufficiently severe burden of life are not reliant on any commitment device and should therefore be expected to more frequently act as lonesome-wolf attackers.

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1 Introduction

Between the end of the notorious World War II Kamikaze missions and the year 1982, suicide attacks have been on hiatus as a combat strategy. On November 11, 1982, then, the Lebanese Shi'ite terror group Hezbollah launched the first post-World War II suicide attack by sending a living bomb directly into the heart of their target, leaving 115 people dead. This triggered the deadly and still rolling wave of what today is called "modern" suicide terrorism. To this day, this wave has mounted to some 5000 suicide attacks worldwide, killing nearly 50,000 people, most of whom were innocent bystanders who happened to be at the wrong place in the wrong time.

As irrational and intellectually misdirected as modern suicide bombers appear in the eyes of most observers, researchers were surprised to find suicide bombers to be all but poorly educated psychopaths or mentally ill fanatics detached from sound social relationships (Bloom 2005, 35-37). Indeed, the suicide bombers appeared to be relatively well educated, materially well endowed and socially integrated individuals that were respected in their communities. If any, most of these people showed a particularly strong rather than a weak character, and they did not convey any sign of being tired of life. All in all, researchers found these people to be rather normal in almost any respect (Krueger 2003; Pape 2003, 2005).

These arguably unexpected findings drew most scholars' attention away from the hitherto perceived weird personality of those individuals that have become notorious as the modern suicide bombers. Rather, the attention was shifted toward the strategic goals of those that hire such individuals, namely terrorist organizations that embed suicide attacks into their overall combat strategy. In this paper, we will refer to the latter as the demand side of the market for suicide bombers. One of the central research questions regarding the demand side has been the following: What is the profile of a person such terrorist organizations would want to single out from the group of those individuals that are willing to give their lives in order to kill others, that is from the suppliers of suicide bombings?

Meanwhile, a solid body of theoretical and empirical work on that particular aspect of the market for suicide bombers has evolved and enriched our knowledge (Berman and Laitin 2005; Pape 2005). Indeed, given the strategic and personal goals of terrorist organizations, suicide attacks have proven to be advantageous in a relatively clearly defined set of circumstances. Adopting suicide attacks as part of a combat strategy can thus be explained as a purely rational, albeit infamous decision on the side of the demanders of suicide bombings.

Although the supply side did not remain fully unexplored, the motives and mechanism at work there remain somewhat mysterious to date. What we know is that recruiting potential suicide bombers turned out to be a surprisingly easy endeavor. While Iannaccone (2006) still bases his theoretical approach on the assumption of shortages in supply, journalist Nasra Hassan (2001) found quite the opposite to be true in her interviews with nearly 250 Palestinians, among which were suicide bombers whose mission had failed, families of deceased bombers, and leading organizers of Palestinian terrorist attacks. She quotes the following words of a senior member of the al-Qassam brigades: "Our biggest problem is the hores of young men who beat on our doors, clamoring to be sent. (...) It is difficult to select only a few. Those whom we turn away return again and again, pestering us, pleading for being accepted." (quoted from Hassan 2001, 9). This quote stands in stark contrast to the quite normal traits and the tentatively even strong character that scholars found among those that blew themselves up only for the sake of killing others. Although Hassan had performed her interviews as early as between 1996 and 1999, there does not seem to be any evidence about a significant change in the characteristics of a typical suicide bomber.

Since any exchange model of suicide bombing would require some sort of self-enforcing mutual agreements, and since a suicide bomber will most naturally not survive the fulfillment of his[1] obligation, exploring the logic of the market for suicide bombing is difficult, to say the least. While the picture

1. We generally use the male form as our generic gender since males are by far the most frequent perpetrators of suicide attacks.

of brainwashed religious fanatics driven by the expectation of 72 virgins in paradise still prevails in the media it is apparently far from addressing the crucial aspects of suicide bombings suppliers' motivation.

Iannaccone (2006) as well as Berman and Laitin (2005) nevertheless concede a certain role of religion to be relevant, but like Pape (2003, 2005), Bloom (2005, 85-88) and Azam (2005), they also refer to assuming altruism as a way out of the inherent consistency problems. However, while altruism might play some role it should be noted that the strategic goal into which terrorist groups embed their suicide attacks is a public good. Contribution to this public good by way of a suicide attack does not only presume altruism. Rather, at least in light of the extremely high individual costs and the limited strategic value of a single attack, some degree of irrationality is at least very likely to be involved in the case of such an attack to be instrumentally motivated.

Hence, while altruism and even expectations of rewards in the hereafter might indeed play a role empirically, referring to such motivators alone comes somewhat too close to tautological immunizations, and it should be surprising if well educated and mentally stable people stemming frequently from a middle-class background were driven by such a huge degree of individually senseless altruism or, alternatively, by some unrealistic promises for the hereafter alone. What is more, suicide bombing is by far not unique to religious terrorists but has been part of combat strategies of both religious and secular groups alike. After all, the LTTE[2] or Tamil Tigers, a secular group that fought for an independent Tamil State in Sri Lanka between 1983 and 2009, was one if not the most deadly group among those that applied suicide attacks (Bloom 2005, 45-75, Hopgood 2005). In general, there is no evidence that secular groups face tighter demand restrictions when recruiting potential suicide bombers.

Given that religious fanaticism alone remains an insufficient explanation, and given that the assumption of pure altruistic motivations contradicts the logic behind the public-goods character of supplying suicide-bombing services in

2. LTTE stands for Liberation Tigers of Tamil Eelam; see details in Bloom (2005, chap.3).

conjunction with a minimum degree of rationality on the side of the perpetrators, a desire to explore alternative motivators remains.

