Impact of terrorism on investment decisions of farmers: evidence from the Punjab insurgency

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Impact of Terrorism on Investment Decisions of Farmers: Evidence from the Punjab Insurgency

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Abstract

This paper provides evidence for a particular channel through which sustained terrorism in rural areas may affect growth in developing countries. Using micro-level data from agricultural surveys during the period of insurgency in Punjab (India), I find significant negative effects of terrorism on the level of investment in long-term agricultural technology but effects are small and insignificant for short-term investment. The presence of a major terrorist incident in a district in a year reduces long-term fixed investment by around 17% after controlling for district fixed-effects, time trends, district trends and other farm-level controls. These negative effects are greater for richer farmers and those living in bordering districts. This results in a farmer losing close to 4% of his income annually because of the insurgency.

1 Introduction

In the past few years, there has been a growing interest in the micro-level approach to studying consequences of violent conflict. The empirical literature which was earlier limited to cross-sectional results has now taken strides into case studies and researchers using household-level panel data are coming closer towards making causal inferences by mitigating problems of reverse causality and omitted variable bias[1]. This paper lies at the intersection of economic effects of violent conflict as well as terrorism, particularly looking at rural developing areas.

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[1]For instance, Households in Conflict Network (www.hicn.org) has an impressive collection of recent microeconomic forays looking at civil conflict.

There has not been much work on the microeconomic impact of terrorism[2], although several studies have analyzed macroeconomic effects[3]. However, there are at least five dimensions that are salient in studying microeconomic outcomes of conflict in general. First, there seem to be immediate adverse effects on long-term investments, for example, educational attainment post-conflict in Rwanda (Akresh and de Walque, 2009) as well as in Peru (León, 2009)[4]. Also, negative effects of civil conflict on health outcomes have been found in Burundi (Akresh, Bundervoet et al, 2009), Iraq (Guerrero-Serdán, 2009) and Colombia (Camacho, 2008). However, we do not know the effects of conflict on long-term vis-à-vis short-term investment. Second, we know little about the persistence of these effects although several studies find no long-run effect of bombings on income levels in Vietnam (Miguel and Roland, 2005), Japan (Davis and Weinstein, 2002) and West Germany (Brakman, Garrtesen and Schramm, 2004). However, Abadie and Gardeazabal (2003) uncover persistent effects on per capita income of low-intensity conflict in Basque country. Third, there can be heterogeneous effects of conflict on different types of investments based on farmer characteristics, for instance, rich may be more affected than the poor for long-term investments. Fourth, it is important to check if these decisions are in line with theory or if individuals behave differently from economic predictions in such a scenario, for example, Brück (2004) finds that economic predictions about high-risk crops (like cotton) increasing welfare do not hold in a post-war economy. Similarly, Bundervoet (2007) finds that wealthier households do not invest less in low-risk low-return activities compared to poorer households during civil war. Fifth, channels through which conflict affects investment need to be better understood.

I will try and address the above dimensions in the context of an insurgency that took place in the Indian state of Punjab during 1981-1993. Although, the conflict in Punjab has occasionally been categorized as a case of civil war, it can perhaps more accurately be called an insurgency where rural insurgents used terrorism as a method for trying to obtain secession. Using data from annual surveys on representative farmers and district-wise major terrorist incidents, I find significantly large negative effects of terrorism on the level of long term agricultural technology as opposed to small insignificant effects on short term investment. Long term technology is proxied by expenditure on wells and tube-wells. The effects are comparatively much smaller for investment in fertilizers, which yield only short term returns. Farmers may be thought of as entrepreneurs who are willing to invest in agricultural technologies if the expected returns are

[2] An exception is Becker and Rubinstein (2004) who show using micro level data from coffee shops in Israel that consumption substantially decreased after terror strikes, but this was not the case for consumers who were spending a large amount of their income on such consumption.

[3] For instance, see Eckstein and Tsiddon (2004), Gupta et al (2004), Eldor and Melnick (2004) and Frey et al (2007) for effects of terrorism on output, public spending, stock markets and life satisfaction.

[4] Shemyakina (2006) looks at the 1992-1998 conflict in Tajikistan and finds exposure to violence leads to a lower likelihood of being enrolled in school, especially for girls. León (2009) also finds a persistent effect on educational attainment that is decreasing over time.

high enough relative to their outside options. Between 1987-1992, the agricultural growth rate in Punjab dipped from 6% to 2% and the World Bank report (2004) conjectured that this may have happened due to a decline in long-term investment amidst the uncertainty surrounding militancy activities. This paper empirically validates that there was a decline in long-term investment because of violent conflict.

I also find that these effects on investment decisions are not persistent but the effect on farm income kicks in after a year. The effects seem to be greater for farmers living in bordering districts and additionally, there is evidence to suggest a greater reduction in investment by richer farmers. At the macro-level, irrigation has been shown to be associated with a decrease in rural poverty and an increase in agricultural growth in India (Bhattarai and Narayanmoorthy, 2003). Thus, terrorism may have an adverse effect on growth through a decline in investment. De Long and Summers (1991) illustrate using cross-country evidence how increasing investment in machinery equipment by 1% of GDP leads to an increase in growth of one-third of a percent. I too, find a delayed effect on the income of the farmer. In particular, I find that an average farmer in the state loses close to 4% of his annual income because of the Punjab insurgency during 1981-90. Thus, it is imperative to understand how investment in agricultural equipment responds to conflict as this may have large growth effects. The relative importance of channels through which violence may affect investment would have different policy implications.

Economic intuition suggests that violent conflict should decrease investment. Indeed, Deininger (2003) shows that conflict decreased investment in non-agricultural enterprise setups in Uganda, it is not immediately obvious that firms could stand to gain. Guidolin and La Ferrara (2004) present an interesting case of diamond-mining firms in Angola that show a loss in value when the civil war comes to a sudden end. This could be explained by lack of transparency during the civil war where firms could get away with illegal dealings or because the civil war had raised the barriers to entry. In the case of agrarian Punjab, the farms could be thought of as firms[5]. If for instance, the farm produce obtained a higher price from the central government when there were terrorist incidents, we could expect them to increase their investment when there are terrorist incidents. Moreover, in the case of Punjab double cropping had increased water requirements, and the new strains of wheat needed a lot of water supply. Surendar Singh (1991) argues that during the insurgency, canal irrigation lacked the kind of flexibility and reliability that could be secured by tube-well irrigation. It was not always available at the desired time and in required volume, so we might expect the farmers to invest more in tube wells especially if reliability of canal irrigation was reduced by terrorism.