More in line with the assumption of at least some minimum degree of rationality, Wintrobe (2006) as well as Harrison (2006) consider wishes for solidarity and identity as arguments in the utility function of potential suicide bombers which they rationally trade against their personal autonomy and which can go as far as to fully adopt the recruiter's preferences. By contrast, Ferrero (2006, 2012) abstains from assuming such particular arguments of the suicide bombers's utility function since they may be viewed as somewhat arbitrary. He rather operates on the basis of a two-period model in which, under certain conditions, a high time-preference rate may be sufficient for a person to enter into what he called a "martyrdom contract". Exceptionally high streams of utility provided to the suppliers by terrorist groups in a first period come at the cost of an obligation to eventually follow a call on a suicide mission in a second period, which happens with a probability below one. The ensuing commitment problem will then be solved by way of penalties so severe that the perspective of continuing one's life under the conditions of the penalties does not appear worth it.

Empirically, suicide bombings explained in such a way should be expected to be organized and performed within the framework of a strictly hierarchical organization capable of enforcing contracts with individuals that face strongest incentives to renege on their obligations. While organizations like Hamas, Hezbollah, or ISIS apparently have such a capacity, a martyrdom contract fails to explain suicide attacks the perpetrators of which could have relatively easily escaped their deadly obligation, making the incentive to breach the underlying contract in the second period overwhelmingly strong.

What is more, a martyrdom-contract theory fails altogether in the case of so called "lonesome-wolf attacks" which the perpetrators claim to perform in the name of some terrorist organization but which the respective terrorist organization has not endorsed. Depending on the expediency of the respective deed for the terrorist group in the name of which the lonesome wolf acted, they do or do not take responsibility for it afterwards. In no case, however,

can the attack be explained by a martyrdom contract, so that there must be more to the motivation of the whole range of suicide attackers than an obligation stemming from such a contract.

Recently, Borowitz (2005) as well as Azam and Ferrero (2016) have argued that some sorts of suicide attacks and mass murders may be led by a quest for notoriety, which they refer to as the "Herostratos Syndrome". People that have a desire to be remembered beyond their earthly existence but that do not have the capacity for magnificent contributions to the cultural or social benefit of society might sometimes bypass this lack in capability by reverting to infamous deeds that make them unforgotten as well, much the way Herostratos did by burning down the famous Artemis Temple in 33 AD who, after all, is remembered for this deed to date.

While convincing in principle, such an explanation leaves it open as to how rational selfish persons could ever reap utility from a disputable stardom when, at the very moment they lay the groundwork for their notoriety, they will cease living. Admittedly, though, the Herostratos syndrome does not aim at explaining suicide bombings alone, and doing so is perhaps not even at the center of this approach. Rather, the authors consider all sorts of deeds the destructive capacity of which is expected to be remembered by as many people over as many generations as possible by the perpetrators. Nevertheless, they apply their approach to suicide attacks and other attacks alike, and they even apply it to non-ideologically motivated acts of mass murder like that of the German Wings pilot who, in 2015, flew a fully occupied Airbus into a mountain in France, killing 150 people including himself.

As a result, there remains a number of puzzles to be solved around the supply side of suicide bombing. Not much light could as yet be shed into the dark of the deeper motivations of suicide bombers; it still remains unclear under which conditions they supply their infamous services to terrorist organizations and, if so, what sort of incentive-compatible and self-enforcing contracts they may have signed. By the same token the conditions are not clear under which those suicidal mass murders that are fully detached from any organization perpetrate their deeds, some even without any articulated

ideological or religious motivation. The phenomenon of the latter brings us close to other groups of mass murders, like school shooters and gunmen, most of whom do not articulate any religious or ideological justification (Holmes and Holmes 2001).

These puzzles are at the heart of the remainder of this paper. It aims at developing a general theoretical framework of mass-murder attacks, the perpetrators of which rationally and willingly sacrifice their life in order to perform these attacks for selfish reasons and without necessarily being mentally ill or tired of life. Our approach can be viewed as a combination and generalization of the martyrdom-contract theory by Ferrero (2006) and the Herostratos approach by Borowitz (2005). As of the former, however, we do not consider the credibility issues of a contract between a perpetrator of a suicide attack and a terror organization. Rather, we explore the time-consistency of an individual plan by an expressively motivated potential suicide bomber.

Our approach enables us to cover all sorts of suicidal mass murders and to solve the discussed puzzles within one generalized framework. In particular, the suicide attackers may act within the structure of some terrorist organization, but they may as well act as "lonesome wolves"; and their deed may be ideologically or religiously motivated or not. This is not to say that all these persons are alike and should exhibit a full set of common characteristics. On the contrary: The framework defines the traits persons need to have when acting as a martyr within some well-defined organizational structure, or the traits a lonesome-wolf attacker would have. As such, the paper aims at providing some clearly defined empirical implications.

The rest of the paper is structured as follows. In section 2 we briefly review the relevant approaches to the market of suicide bombers. In section 3 we explore the general characteristics of the supply side of suicide bombing. In section 4 we present a formalized theory of expressive suicidal mass murder. In section 5 we discuss empirical as well as policy implications and conclude.

2 The Market for Suicide Bombers

The demand side of suicide bombing is easier to grasp than the supply side since the use of suicide missions, as infamous as they are, follows some clearly traceable strategic advantages to terrorists (Bloom 2005, 76-100). Following Pape (2005, 346-347), three of them are key: Firstly, a suicide attack is much more devastating and hence, in the view of terrorists, more effective than traditional terrorist attacks. For the period from 1980 to 2001, Pape (2003, 346) finds suicide attacks to be associated with a death count of 13 people on average, excluding 9/11, as compared to less than one in the case of traditional terrorist attacks. Although the number of people killed in a suicide attack has dropped to about 9 per incident[3] between 2002 and 2015, it is still way above that of traditional terrorist attacks. Central reasons for this high efficacy are that suicide attackers can make use of means that are not available for traditional fighters and that they do not need escape plans. Secondly, suicide attacks are a most convincing signal to the coerced of more pain to come which is important for reasons to be explained below. Thirdly, suicide attacks signal a strong commitment to deliberate norm violations for the sake of ruthless utilization of the ensuing strategic advantage.

Terrorism as a combat strategy is generally attractive to organizations that fight against an enemy—typically some sort of an occupant—that is so overwhelmingly superior in terms of military power that the organization cannot have any hope to defeat the enemy in traditional combat. The latter particularly applies to transnational terrorism (Krieger and Meierrieks 2011). Raising the enemy's costs in terms of losses in human life and an atmosphere of panic and horror on the side of the population is the strategic goal of terrorism. To that end, traditional terrorism aims at soft targets like gatherings of people at airports, subways, stadiums and the like. The more the enemy progresses in better protecting these environments, however, the harder to reach these targets become, and this is what makes a shift toward suicide

3. The number is taken from the Chicago Project Security and Terrorism database, see $http://cpostdata.uchicago.edu/search_new.php$.

terrorism relatively more attractive. Well protected targets become more vulnerable when attackers can hide weapons and bombs on their body and when they do not need plans for retreat after their deed. Hence, as a rule, suicide attacks are the more rewarding the harder the targets and the higher the damage that the terrorists aim at (Berman and Laitin 2005).

The strategic use of suicide attacks is nevertheless not a low-cost option for terrorist organizations. While the technical construction of a human bomb alone is quite easy and cheap[4], the cost of orchestrating the entire operation within a strategic setting is much higher: The attacker needs to be recruited, committed, and trained, families are usually compensated for the loss of their beloved, and considerable effort is necessary to build a myth around the martyr following the attack. The latter is necessary for both, committing the attacker and achieving the strategic goal of the attack. Carefully screening potential candidates, investing in their commitment and intensely training them is of utmost importance for both the strategic goal of the attack and the security of its organizers. Any failure of a scheduled suicide attack or any defection of a fighter can have severe and even lethal consequences for the rest of the terrorist organization, especially since an arrested attacker who failed or reneged is potentially threatening, as he may reveal important information resulting in the capture of further terrorists, the prevention of further planned attacks, or the disclosure of strategically important information.

This leads the terrorist organization into a classical choice problem. Choosing the most committed, skilled and capable fighter raises the costs in terms of the loss of a particularly valuable member. But reducing these costs has its price as well, and for the reasons above, this price may turn out to be substantial. Hence, under certain circumstances terrorist organizations are willing to bear the high costs of loosing a skilled and committed fighter.

All this makes perfect sense from the point of view of the demanders of suicide bombings but not necessarily from the perspective of the suppliers. It is certainly convincing to state that embedding a suicide attack into an

4. According to a a Palestinian security officer, the cost of such a bomb is around 150 US-Dollars; see Hassan (2001).

overall strategy, including the recruitment of suitable fighters and the launch of an effective propaganda machine, is expensive for the respective terrorist organization. But most of these costs are not relevant for a potential lonesome-wolf terrorist who perpetrates a suicide attack on his own. For such a person, only the hundred and fifty Dollar or so for assembling a bomb would suffice, enabling most if not all of those that were rejected by some terrorist organization to perform a suicide attack alone. Why, then, are there so few lonesome-wolf suicide bombers, given that so many individuals are eager of becoming martyrs? This question is all the more relevant since terrorist leaders quite frequently encourage people to do so. More recently, this applies to ISIS, but it goes back at least to Bin Laden's "World Islamic Statement" of 1998, which went as follows: "To kill Americans and their allies, both civil and military, is an individual duty of every Muslim who is able, in any country where this is possible (...). Likewise we call on the Muslim ulema and leaders and youth and soldiers to launch attacks against the armies of the American devils and against those who are allied with them from among the helpers of Satan."[5]

The contrast between the eagerness of so many individuals to give their life as a suicide bomber when representing some prominent terrorist organization on the one hand and the reluctance to follow invocations like the "World Islamic Statement" by no less prominent persons or organizations supports an assumption according to which the public-good character of the respective strategic goals is relevant in the latter but not in the former case. In brief: Most of these individuals are eager to die for the public good, given that they act on behalf of some prestigious terrorist group, but not so when acting on their own behalf.

Since terrorist organizations screen applicants that fit a specific profile, there is obviously a selection bias in the picture of traits of suicide bombing suppliers in what has so far been distilled from the empirical basis. Indeed, those

5. Quoted from: Bernard Lewis, License to Kill: Usama bin Ladin's Declaration of Jihad, *Foreign Affairs*, November/December 1998; downloaded from: $www.foreignaffairs.com/articles/saudi-arabia/1998-11-01/license-kill-usama-bin-ladins-declaration-jihad$ on November 7, 2016.

individuals that actually commit suicide attacks in the name of some terrorist group are apparently not the impoverished, asocial and possibly mentally ill individuals. But this does not necessarily apply to the entirety of all those that solicit a terrorist group for becoming a martyr. Rather, it only applies to those that solicit a terrorist group *and* are selected by such a group for a martyrdom operation.

Hence, even if we accepted the popular hypothesis of rewards in the hereafter or, for that matter, the notorious 72 virgins at the martyr's disposal, or if we surrendered the assumption of at least some minimum rationality and if we even accepted irrational altruism for the sake of the respective terrorist groups's goals, as hypothesized in Pape (2005), then still the question remains to be answered as to why so few of those that were rejected as martyrs by a terrorist group tie in with Bin Laden's call and launch their own suicide attack? This question is at the heart of the supplier's motivations and will thus be the leading question for the following section.

3 The Supply Side of Suicide Bombers

It would be wrong to assume that there are no lonesome-wolf terrorist attacks, although it is frequently difficult to discern them since the perpetrators often claim to have acted in the name of some organization and since these organizations sometimes take responsibility for the attack in order to exploit the deed for their propaganda. They may even be urged to do so in cases where they are not exactly happy about the attack for some strategical reasons (Ferrero 2012). But there is a class of attacks that comes fairly close to the lonesome-wolf suicide attacks as relevant here, except that the respective deeds are perpetrated not in the name of some organization, some ideology or religion but rather without any attachment to any organization and without any of the aforementioned. It is that of school shooters, gunmen or, more spectacular still, the extended suicide of the Germanwings pilot that flew an Airbus carrying 150 people into the French Alps in 2015 (Huff-Corzine et al.

2013).