On the other hand, insecurity of life and property should discourage agricultural investment as would an environment with heightened uncertainty and high operating costs for firms. Besley (1995) provides evidence of the link between

[5] Although it has only 3% of India's net sown area and 1.5% of its farming population, Punjab produces 10% of the country's rice, 20% of its wheat and 45% of all rice and wheat procured by the government (World Bank report, 2004).

property rights and investment in Ghana and argues that improving property rights could increase investment in three possible ways. First, people would be more secure about their future and will therefore invest more. Second, because land would be easier to collateralize, it would increase land investment. Third, through expanded possibilities from trade[6].

The paper is organized as follows. After a brief historical background in Section 2, more light is shed on the underlying channels in Punjab's case in Section 3. Data is described in Section 4 and Section 5 reports the empirical specification followed by core results in Section 6. Next, I highlight robustness checks and concerns in Sections 7 and 8. Heterogeneous treatment effects are tested for in Section 9 and implications for policy are suggested in Section 10.

2 Historical background

The insurgency in Punjab has not been studied by economists, although there have been several studies in sociology and anthropology[7]. In 1981, the population of Punjab was 16.7 million out of which 12 million lived in rural areas. The population density was 333 persons per square km and though it occupied only 1.5% of India's land, it contributed close to 4% to the national GDP. Sikhs formed more than 60% of the population and in rural areas, their proportion went up to over 80%. In 1978, Bhindranwale, who was the head priest of a religious organization Dam Dama Taksal started recruiting Sikhs under AISSF for the cause of an autonomous Sikh region[8]. What initially began as protests against the Nirankaris (a "sect" of the Sikhs) rapidly resulted in attacks against Hindus[9]. These were followed by attacks on policemen, farmers, police informers and civilians and a multitude of militant groups sprouted proclaiming to fight for a Sikh nation called Khalistan. Thus, the first phase of the conflict can be classified as ethnic conflict (Besançon, 2005).

In 1985, President's rule that had been imposed in 1984 following riots was lifted with a peace accord between the Indian state and a moderate representative of the militant groups. The accord referred all issues relating to autonomy of the state to several commissions. The accord, however, was never fully implemented by the central government (Telford, 1992). Death toll due to violence rose from 1,333 in 1987 to 5,265 in 1991 and tapered to 871 in 1993. By 1994, the police declared that terrorism had been defeated and that normalcy had returned.

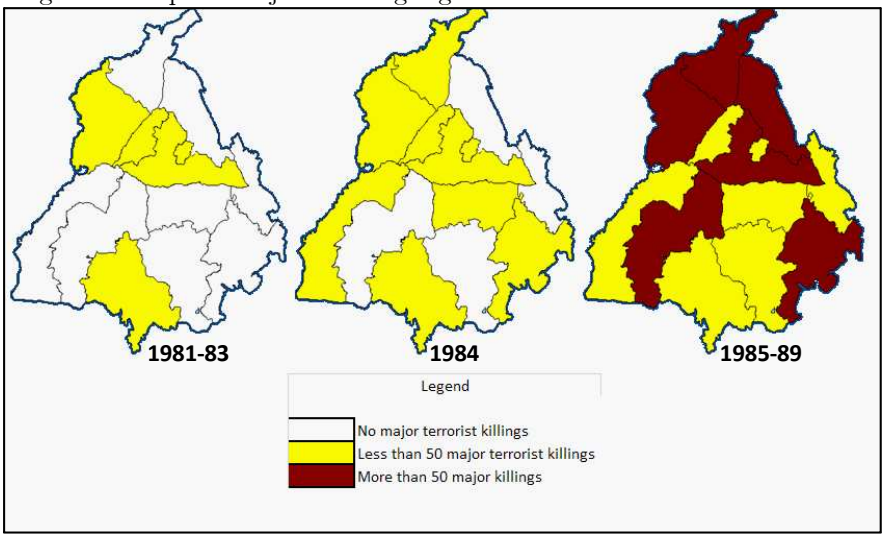
[6] The third channel seems unlikely here as the farmers surveyed sold their produce within the state.

[7] For example, Judge et al (1999) interview villagers about motivations, traits and activities of terrorist fighters for Khalistan. Axel (2001) gives an anthropological account of how the formation of a diaspora contributed to the struggle for a separate nation.

[8] Apart from increased autonomy, the rebel groups also wanted transference of Chandigarh to Punjab, redrawing of borders to include Punjabi-speaking areas in Punjab and a greater share of river water for the state.

[9] One of the major attacks on Hindus was that of Jagat Narain, a Hindu editor and political leader, who was shot dead in a vastly publicized incident in 1981. He was against the idea of a separate Sikh nation.

Figure 1: Map of Punjab showing regional variations in conflict over time



Punjab is arguably a case of where persistent and heightened rural terrorism was used within a secessionist movement rather than that of civil war even though it has been categorized by the UCDP/PRIO Armed conflict dataset as undergoing civil war from 1983 to 1993 due to the number of civilians killed. One can also consider the secessionist movement as an insurgency as Fearon (2003) calls it "a technology of military conflict typical of guerrilla warfare operating from a *rural base* through small and lightly armed bandits." The technology used by insurgents to further their economic and political goals was extortions[10]. Having a rural base was essential as this helped them remain hidden from the police forces. Kidnapping was an efficient technology used by militants to extract their rents (Judge et al, 1999). Figure 1 shows the dispersion of terrorism over time to all districts and the increase in its intensity. Until 1986, guerilla activities were sporadic and uncoordinated, largely confined to the border regions. Between 1987-88, resistance began to proliferate and the strength of groups surged. The deep red areas in the figure show areas of intense conflict. By 1989, all districts had witnessed at least one major terrorist incident. Puri and Judge (1999) find through recall surveys that two-thirds of the militants were from landless labourer and small farmer communities, 22 percent were middle-income farmers and a small percentage were rich. Close to 80 percent were between the age of 14-25.