Apparently, the latter individuals could not be any more different from those suicide attackers that are sent by typical terrorist organizations, even less so when we take the above-cited empirical picture into account. One of the most striking differences between the two groups is that the "official" suicide bombers exhibit a remarkable degree of commitment as well as strength in character. As shown above, however, this finding is due to a demand-side driven selection bias since the terrorist organizations rely on these traits to achieve their goals. By contrast, school shooters, gunmen and other mass murders, for whom being killed is either a goal of their deed or at least a fact they surely acquiesce, typically appear to be weak in character, unstable, socially isolated and frequently mentally ill[6].

While the two groups of suicide murders may still have one motive in common, the difference in the rest of their personal traits decides whether they perform their deeds as martyrs acting in the name of an allegedly glorious end or as lonesome wolfs that see no alternative to reaching some dismal notoriety by an infamous mass killing. Clearly, the moral judgment of each respective deed depends on the perspective of the observer.

Apart from these differences, then, we assume an expressive rather than an instrumental motivation for both groups of suicide bombers to be relevant (Hillman 2010). In its most extreme form, such an expressive motivation is what Borowitz (2005) has referred to as the Herostratus motive, that is with a quest for self-glorification and notoriety (Azam and Ferrero 2016). Note, however, that an expressive motivation does not necessarily need to go that far. In any case, it is apparent that a certain degree of expressive self-glorification is generally a strong motivation for at least many human beings—although using the term self-glorification might appear a bit libelous in most cases, as most of these people will never do any wrong on the basis

6. This applies not only to young school shooters but more generally to different subsets of mass shooters. It should be noted, though, that the mental disease is usually accompanied by a feeling of being victim of mistreatment for which the mass shooters seek revenge; see Bonanno and Levenson (2014) and Fox and DeLateur (2013).

of such a motivation. Drawing utility from the awareness of having achieved something highly regarded in public and possibly even outliving ones earthly existence—e.g. an A-journal publication—should at least not be too unfamiliar a motivation for people who work in academia.

Some people, then, have both the capability and the opportunity to create something that is truly impressive in terms of science, architecture, art, music or, for that matter, empires, but others may either lack the capability or the sheer opportunity for doing so. Consequently, the individual return on investment in different sources of notoriety will be determined by relative prices, that is by the respective degree of capability, opportunity, and moral scruple, as they are inputs necessary for the diverse sources of notoriety in particular circumstances and for particular individuals. This leads some people to invest in their skills as scientists, musicians, or artists but others to allocate effort into grossly destructive or even murderous activities of some sort. Of the latter, some of these activities may be regarded as malicious only by some groups while they may be appreciated as heroic and devotional by others.

The most impressing but also most costly expressive act in this sense is the credible commitment of a person to finally sacrifice his life. However, a person that gives his life for a suicide attack will most brutally interrupt the associated stream of utility from notoriety at the very moment it unfolds. This inconsistency, however, vanishes once we recognize that the preparation of a suicide attack takes time and that its perpetrators can enjoy the perspective of gaining notoriety during the period of preparation. If an individual exhibits a sufficiently high time-preference rate, this may suffice for triggering a process of rational intoxication with self glorification, leveraged by the commitment to finally even sacrifice his life in exchange for utility derived from the expectation of some historical notoriety of sort. As odd as this may appear at first glance, it is not based on irrationality but solely on a certain individual preference, so that it can be fully consistent with rational behavior, given a sufficiently high rate of time preference and given the associated motives to enter one's utility function as a sufficiently powerful

argument.

Suppose, for that matter, a person with a strong expressive desire in the described sense. Assume further a high time-preference rate of that person, but poor opportunities for achieving something special in all but one respect, for reasons of lack of talent, of wealth, or simply of chances within an unfortunate and possibly even hostile environment, or for whatever reasons else. The one remaining opportunity then were a deed the effectiveness of which hinges upon the eventual sacrifice of the respective person's life. This person could then sign into a contract which structurally corresponds to Ferrero's (2006) martyrdom contract but which the person concludes with himself. The contract stipulates that the person prepares the act within a period $t \in [0, b)$ and then commits the suicide attack in $t = b$.

We assume the preparation of the attack to be a source of utility which arises from the expectation of somehow becoming notorious following the suicide attack. For that matter, we assume a cumulative rise in the level of utility during the period $t \in [0, b)$ in the followings sense: The utility at each respective point t in time within that period is a function of the cumulative efforts spent so far for preparing the suicide attack. The efforts have hence a self-feeding investment character in that levels of utility derived from preparation activities at any point in time are a function of the sum of all past efforts and thus of the time elapsed since $t = 0$. Hence, the utility of preparing the attack monotonically rises within the period $t \in [0, b)$. At $t = b$, however, the second element of the contract is due, an element constitutive for the stream of monotonically rising levels of utility to start flowing in $t = 0$. This element consists of staging the final act, to pull the trigger of the suicide bomb.

If, in whatever is $t = 0$, the present value of the stream of utility until $t = b$ exceeds the present value of the utility an individual would be able to enjoy in the best of all alternative paths of life, then this individual will be willing to sign into the contract with himself. Such a Faustian contract is not as extreme as it appears at first glance. It rather matches the so called "Goldman dilemma" which describes empirical findings by Goldman, Bush,

and Klatz (1984) who asked 198 world class athletes in 1982 whether they would accept a deal according to which they had to take an undetectable drug that guaranteed them a gold medal in the Olympic Games but would kill them with certainty within five years. In the original study, around 50 percent of the respondents accepted such a deal, and this result was replicated in a series of follow-ups. A critical study by Connor, Woolf, and Mazanov (2012) found significantly lower acceptance rates upon an adjustment of the interview techniques. Nevertheless, the rates remained positive at some 5.5 and 6.8 percent. Although way lower, the results indicate that a considerable share of the population exhibits discount rates sufficiently high as to make them willing to trade longevity against present utility. Empirically, hence, the existence of individuals that sign into a contract as described above does not appear too outlandish an assumption.