[10] In a Police Intelligence report (6th February, 1987) shared with me by a former police commissioner: "The extortion money is used by the terrorists to enrich themselves, to purchase weapons, and to get associates released from police or courts. There are disturbing trends in the recruitment of terrorists. There is respect for the relatives of terrorists. They are always offered tea by the villagers. There are now 15 major terrorist groups with 10 to 30 members each and having sophisticated weapons."

Of all victims, 71 per cent came from rural areas (Kumar et al, 2001). Pettigrew's (1995) detailed sociological studies on the Punjab insurgency showed that guerrilla activity had been persistent and every district was affected by it. Armed groups stalked the countryside and the distinction between a policeman and a militant became blurred as guerilla cadres were infiltrated by undercover policemen. Later in the insurgency, ordinary villagers were targeted in violence where armed bands looted farming families and the rural households were subjected to attacks on their lives and property. The viability of the insurgency was dependent on the coerced cooperation of the local population to provide them with food, shelter, money and safety. These patterns are consistent with Schechter (2004) which finds an increase in giving of gifts when trust is low and probability of theft high in rural Paraguay.

3 Conceptual framework

Let p_{jt} be the probability of a district j suffering from a major terrorist attack in a given year t in district j. Assume that the probability of a farmer being attacked is exogenously determined at the district level. This means that the probability of a farmer being hit within a district is the same for all farmers. Here, "being hit" does not necessarily mean that the farmer will be personally attacked. It could also be that output-input markets are impacted for farmers such that the output price increases or the price of inputs is adversely affected. Thus, it can be considered as a general decline in safety or security in the district. For example, Besley and Mueller (2009) argue that the sustained violence in Northern Ireland was a local public bad associated with killings in a neighborhood. In Punjab's case too, as the probability of being personally attacked by insurgents is very low if it is measured by the number of killings in a district divided by the population of farmers in that district. For instance, in the terrorist-prone district of Amritsar there were on average 35 major killings per year between 1978-89, but the population of Amritsar's rural male farmers in 1981 was 324,736 according to the Census of India. Thus, it may be plausible to think about killings in the district as affecting the farmer through negative shocks to either present or future prices of inputs as well as outputs[11].

The farmer can invest in two types of assets: short-term and long-term agricultural equipment. The long-term equipment requires a fixed cost in time period t and then no investment is required for the next T years where T is the expected time horizon for the long-term equipment. Short-term investment is more flexible as the farmer can change his investment level every season. The expected time horizon is normalized to one year for the short-term equipment. Also, the farmer reduces his investment if probability of being hit at least once in a given time period exceeds $\overline{p}_{it}$, which is a function of his outside option, say

[11] It is possible, however, that at an extremely local level, violence is endogenous to the farmer's investments. But, we are not measuring local violence. We are using major terrorist killings at the district level as a proxy for the "public bad" and this has fewer problems associated with reverse causality.

w_{it}. Assume that $\overline{p}'(w_{it}) < 0$. This implies that as the outside option becomes more attractive, it reduces the threshold level below which the farmer invests in agricultural equipment. We know that the probability of being hit at least once in n periods is equal to $[1-(1-p_{jt})^n]$.

He will invest in short-term equipment if:

$p_{jt} < \overline{p}(w_{it})$ (1)

He will invest in long-term equipment if:

$1-(1-p_{jt})^T < \overline{p}(w_{it})$ (2)

The farmer always invests in short-term equipment if condition (2) for long-term equipment is satisfied but will not invest in long-term equipment if (1) holds but (2) does not hold[12]. Therefore, the decision to invest in longer-term equipment will be more sensitive to the probability of being attacked.

There are several points to keep in mind while understanding the conceptual framework above. First, it assumes that there are no complementarities between short-term and long-term investment. For example, short-term investment may be of little use unless the farmer also invests in long-term investment. In our context, however, equipment for tubewells is not essential for augmenting fertilizer productivity as there are other ways through which water can be supplied to the crops, including rain water, older wells, canal water and taking water from nearby farms.

Second, the channels of decrease in the short-term and long-term investment are not modeled explicitly. For example, there may have been supply-side shocks that may have affected the two differentially when the farmer is hit. A perpetual shortage of electricity following terrorist attacks may have disincentivized investment in electric motors for the tube well but may not have changed any returns to investment in fertilizers. Daljit Singh (1992) mentions that during the 1980's, the cost of tube-well irrigation by electricity was three to four times more than canal irrigation, and uninterrupted supply of power from diesel and electricity was hardly assured[13]. Grewal and Rangi (1989) report that procurement prices offered to farmers by the government for wheat could not keep pace with increases in the price of inputs. This points to either a decrease in the expected selling price of output or an increase in the price of capital (either directly or if long-term loans become more expensive), or a change in the expected rate of growth when the farmer's district is hit with a terrorist shock[14]. The channel could also be through a change in wage level or labor market structure. For instance, Greenbaum et al. (2007) study the impact of terrorism on employment in Italy from 1985 to 1997 and find that terrorist attacks reduce employment in the year following an attack. It would be useful to distinguish between the individual channels empirically, but this is not possible at present with the available data.

[12] This result only becomes stronger if the threat of extortion increases when long-term investment is visible to outsiders.

[13] Also, the time horizon of the investments may change.

[14] Also, the outside option may itself be lower for farmers in districts that have a shock of violence as other investment opportunities may shrink.

Another channel that is possible is through the variance of returns caused by uncertainty in prices due to the terrorist incidents. The World Bank report (2004) hinted at increased uncertainty for farmers resulting from militancy activities. Adapting the model of Dixit and Pindyck (1994) to our case, we can show that if terrorism decreases the drift parameter and increases the uncertainty parameter, the net effect would be ambiguous. Empirically, periods of increased inflation uncertainty have been associated with substantially lower investments in fixed assets among Dominican micro-entrepreneurs (Fischer, 2009). Aggregate and industry-wide uncertainty exert a significantly negative effect on fixed investment (Ogawa and Suzuki, 2000). However, uncertainty may not necessarily lead to lower investment, even in the presence of irreversibility of investment (Abel and Eberly, 1994).

Third, the model gives no prediction about the extent of the decline in investment. It would be more useful to calibrate the parameters on which the investments are affected using the data. This would require dynamic modeling with a pre-specified production function, but I lack evidence on the returns to short term and long term investments in this setting.

Fourth, there may also be an element of fear that reduces not only the investment but also the utility gained from an extra unit of consumption that could in turn affect investment decisions (Becker and Rubinstein, 2008) if households are assumed to be utility-maximizers rather than profit-maximizing firms.

Fifth, risk aversion of farmers may be different for richer farmers. Indeed, Binswanger's (1981) experiment among farmers in India found decreasing absolute risk-aversion. This implies that as the farmer's wealth increases, he is more willing to take risks. For our empirical analysis, it would suggest that richer farmers are less likely to reduce their investment during conflict. On the other hand, richer farmers may also be more likely to use other complementary inputs (labour or capital) that are likely to become more expensive. Therefore, the effect of terrorism on investment for richer farmers is theoretically ambiguous. It has also been common to assume that individuals exhibit increasing partial risk aversion, i.e., more risk aversion for higher stakes (Menezes and Hanson, 1970). This bolsters the result from earlier mechanisms on why longer-term investments that require fixed costs may be affected more than short-term investments during conflict.

4 Data

The data on investments of 510 farmers is taken from twelve annual sub-district level surveys (from July, 1978 to June, 1990) conducted by a team working for the Economic Advisor to the Government of Punjab. These were taken between July and June (an agricultural year). From each sub-district, one household was selected and this was repeated every year. The structure of data is that it is household-level data that is in repeated cross-section form. From each sub-district, one household has been sampled annually but different households have been surveyed every year. It is an unbalanced-panel on 46 sub-districts as

Table 1: Number of households surveyed every year

Number of households sampled	Agricultural year
35	1978
39	1979
37	1980
44	1981
44	1982
43	1983
43	1984
43	1985
45	1986
45	1987
46	1988
46	1989

Notes:
1) The total number of households surveyed is equal to 510.
2) An Agricultural year lasts from July to June.

all sub-districts were not surveyed every year, especially between 1978-81 when violence had not started. Table 1 illustrates the number of households surveyed (each from a different sub-district) for every year.

The surveys are supposed to be representative of the farmers in the state. According to Raikhy and Mehra (2000), only 8% of the workers were employed in industry in 1981 and farming was the predominant occupation in Punjab. The main objectives of family budget and farm account surveys were to assess the extent of income accruing from different sources, to examine the level of expenditure on various household items of expenditure and to determine the extent of surplus or deficit of family budgets. The selection depended on the representative character of the cultivating holding for the area and the willingness and capability of the cultivator to record agricultural data about agricultural operations on his farm and family budgets. Only farmers who used bullock-carts for cultivation were taken for the entire period. Bullock-cart was the primary mode of cultivation in districts of Punjab though tractors became more common in late 1980's.

The sample included all types of farmers - well to do, average and poor. The average farm income per capita for a sampled farmer in 1981 was Rs. 4096, whereas the average per capita income in the state was Rs. 3126 according to the Census of India statistics. A register with a set of instructions was supplied to the selected cultivators for recording day-to-day income from various sources and expenditure on agricultural inputs. Two investigators posted at the block level visited the selected cultivators once a month to help the cultivator in completing the required entries in the register. The completed registers were collected from the cultivators at the end of the agricultural year. Each farmers was paid Rs. 75 for maintaining these records.

Farm surveys from July, 1990 onwards are not available which was a period of even greater violence. Summary statistics for the farm surveys are given in Table 2a. The figures reveal roughly the same amount of money being invested in both wells and fertilizers. In our sample, there were on average 8 family members and the average area held was 4.6 hectares in 1981. According to the Census of India report, each household in Punjab had on average 6 members in a household in 1981. However, this includes the urban households where family size was less. The median farm size in Punjab in 1981 was close to 4 hectares, showing the representativeness of the farmers.

Expenditure on wells comprised of new investment on electric motors, pumps, belts, boring pipes, water tanks, sprinklers and pump houses and also the interest payable if loans taken. Expenditure on repairs, replacements, diesel oil and electricity for the wells was also included in this figure, although no breakdown is available. It should be considered as a good proxy for investment in long-term agricultural technology as the average depreciation on wells is only 3% per year. Buying components for wells is a fixed investment that accrues returns over a long horizon and is not as lumpy due to the availability of several parts. For example, Michael et al. (2008) report the average life of centrifugal pumps to be between 15-25 years, electric motors between 25-35 years, and galvanized iron pipes and hydrants between 20-40 years in Punjab. Chadha (1985) reports that in 1984, 58.65% of the cultivated area was irrigated by tube wells compared to 41% by government canals. Expenditure on fertilizers includes chemical fertilizers, compost and farm yard manure (whether home produced or purchased) during the year. Home produced manure was priced at village rates. As fertilizers are perishable commodities generally used on only one crop, this can be considered as a short-term investment.

The data set on terrorism has been taken from the South Asia Terrorism Portal, which has a district-wise record of all major terrorist incidents in the state[15]. Major terrorist incidents are those where the number of civilians killed were greater than or equal to 3. There are 1045 major terrorist killings recorded in the data set and 149 incidents. In total, major as well as minor incidents accounted for 5070 civilian killings during the period 1978-1989, but the minor incidents have not been disaggregated district-wise. However, the temporal pattern in terrorist killings of civilians in major incidents and civilians killed in all terrorist incidents is remarkably similar at the state-level. Major terrorist killings start from 1981 with average terrorist killings being 9.7 in a district in a year and average terrorism cases being 1.4. Annual crime statistics of district-level murders and thefts have been taken from the Crime Records Bureau in New Delhi. Table 2b shows that annual mean terrorist incidents, killings, murders and thefts for each district.

[15] The former Director General of Police in Punjab, K.P.S. Gill heads the Institute of Conflict and Management, which runs the South Asia Terrorism Portal.