As an illustration from the world of suicide bombers rather than that of top-ranking athletes, these are the words of a suicide bomber whose mission failed for reasons beyond his control and who was quoted five years later by Hassan (2001) who called him S.:

> "We were floating, swimming, in the feeling that we were about to enter eternity. We had no doubts. We made an oath on the Koran, in the presence of Allah—a pledge not to waver. This jihad pledge is called *bayt al ridwan*, after the garden in Paradise that is reserved for the prophets and the martyrs. I know that there are other ways to do jihad. But this one is sweet—the sweetest. All martyrdom operations, if done for Allah's sake, hurt less than a gnat's bite!"

Note that his commemoration almost exclusively refers to the joy that S. and his comrades felt prior to the moment they were due to pull the trigger, that is to the time while they were "floating" and "swimming". Note also that there are no signs of regret on the fact that his operation failed and that he is now a caring husband and father of three rather than a martyr's soul in the hereafter. This is fully in line with what a person can expect from a contract with himself, but there is, of course, something that such a person has to

give in exchange to the joy during the preparation period: Since the source of joy during the preparation period depends on the person's commitment to finally trigger the suicide bomb, the person is reliant on committing to the last step in which he sacrifices his life for the sake of the heroic deed. A lack in the credibility of that commitment would instantaneously dry the source of utility during the preparation period. Because the failure of the above quoted suicide bomber S. was beyond his influence, he happened to end up in the best of all worlds: Being fully committed enabled him to reap all the benefits during the preparation period, and the mere technical failure of the suicide attack beyond his control gave him the opportunity to continue his secular life as a quite normal family man.

The example of S. illustrates what comes as a central issue for expressively motivated suicide bombers: They face a severe commitment problem which a rational and mentally healthy person is not likely to be able to solve without some highly effective commitment device. But as described above, most of the suicide bombers that we are aware of have turned out to be quite rational, mentally healthy and of a strong character. In order to analyze the related questions, we formalize the contract of a potential suicide bomber with himself. As a corollary, this formalization demonstrates the peculiar existence of individual plans of action—the contract of the individual with himself—that are time-inconsistent although they are not strategically interacting with individual plans of action of any other individual.

4 Expressive Suicidal Mass Murder

Consider a life cycle observed from the moment $t = 0$ at which an individual may initially decide to prepare and eventually to commit to some sort of mass murder that is associated with the certain death of the perpetrator. If so, then the individual will plan to kill himself at time $t = b$, with $b \in (0, h)$ being the moment of the deed which we will generally refer to as the suicide

attack. If not, then the individual's life expectancy is h.[7]

For reasons of simplicity, we assume an additive separable utility function. In the next-best alternative to becoming engaged in a suicide attack, the individual would enjoy a gross utility of u_t^R at each point t in time from $t = 0$ to $t = h$. This gross reservation utility is determined by the individual's permanent income as well as by the individual's ability to satisfy his desire for achieving some degree of notoriety with some work that is different from a suicide attack.[8] We follow Hamermesh and Soss (1974) in modeling the individual such that he may or may not expect to suffer from burdens like a physical or mental disease in the future (see also Chen et al. 2012). To the extent that this is the case, the first symptoms are perceptible as early as in $t = 0$,[9] which we consider as an initial value c_0 of a cost in $t = 0$. This life burden is then expected to follow a growth path over the time the individual grows older, so that the burden at each subsequent period is $c_t = c_0 e^{\lambda t}$ with $\lambda \geqslant 0$. The net reservation utility of our individual at any point t in time is hence:

$$u_t^R = u_0 - c_0 e^{\lambda t}. \tag{1}$$

As an alternative, the individual may embark on a path along which he continuously invests into notoriety within a period $t \in [0, b)$ by preparing for a suicide attack. The individual then directly derives utility from these preparation activities, and as the preparations accumulate over time, the derived utility continuously rises by a rate k up until $t = b$. The individual's utility on this alternative path at each point t in time is:

$$u_t = u_0 e^{kt} - c_0 e^{\lambda t}. \tag{2}$$

At each point $s \in [0, b)$ in time, then, the individual (re-)evaluates the net

7. We assume the individual to be risk neutral.

8. For an analysis of the Palestinian case, see Sayre (2009).

9. Possibly only in the form of some unpleasant expectation of something that might develop in the future.

present value of his expected lifetime utility from the point s in time of evaluation to either b or h for the suicide-attack path and the reservation-utility path, respectively. The first evaluation will be done at the start of the preparations in $s = 0$. Then the individual continuously reevaluates the net present value for all further points s in time of evaluation up until $s = b$ is reached. Given a discount rate δ, the net present value of the individual's lifetime utility for each s is:

$$U_s^R = \int_s^h (u_0 - c_0 e^{\lambda t}) e^{-\delta(t-s)} dt$$

for the reservation utility and

$$U_s = \int_s^b (u_0 e^{kt} - c_0 e^{\lambda t}) e^{-\delta(t-s)} dt.$$

for the utility of a path to a suicide attack. Rearranged, we have:

$$U_s^R = \int_s^h (u_0 e^{-\delta(t-s)} - c_0 e^{\lambda t - \delta(t-s)}) dt \tag{3}$$

for the reservation utility and

$$U_s = \int_s^b (u_0 e^{kt-\delta(t-s)} - c_0 e^{\lambda t - \delta(t-s)}) dt. \tag{4}$$

for the utility of a path to a suicide attack. The net advantage of embarking on a path to a suicide attack at any time $s \in [0, b)$ of evaluation is $U_s - U_s^R$ or, after some manipulations:

$$U_s^n = u_0 \int_s^b [e^{kt-\delta(t-s)} - e^{-\delta(t-s)}] dt - \int_b^h [u_0 e^{-\delta(t-s)} - c_0 e^{\lambda t - \delta(t-s)}] dt. \tag{5}$$

The first term in equation 5 gives the present value of the gross extra utility generated by embarking on a path to a suicide attack at any time s of evaluation during the preparation period. The second term represents the net opportunity costs of the path to a suicide attack in terms of the foregone net utility stream over the period $t \in [b, h)$.