Table 2a: Summary Statistics from farm surveys

Variable	Obs	Mean	Std. Dev.	Min	Max
Wells	510	1086	733	0	4141
Fertilizers	510	1154	586	15	3944
Seeds	510	370	4337	2584	35632
Implements	510	257	601	51	8767
Rent	510	3376	250	5	3078
Farm expenditure	510	10595	1579	491	13586
Farm income	510	39529	26672	-2123	166900
Total family members	510	8.15	3.42	2	23
Area held in hectares	510	4.87	2.51	1.21	21.46

Table 2b: District-wise annual means of terrorist incidents and crime (1978-1989)

District	Obs	Mean terrorist incidents	Mean terrorist killings	Mean murders	Mean thefts
Amritsar	12	5.92	35	235	341
Bhatinda	12	0.33	2	73	131
Faridkot	12	0.5	6	73	129
Ferozepur	12	0.92	5	76	136
Gurdaspur	12	1.08	7	85	157
Hoshiarpur	12	0.25	6	39	103
Jalandhar	12	1.25	6	78	283
Kapurthala	12	0.67	4	24	70
Ludhiana	12	0.5	4	82	289
Patiala	12	0.75	10	57	216
Ropar	12	0.17	3	25	85
Sangrur	12	0.08	1	55	113
Punjab (total)	144	12.42	87	902	2053

Notes:

1) The variables, terrorist incidents and terrorist killings have been recorded from South Asia Terrorism Portal's data on terrorism in Punjab. Terrorist incidents are recorded only if it is classified as "major", i.e. if killings are greater than equal to 3 in that incident. Terrorist killings measure the killings in major terrorist incidents.

2) murders and thefts are absolute numbers of the crimes in each district over the period 1978-1989 (inclusive of both years). These are available from the Crime Records Bureau, New Delhi, India.

5 Empirical methodology

5.1 Specification

Baseline regressions to find the reduced form causal effect of terrorism are of the form:

$$y_{ijt} = \alpha_t + \gamma_j + \beta(f(Terrorist_{jt-1})) + \mu_j t + \phi D_{jt} + \delta X_{ijt} + \varepsilon_{ijt}$$

y_{ijt} is the outcome variable - investment in agricultural technology by the household i in district j in year t[16] and D_{jt} and X_{ijt} are district and household controls. α_t are year effects that are included to account for any time-specific effects in both investment in agriculture and terrorism across the state as a whole. These would help in controlling for any linear trends in both agricultural technology and terrorism that would otherwise lead to an omitted variable bias. District fixed effects or γ_j can account for all unobservables or observables that are fixed within a district and across time. These could be a district's size, distance from the international border, terrain, culture, religious intensity, legal and political institutions and other unobservable characteristics that are fixed in a district and may potentially be correlated with terrorism. Comparing performance of districts with each other can lead to spurious correlations. In a study done at the farmer-level, we can look within a district over time rather than across districts. The term $\mu_j t$ includes all within-district time trends that are correlated with terrorism, for example, different rates of technology adoption in different districts (such as adoption of tractors or HYV crops) that could be correlated with terrorism. The problem of reverse causality is also avoided as the investments are taken at the level of the farmer whose investment is assumed to be small enough to not have any impact on district terrorist killings. There could potentially be an issue of endogeneity associated with the regression if the investment data was at the level of the sub-district or the district[17].

We are interested in the estimate of β, which would give us the effect of that function of terrorist killings in the past year on the investments of the farmer in the present year if there is no endogeneity. As we only know the total investments and killings in a given year, taking the previous year's killings should give us the cleanest estimate.

5.2 Application of the specification

In our baseline specification, the independent variable of interest, $f(Terrorist_{jt-1})$ is taken to be $\log(Terrorist_{jt-0.5})$. This is log of terrorist killings in district j in that calendar year if there are killings. If there are no major terrorist incidents, it has been assigned a value of zero[18]. For example, if y_{ijt} (investment) is recorded from July 1984 to June 1985, $(Terrorist)_{jt-0.5}$ refers to the total number of terrorist killings in district j in the calendar year 1984. The use of the unconventional subscript $t - 0.5$ has been taken because of the 6 month difference in timings of the investment surveys and the data on terrorism

[16] In accordance with the model, one could also construct a binary variable that takes value equal to 1 if investment is non-zero and 0 otherwise. However, in the data, there are only 33 farmers out of 510 who do not invest in well equipment in a year. Moreover, the data definition of investment in wells also includes maintenance expenditure which is unlikely to be 0.

[17] For instance, Moradi (2005) finds that a drop in agricultural production and lack of nutrition is linked to civil wars in Africa.

[18] There is no case where terrorist killings are one, so log 1 will never be calculated. Another way of looking at $\log(Terrorist)_{jt}$ is an interaction between a dummy for terror and log of the killings.

incidents. The function log is chosen because investment is likely to be very sensitive to the first few killings but will respond less when terrorist killings become more common. Moreover, log is commonly used in regression analysis to check for non-linear effects and here, the results are robust qualitatively if a linear function is considered.

I construct three measures of terrorism: first, log *terrorist*, is log of the total annual killings by terrorists in a district[19]. Second is the intensity of terrorism (*log intensity*), which measures how many people were killed on average in terrorist incidents in that district in that calendar year. Intensity can measure on average the lethality of a terrorist incident. The third measure, *dummyterror* is a dummy for whether the district experienced terrorism in that year or not.

As one representative farmer from each sub-district is surveyed every year, the values of the district level variables have been superimposed over the sub-districts belonging to that district. There is a six-month overlap between the survey and terrorism data, so our estimates could suffer from the problem of farmers changing their investment before the terrorist attack. This could bias our results, but to the extent that we take the investments at the end of June, the farmer still has a full six months after potentially the last terrorist attack to make changes to his investments. Moreover, the actual timing of investments in a calendar year as explained in the penultimate section would mitigate the problem even further.