Note that $U_s^n \geqslant 0$ is an incentive-compatibility constraint at any time s of evaluation. In order to analyze under which conditions this constraint holds, we explore the model step by step. In the first step, we assume a zero-burden-of-life situation and in the second step, we include some positive burden of life.

4.1 Zero Burden of Life

In this situation, the individual does not expect any particular burden of life like chronic pain, depression or the like, so that $c_0 = 0$. According to equation 5, then, the extra utility from embarking on a path leading to a suicide attack needs to exceed the opportunity costs of the suicide deed in order for such a path to become rewarding. It directly follows from equation 5 that both terms are strictly positive for all points in time of evaluation $s < b$. At $s = b$, however, the first term in equation 5 becomes zero while the second term remains positive until h. For any point in time of evaluation $s \in [0, b)$, hence, a growth rate k sufficiently high for $U_s^n > 0$ exists. By the same token, however, there will be a critical point in time of evaluation $s = cr < b$ for any given growth rate k at which the extra utility of a path to suicide bombing drops below the opportunity costs, implying $U_s^n < 0$.

As a result, for any sufficiently high growth rate k, the individual will find it rewarding at time $s = 0$ of evaluation to embark on a path that ends in a suicide attack at $t = b$. But, just as well, there will always be a critical point in time $s = cr$ of evaluation beyond which the present value of the future utility stemming from the suicide-attack path drops below its opportunity costs. The incentive-compatibility constraint $U^n \geqslant 0$ will thus be satisfied between the points in time $s = 0$ and $s = cr$ of evaluation for any sufficiently high growth rate k, but it will always be violated from $cr < b$ on. Since, by assumption, being credibly committed to the final step—i.e. the suicide attack—is a precondition for growth along the rate k to materialize, a rational individual will anticipate the incentive-compatibility constraint to be violated at $cr < b$. He will abstain from embarking on a suicide-attack path right

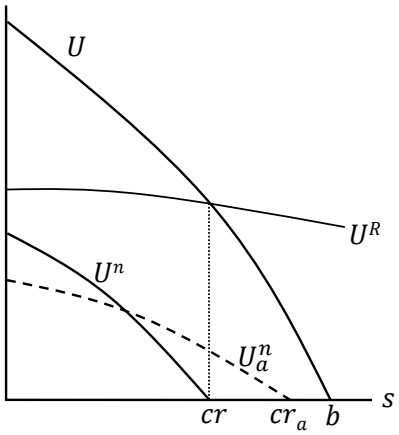

Figure 1: Zero Burden of Life

away, since he knows that the second part of the contract with himself is not time consistent.

Figure 1 illustrates this result. Lines U and U^R represent the present value of lifetime utility for the individual as a suicide bomber (U) or in the next best alternative (U^R), as calculated at any point in time s of evaluation over the whole range $s \in [0, b)$ from the initial decision on embarking or not on a suicide-bombing path to the moment $s = b$ of an attack. Over time, both lines drop continuously and line U reaches zero exactly at time b of the attack, while line U^R reaches zero exactly at time h of the natural end of life (not shown). These intersections with the abscissa are due to our temporary assumption of a zero burden of life ($c_0 = 0$) and will change as soon as we relax this assumption further below.

Given the underlying parameters of figure 1, the condition for embarking on a suicide-attack path is satisfied at the time of the initial evaluation $s = 0$. Hence, a rational selfish individual would want to do so, but only conditional on its ability to credibly commit to the final act of the suicide attack in b. However, the individual knows that the incentive-compatibility constraint will be violated from point cr on, so that the individual expects himself to switch from path U to path U^R at point $s = cr$. Knowing this, however, makes it impossible to embark on the U-path in the first place, since the

growth-rate k in utility will be zero given the knowledge about the lacking credibility. Without any external commitment device, the individual will hence be unable to embark on the suicide-bombing path.

The length of the critical period $b-cr$ during which the incentive-compatibility constraint is violated will be affected by changes in the growth parameter k and the discount rate δ. The first derivative of the net-utility function 5 with respect to k is:

$$U^{n'}(k) = u_0 \int_s^b t e^{kt-\delta(t-s)} dt \geq 0 \quad \forall s \leq b. \tag{6}$$

This effect is clearly unambiguous: A rise in the growth rate k of utility during the preparation period raises the net advantage of embarking on a path to a suicide attack for any point in time s of evaluation. By implication, the critical point in time cr rises too.

A rise in the discount rate is slightly more complex but finally has the same effect. It is given by the first derivative of the net-utility function 5 with respect to δ. Note that we assume a zero burden of life in this subsection, so that the costs in equation 5 are zero as well. Given that, the derivative with respect to δ is:

$$U^{n'}(\delta) =$$
$$\int_b^h [(t-s)u_0 e^{-\delta(t-s)}]dt - u_0 \int_s^b [(t-s)e^{kt-\delta(t-s)} - e^{-\delta(t-s)}]dt. \tag{7}$$

The first term represents the change in opportunity costs of the path to a suicide attack due to a change in the discount rate δ from $t = b$ on. The second term represents the change in extra utility of a path to a suicide attack due to a change in the discount rate. Both terms are positive but as the second is subtracted from the first, the total effect of a change in δ depends on the size of the respective effects. Note, however, that the second term approaches zero as s approaches b. Hence, in the region close to a suicide attack an increase in the discount rate will raise the net utility of the path to a

suicide attack. The implication is illustrated by the dashed net-utility line U_a^n in figure 1. The critical point cr in time of evaluation rises with a rise in the discount rate from the original cr to cr_a. As a result, both a stronger dynamic of growth in the utility of the path to a suicide attack and a higher discount rate shrink the time period in which the incentive-compatibility constraint is violated. Each of these effects alleviates the commitment problem.