6 Results

Running the baseline specification, columns (1)-(3) in table 3 report the results of the impact of each of the three terrorist measures on investment in wells controlling for the twelve district and ten year dummies (July, 1980 to June, 1990) as terrorism begins in 1981. If there is a major terrorist attack in a district in a year, it causes a decline of more than 20% on average on investment in wells. The estimates for impact on fertilizer investment are negative but measured with high standard error and so are insignificant and even the impacts are half as large as those for terrorist killings and dummy for terrorism on investment in wells. We also see that terrorist killings, intensity of attack and presence of terrorism have coefficients that are significant at the 1% level for investment in wells. However, our estimates may be biased because there may be trends in agriculture, for instance declining returns to the Green Revolution that may differ across districts or there may be different returns to adoption of new technologies. If this is indeed the case, or there are any other issues such as population growth at different rates that is driving both investment and terrorism, then our estimates would not give consistent results.

Columns (4)-(6) show results after including within-district linear trends. There are twelve of these (1 for each district) and their value increases by 1 at

[19] Another functional form that can be employed is log(1+*terrorist*). The correlation between this variable and the one used in our regressions is 0.9991. Using the alternative form makes almost no difference to our estimates and standard errors.

the end of each year for that particular district and is 0 for all other districts. Although the estimates for 'log killings' and 'dummyterror' are significant now only at the 5% level, yet the impacts are still large in magnitude for investment in wells.

Miguel (2005) uses rainfall variation to estimate the impact of income shocks on murder in rural Tanzania. Miguel, Satyanath and Sergenti (2006) also look at weather variation to estimate the causal effect of growth on probability of conflict in Africa. Even though the historical literature points to economic and political factors leading to the insurgency, violence in Punjab could have been related to income shocks through rainfall and including rainfall as a regressor should certainly make our estimates more accurate. I control for rainfall at the farm level (measured by the nearest weather station to the farm village) and also for soil quality (5 distinct types and percentage area under each type), total family members, crop intensity and area held and find that it makes little difference to our estimates. It is important to check after controlling for area held as it has been shown to be an important determinant of investment in wells (Fujita and Hussain, 1995). These control variables have been added for greater efficiency as these are not captured by either year or district fixed effects. As crop intensity and area held may be jointly determined with the amount of investment in wells and fertilizers, I check with their exclusion as well but the results remain virtually the same. The estimates are slightly reduced, but even here, their significance remains intact.

There may still be problems with this regression as districts growing economically at different rates may be determining both conflict and agricultural investment. Without controlling for district income, one may argue that the estimates may be biased especially if poorer districts are more prone to conflict and also have lower growth in long-run investment. Therefore, in columns (7)-(9), I also include district income (under other controls) for all these years.

The presence of a major terrorist incident in a district leads to an average fall in well investment of around 17%. The figure is close to the estimate obtained from using the coefficient on log terrorist killings and finding the effect of "average number of killings" on well investment, which turns out to be 16%. In table 4, this figure drops to 6% for fertilizers which is insignificant. This points to a novel result in the paper - terrorism affects long-term investment but has little effect on short-term investment.

Table 3: Effect of terrorism on well investment

	Dependent variable: Investment in wells equipment								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log terrorist	-87.79***			-62.43**			-54.87**		
	(30.64)			(24.84)			(26.30)		
log intensity		-107.3***			-91.02***			-87.74***	
		(35.49)			(31.20)			(32.61)	
dummyterror			-205.1***			-181.8**			-169.7**
			(77.35)			(70.35)			(71.50)
District and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within-district trend	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	No	No	No	No	No	No	Yes	Yes	Yes
R-squared	0.347	0.346	0.343	0.379	0.381	0.380	0.395	0.397	0.396
Observations	510	510	510	510	510	510	510	510	510

*** p<0.01, ** p<0.05, *p<0.1. Robust standard errors are clustered at the village level and are in parenthesis.

Notes:

1) log terrorist is log of all positive killings by terrorists in a district in a year. If killings are 0, this variable takes the value of 0. The variable intensity is found by dividing the total terrorist killings by the total number of terrorist incidents.
2) There are 12 district dummies (1 for each district) and 10 year dummies (1981-1990).
3) Other controls include annual district income, rainfall at the farm level (measured by the nearest weather station to the farm village), soil quality of farm (5 types), total family members, crop intensity and area held.

Table 4: Effect of terrorism on fertilizer investment

	Dependent variable: Investment in fertilizers								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log terrorist	-42.28*			-23.93			-21.87		
	(24.13)			(28.63)			(28.41)		
log intensity		-36.89			-9.628			-9.061	
		(32.47)			(35.41)			(35.04)	
dummyterror			-103.60			-65.81			-63.96
			(63.84)			(69.61)			(68.76)
District and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within-district trend	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	No	No	No	No	No	No	Yes	Yes	Yes
R-squared	0.407	0.404	0.406	0.424	0.423	0.424	0.440	0.439	0.423
Observations	510	510	510	510	510	510	510	510	510

*** p<0.01, ** p<0.05, *p<0.1. Robust standard errors are clustered at the village level and are in parenthesis.

Notes:

1) log terrorist is log of all positive killings by terrorists in a district in a year. If killings are 0, this variable takes the value of 0. Non-zero killings are always greater than or equal to 3 by definition of a major terrorist incident. log terrorist is log of all positive killings by terrorists in a district in a year. If killings are 0, this variable takes the value of 0. The variable intensity is found by dividing the total terrorist killings by the total number of terrorist incidents.
2) There are 12 district dummies (1 for each district) and 10 year dummies (1981-1990).
3) Other controls include annual district income, rainfall at the farm level (measured by the nearest weather station to the farm village), soil quality of farm (5 types), total family members, crop intensity and area held.

Next, I test for lagged effects of terrorism on investments as well as income per hectare. Looking at columns (1)-(3) in table 5, we find that only coefficient

Table 5: Checking for lagged effects of terrorism

	Wells			Fertilizers			Net income per hectare		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log terrorist (t)	-50.80*			-23.73			31.27		
	(28.70)			(27.97)			(129.50)		
log terrorist (t-1)	31.44			-14.75			-230.05*		
	(31.80)			(24.13)			(128.18)		
log intensity (t)		-80.43**			-18.68			28.63	
		(36.00)			(36.80)			(157.17)	
log intensity (t-1)		24.50			-45.90			-378.76**	
		(44.50)			(29.95)			(157.79)	
dummyterror (t)			-168.40**			-61.87			109.11
			(78.40)			(67.73)			(333.43)
dummyterror (t-1)			39.04			-44.30			-588.56*
			(78.60)			(60.54)			(320.33)
District and year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within-district trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.35	0.36	0.35	0.40	0.41	0.40	0.23	0.24	0.23
Observations	453	453	453	453	453	453	453	453	453

*** p<0.01, ** p<0.05, *p<0.1. Robust standard errors are clustered at the village level and are in parenthesis.

Notes:

1) log terrorist is log of all positive killings by terrorists in a district in a year. If killings are 0, this variable takes the value of 0. Non-zero killings are always greater than or equal to 3 by definition of a major terrorist incident. The variable intensity is found by dividing the total terrorist killings by the total number of terrorist incidents.