Nevertheless, the critical period $b - cr$ always remains positive, so that there will always be some time in which the individual is in need of an external commitment device. It may find such a device in the existence of a terror organization that recruits potential suicide bombers. Such a terror organization can make the individual's plan of action credible by embedding it into a martyrdom contract (Ferrero 2006). Being bound in such a way enables the individual to reap the extraordinarily high benefits during the first period by making the obligation in exchange for these benefits at point b in time credible. The individual does so by bridging the critical period between the moments cr and b in time during which he knows in advance that he would want to switch back to path U^R and hence to escape from the path to his suicide obligation—and perhaps desperately so. Indeed, given $U > U^R$ at $s = 0$, the individual has an incentive to entrap himself in a situation that either will not allow him to switch back from path U to path U^R anymore or that is even structured in such a devilish way that it makes the individual not even want to switch back to path U^R.

Our approach is in line with the empirical findings on suicide bombers that act in the name of some terror organization. They appear relatively normal on the outside, and while religion, ideology and fanaticism may play a certain role, this role is not at the heart of the respective individual's motivation but rather an accommodating one. It is accommodating in a way as to bridge the critical period of time between the points cr and b. In order to structure that accommodating role, the terror organization:

- induces the individual to substitute his social structure for all that has hitherto been his regular social environment;

- promises rewards and compensations for the individual's family;
- publicly glorifies martyrs by way of posters, social media and the like;
- and systematically destroys any perspective of a personal, economic and social recommencement of the individual outside of the organization, thus making it literally impossible to escape the obligation of the suicide attack.

Note that all this is what the individual strives for at a time $s = 0$ since it is these measures that turn the individual's commitment credible, and that in turn is a *sine qua non* for enjoying the extraordinarily high utility during the preparation period between $s = 0$ and $s = cr$. Note also that the length of the critical time period $b - cr$ to be bridged does not depend on some degree of fanaticism, religious belief or hate against the enemy, but rather on the growth dynamic of expressive utility k and the discount rate δ. A terror organization will thus find it easier to commit people during $b - cr$ that have high growth rates of expressive behavior but that strongly discount future benefits. By contrast, promising rewards in the hereafter—like the 72 virgins—as well as further religious or ideological indoctrination may turn out to be of some help only for the remaining length of the critical period, but they are neither necessary nor central within the entire set of provisions installed for helplessly enmeshing the individual into a structure that he will not be able to escape from anymore. This explains why religious groups are far from being the only terrorists to operate with suicide missions. The now notorious "Allahu Akbar" that has frequently been heard prior to an attack would, from that perspective, be little more than some whistling in the dark, performed hoping that this will alleviate the horrifying duty to pull the trigger and to wipe out one's secular existence.

The description by eyewitness Bley Bilal Mokono to a french journalist of a putative suicide bomber illustrates what the euphoric "Allahu Akbar" scansion might aim at palliating: the elemental instinct of self-preservation and its implied horror in the light of the final step to be taken. Mokono's attention was attracted by a man whom he believes to be one of the suicide bombers

of the 2015 attack on the soccer stadium "Stade de France" in Paris, shortly before he blew himself up. He reported: "I stumbled onto a bearded person with a sweaty face. He was visibly frightened. His hands were holding onto the sink while he was fixating the mirror. I thought to myself that this is a weird guy."[10] While being anecdotal, this description may indeed describe a person that once had enjoyed a period of deliberately roping himself into a situation from which there is no escape but that now regrets what he had nevertheless once rationally decided to set in motion.

According to our theory, there is no path into the extraordinary levels of expressive utility reaped from the perspective of becoming a martyr short of a credible commitment to overcoming the dreadful critical period between cr and b and to finally pulling the trigger. Being aware of this, and knowing that a contract with himself will not be incentive compatible, the individual will rationally supply his suicide bombing "service" to a terrorist organization in exchange for the desired external commitment device. Upon having been rejected, though, the same individual would rather renounce his entire suicide-attack plan than proceeding to the closest available alternative, that is to commit a lonesome-wolf suicide attack.

4.2 Positive Burden of Life

As far as there is a dynamic of some future burden of life, the critical period $b-cr$ for which the incentive-compatibility constraint is violated shrinks and may even completely vanish. Figure 2 illustrates this case. The dynamics of the burden of life is given by the parameter λ (Hamermesh and Soss 1974). Rises in that parameter gradually shift the intersection of the reservation-utility line U^R with the abscissa to the left. In figure 2 the intersection is even to the left of point b for which the suicide attack is scheduled. From

10. Quoted from BFMTV 16.11.2015, Attaques au Stade de France: "Je me suis dit, il est bizarre ce mec", raconte un rescapé; downloaded from $www.bfmtv.com/societe/attaques-au-stade-de-france-je-me-suis-dit-il-est-bizarre-ce-mec-raconte-un-rescape-930504.htmlat$9.11.2016. Translation by the author.

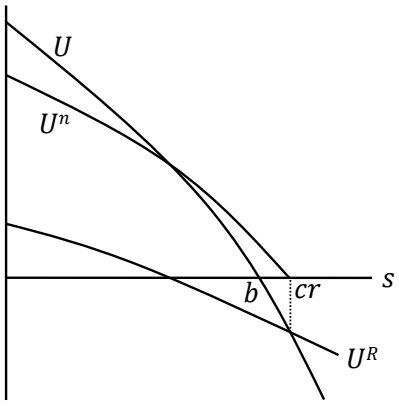

Figure 2: Zero Burden of Life

the point of the intersection of U^R with the abscissa on, the net utility line U^n lies above the line U, the latter of which intersects the abscissa at point b. In that case, the critical point in time of evaluation cr lies beyond the scheduled moment of the suicide attack, so that the path into such an attack remains incentive compatible from $s = 0$ all the way to $s = b$, that is over the relevant period of time.

Technically, point cr is again the higher the stronger is the dynamic of expressive utility in the preparation of the suicide attack, as indicated by parameter k, and by a rise in discount rate δ. Additionally, though, cr also rises with a stronger dynamic of the burden of life, as given by the derivative of the net-utility function 5 with respect to λ, which is:

$$U^{n\prime}(\lambda) = c_0 \int_b^h te^{\lambda t - \delta(t-s)} dt \geq 0 \qquad \forall b \leq h. \tag{8}$$

Note, however, that $cr > b$ implies that an individual wishes to end his life at point b at the latest anyway. What is more, if it were not for the path along U to a suicide attack, the individual would have wanted to end his life even earlier, namely at the intersection point of U^R with the abscissa. The fact that the individual bears his life up to point b when having decided to embark on a path to a suicide attack is that this path temporarily provides

for some additional utility that compensates for the burden of life, but only up to point b.

Apart from these technical considerations, such a situation is imaginable only for individuals that suffer from some severe mental or physical illness. These people may indeed extent the period of time for which they find their life bearable. The expressive utility derived from intense preparations of a spectacular deed may temporarily help them to overcome the burden of whatever they suffer from, but when the time of the deed has come they see no reason to continue their life and they will hence not hesitate to pull the trigger. For that to be time consistent no further commitment device is necessary.

It may indeed be the case that the expressive utility from a suicide attack may be bigger and the dynamic stronger if a thus characterized person gets himself integrated into the organizational structure of some terrorist group. As shown above, however, most of these persons are not attractive to terrorists groups, at least not when their burden of life stems from some mental illness. The reason is that mentally ill individuals tend to be less reliable.

As a result of our model we would expect suicide bombers that are young, healthy, mentally stable and skilled to appear as representatives of some established terror organization. The more established and "famous" these groups are, the more would these traits apply to the suicide bombers they hire, and for two reasons: The first is that the commitment problem of the suicide bombers is the more severe the more healthy, wealthy and mentally stable as well as skilled they are; hence only well established, powerful and prestigious groups, the influence and power of which is far reaching in any respect, would ever be able to solve the commitment problems of such individuals. The second reason is that it is only these particular terrorist groups that are in a position to select individuals exhibiting such traits as suicide bombers. On the other hand, a less established terrorist group would resort to persons that are less young, healthy, mentally stable and skilled, because the commitment problem of the latter is less pronounced and the organization would not be in a position to hire the "best" of all candidates.

In an extreme case, then, a potential suicide bomber would not need a commitment device at all and hence could do without the affiliation to some terrorist organization. Note that such an individual would not even need any ideological or religious legitimation but may be fine with a purely "Herostratic" deed of some sort sufficiently spectacular for skyrocketing the individual into a broad public's attention. Within the logic of our model, these latter people are, in principle, no different from religious or ideological suicide bombers as they, too, are driven by some extreme form of expressive motivation. But they are different in that the latter comes in combination with some burden of live—usually some severe mental illness. Had the Germanwings pilot in 2015 just been driven into suicide by the severe depression he did indeed suffer from, then he could as well have done that in a different way, possibly by help of a small single-engine airplane of which we know he had access to. The fact that he choose an Airbus with 150 people aboard indicates that there was more to his motivation than just the desire for committing suicide. But as cynical as it may appear, the depression solved his commitment problem for which persons driven by the same expressive motivation but not plagued by the Germanwings pilot's mental distress would have needed an external commitment device.

5 Conclusions

We presented a model of expressive suicidal mass murder in order to shed light onto the motives of suppliers of suicide attacks and the conditions under which their individual plans call for an external enforcement mechanism. We hypothesize that suppliers of suicide attacks are driven by an extraordinary but not necessarily irrational expressive desire combined with a particularly high discount rate on future utility. In its most extreme form, this has become known in the literature as a "Herostratic" motive, the ensuing particular commitment problem of which has remained unexplored as yet, although comparable commitment problems resulting from alternative motivational structures exist and have been discussed in literature. In any case, however,

the commitment problem is particularly relevant to our approach with regard to those individuals that do not suffer from any mental or physical burden of life. What is more, since it is the latter individuals that exhibit those personal traits terrorist organizations are looking for when hiring suicide bombers, the individual commitment problem is what constitutes the market for suicide bombers. As a corollary, our theory demonstrates that a rational individual's plan of action that is not involved in some strategic interaction with any plan of other individuals can nevertheless be time-inconsistent and hence non-credible.

The most obvious empirical implication of our theory is that we should find suicide attackers acting in the name of some well-organized and strategically motivated combat or terror organization to exhibit no signs of a mental or physical burden of life severe enough for them to commit to suicide anyway. By contrast, we should find such a burden of life at least significantly more frequently among those suicidal mass murders that act on a lonesome-wolf basis. While existing observations that point in this direction belong to the motivations of this paper there is clearly a desire for more systematic empirical work on that topic.

There are a number of potential policy implications of our approach. One is that anti-terror policy would become more effective if it aimed, among other measures, at undermining the capacity of terror groups to supply commitment devices for expressively motivated potential suicide attackers. In particular, one may think of developing openly communicated escape opportunities for individuals on a path to a suicide mission in their critical period, that is while their individual plan of action is not time-consistent anymore. As a rule of thumb, we may generally find that commitment devices are less binding in more open societies as compared to autocratic systems lacking freedom of speech and press as well as open public discourse.

Additionally, the social and political environment should be key regarding its capacity to echo expressive desires of potential suicide attackers. A conflict-prone environment associated with ideological or religious cleavages serves as a fertile ground for the heroization of perpetrators, and that tends to at-

tract potential additional suppliers of suicide deeds. A peaceful environment characterized by mutual tolerance and respect, by contrast, should provide significantly less resonant cavity for allegedly heroic deeds and it should tend to generate disgusted reactions to the ferocious violence even by potential ideological or religious supporters. Indeed, the separatist Kurdish Workers' Party PKK abolished suicide attacks altogether upon having realized that they induced abhorred reactions by the Kurdish people (Bloom 2005, chap.5).

Unfortunately, most of such measures might be useless in the case of lonesome-wolf attackers. These people do not need commitment devices and some of them are not even interested in any ideological or religious legitimization. As far as the latter applies, these people are merely interested in the sheer public attention their attack generates. What is worse, in line with the slogan "good news are bad news" a particularly horrifying deed might leverage public attention significantly stronger than any alternative that the public would tend to appreciate. It looks that there is hardly any effective remedy against suicide attacks by these latter individuals.

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