2) Here, terrorist (t-1) measures the total number of terrorist killings in a district in the year one year prior to the normal terrorist (t) variable. This means there is a clear lag of six months from the year when terrorist (t-1) is calculated and when investment is recorded. In terrorist (t) there was a six month overlap between the terrorism and investment data.

on terrorism in the year when the survey starts is significant. The variable, log terrorist (t-1) is based on the killings in the year prior to when the survey starts. Therefore, the end dates of the record for the terrorist incidents and the farm surveys are 18 months apart. Further lags give similar results.

The coefficients on lagged terrorism in columns (4)-(6) show a negative and insignificant effect as is the case for contemporary terrorism. The results mean that even though there is an effect of terrorism on investment in wells in the short-run, it is not persistent in the long-run. If long-term investment is affected, we should see an effect on the incomes of the farmer as well. I check for this effect and find that the negative effect kicks in with lagged terrorism. Therefore, it takes a year for the decline in investment to potentially show up as a fall in income per hectare.

7 Robustness checks

Another short-term investment that farmers spend their income on are seeds. Here too, we should see little change in investment due to terrorism. Regressions in columns (1)-(3) in table 6 show that coefficients are insignificant and positive.

Table 6: Robustness checks using alternative outcomes and additional controls

	Seeds			Implements			Wells			Fertilizers		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
log terrorist	55.86			-0.17			-53.25**			-20.69		
	(39.21)			(9.33)			(26.58)			(24.53)		
log intensity		66.26			7.02			-87.51**			-5.32	
		(49.42)			(15.58)			(34.07)			(31.82)	
dummyterror			130.36			24.54			-167.16**			-57.27
			(88.20)			(34.07)			(71.60)			(60.07)
log murder	63.39	65.93	77.47	26.13	23.74	24.10	-58.20	-52.59	-68.19	-17.81	-25.10	-22.30
	(69.18)	(69.94)	(77.19)	(31.63)	(32.07)	(31.49)	(122.17)	(124.32)	(123.21)	(88.47)	(87.99)	(88.34)
log theft	-101.38**	-85.24*	-107.91**	-1.40	1.84	0.06	18.08	-8.40	21.82	-3.35	-0.57	-1.45
	(49.49)	(44.10)	(49.75)	(24.56)	(28.08)	(24.32)	(77.15)	(78.59)	(77.20)	(82.90)	(82.22)	(83.14)
All other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.21	0.21	0.21	0.24	0.24	0.24	0.40	0.40	0.40	0.44	0.44	0.44
Observations	510	510	510	510	510	510	510	510	510	510	510	510

*** p<0.01, ** p<0.05, *p<0.1. Robust standard errors are clustered at the village level and are in parenthesis.

Notes:

1) All other controls include district fixed effects, year dummies, within district trends, annual district income, rainfall at the farm level (measured by the nearest weather station to the farm village), soil quality of farm (5 types), total family members, crop intensity and area held.

2) murder and theft are absolute numbers of the crimes in each district over the period 1978-1989 (inclusive of both years). These are available from the Crime Records Bureau, New Delhi, India.

3) Seeds and Implements are annual expenditures on seeds and implements respectively by the selected farmer.

4) The variable log terrorist is log of all positive killings by terrorists in a district in a year. If killings are 0, this variable takes the value of 0. Non-zero killings are always greater than or equal to 3 by definition of a major terrorist incident. The variable intensity is found by dividing the total terrorist killings by the total number of terrorist incidents.

For long-term investment, wells is a special case on two accounts - first, it is mostly immobile and second, the maintenance of a well is not essential for growing crops. On the other hand, expenditure on implements includes the cost of repairs, replacements and servicing. These expenditures are essential and are on average less than a quarter of the expenditure required on equipments for wells and tubewells. Secondly, implements used for farming are mobile as the farmer can easily carry them with him when he migrates (in fact, he would be inclined to take them if he is starting on a new farm). Therefore, we should not observe a huge effect on investment into implements of terrorism. In columns (4)-(6) in table 6, we observe negligibly small and positive but insignificant effects. In regressions (7)-(9), I also control for log murders and log thefts as proxies for the security presence within a district in a given year but find estimates on crime variables to be very small and insignificant in explaining investment in wells. Our earlier estimates though slightly reduced still remain robust and significant.

For investment in fertilizers too, the estimates go down but they remain insignificant and negative. I also test controlling for the three combinations by including any two terrorism variables out of the three, and the results show insignificance for both coefficients due to the multicollinearity problem. Also, the results remain the same even if we take quadratic trends in the state.

Additionally, an alternative specification can also include the previous year's investment by the farmer on the right hand side. However, this can be unbi-

asedly estimated with the Arellano-Bond GMM estimator. As I do not have the previous year's investment of the same farmer, this is not in my baseline specification. However, as we have a relatively small T and large N, it makes sense to do a robustness check with the Arellano-Bond Dynamic Panel GMM estimator by assuming that the previous farmer surveyed from the same subdistrict would be similar to the present farmer. I implement this and find that my coefficient on dummyterror is actually larger and more significant. See Table A1 in Appendix for details.

8 Concerns

There could be at least five concerns about interpreting β as causal. First, any policy change (for instance, number of police personnel) within a district that is correlated with terrorism and also affects investment has not been accounted for. However, if changes in policy of security are captured by crime levels, then including crime variables (such as murder and theft) does not change our results.

Second, due to a six months overlap between the terrorism and investment data, it is possible for some of the investments to have actually been made before the terrorist attack. This could bias our results, but the farmer still has a full six months after potentially the last terrorist attack to make changes to his investments. Another important reason why the bias is likely to be insignificant for investment into wells can be explained by the timing of investments in a calendar year. There are two main crops in Punjab, wheat and rice paddy[20]. Farmers normally irrigate just before they apply fertilizers to the crops. Looking at Figure 2, we see that wheat is sown around early November, so manure is used along with irrigated water around this time. Then, well water is needed around January and February together with chemical fertilizers (nitrogen, phosphate and potash). For paddy, rainfall in the months of July and August is usually sufficient along with the same chemical fertilizers (the blue shaded region). Therefore, the main requirement for well irrigation is after the rainy season and before January. This implies, that a rational farmer will make his investments into well equipment only in the later part of the calendar year (around October and November). Fortuitously, this coincides with clean timing of the terrorist incidents, since most terrorist incidents would have already taken place by then. In case the farmer wants to hedge the risk of rainfall in July, he would invest before July, again mitigating the overlap problem.

Third, the estimate could be biased if households built the wells early on in each district and later they were only spending on maintenance. There would be a discontinuity somewhere for each district – depending on how developed that district is – leading to a spurious correlation between increase in terrorism and decrease in wells expenditure. However, there are at least three reasons why these would not lead to a bias. First, almost all households had sunk wells

[20] In 1980-81, for example, Punjab's contribution to the central pool of wheat was 73% and 45% to rice.

Figure 2: Timing of investment into fertilizers and wells with the shaded area showing rainy season

(if not tube wells), so the expenditure was mainly on their maintenance and buying new equipment and not on construction of new wells per se showing that investment can be assumed to have a continuum of values as opposed to being lumpy (and is observed to be so in the data). Second, even if it is the case that there are discontinuities at different stages in the districts, it is not obvious why these would be correlated systematically with the irregular pattern of terrorism in the districts, for instance, terrorism falls in 1985 and 1989 due to peace agreements. Finally, we have included district-specific time trends to account for different rates of new technology adoption.

Fourth, one would expect the investment in equipment for tube wells to depend on access to credit markets (Dhawan, 1977), price of diesel for use in motors (Shah and Ballabh, 1997), knowledge of the farmer and other farmer-level unobservables. Controlling for all these would undoubtedly improve the efficiency of our estimates and help us in understanding the channels better. However, for any bias in the reduced form regressions, terrorism levels in the district should be correlated with these household level characteristics. Also, these should not already be proxied for by household-level controls in our regressions (e.g. household income, family size, soil quality and cropping intensity) or by district trends and income levels. A related concern (on understanding the channels) is that the effect of counterinsurgency measures cannot be totally captured as we do not have information on government spending on counterinsurgency. We observe the equilibrium number of terrorist killings given the counterinsurgency spending. Therefore, we do not know the effect of counterinsurgency via increased policing, but only the reduced form effect of the increase in terrorist killings[21]. However, I do control for district income which should be a good proxy for spending on district's spending on counterinsurgency and other law enforcing activities.

One problem that has been ignored so far is selection bias related to farmers and villages. As farmers in our study all own bullock-carts, it is clear that the sample cannot be representative of farmers owning tractors. It may also be the case that an unobservable characteristic of a farmer is driving him towards both investing in bullock-cart instead of a tractor and reducing investment in wells in response to terrorism. This unobservable characteristic is an omitted variable

[21] To get at that precise effect, one would need spending on counterinsurgency activities at the district level but this is confidential information.

that I do not have data to control for. However, it is important to notice that for the vast majority of farmers during the 1980's, bullock carts were the primary mode of cultivation. Second, any secular adoption in tractors technology can be captured by district trends. The impact is also likely to be a lower bound of the true effect as they could have used the money to buy tractors. The selection of villages could also influence the bias as they are not chosen randomly. To the extent that the selection of villages that are surveyed is not correlated with terrorism (the study surveys a village for four consecutive years on average and it also does not mention terrorism), we do not have a bias. However, it may be reasonable to think that villages selected were less prone to terrorism, due to safety concerns of the researcher who was required to make monthly visits to the farmers being surveyed. If this is the case, then the impact would again be a lower bound of the true causal effect of terrorism on investment.

9 Heterogeneous effects

As suggested in the conceptual framework, the impact of terrorism on investment is likely to vary by wealth of farmer. In particular, if the absolute risk aversion channel dominates other channels, we should observe richer farmers show less fall in long-term investment relative to poorer farmers. This could be tested by interacting a measure of terrorism (here, I use dummyterror) with a dummy for rich farmer which takes value one if the farmer is above the 90th percentile level of gross farm income per capita. The coefficient gives the effect of presence of terrorism if the farmer is rich and γ tells us by how much additional investment is affected by terrorism if the farmer is rich rather than poor. The hypothesis predicts that the rich should respond more to the attacks as they may be more mobile and may also be a target of more extortion. In other words, we expect γ to be negative but δ to be positive. However, there may be an endogeneity problem if investment in agricultural technology affects whether one is categorized as rich or poor (but this is unlikely to happen in the same year). The empirical specification for testing heterogeneous effects is as follows:

$y_{ijt} = \delta.rich_{ijt} + \beta(dummyterror_{jt-0.5}) + \gamma(dummyterror_{jt-0.5} * rich_{ijt}) + \alpha_t + \gamma_j + \mu_j t + \varepsilon_{ijt}$

Table 7 shows that estimates for β are γ negative and significant and δ is positive. These results also hold if we define dummy on area held as opposed to income per capita. This implies that there may have been adverse changes to complementary inputs used by richer farmers during terrorism. These effects are strong enough to dominate the declining absolute risk aversion channel.

Another hypothesis that can be tested is that families with more members are likely to have higher costs of moving to an outside option (for instance, by migrating) and so would not reduce their investment in wells as much as smaller families. In columns (3) and (4), we get a weaker confirmation of our hypothesis. Only very large families (those above the 95th percentile) seem to show significant positive interaction effects with dummyterror. This means

Table 7: Heterogeneous effects on type and location of farmer

Dependent variable: Investment in wells equipment					
	(1)	(2)	(3)	(4)	(5)
dummyterror	-144.11*	-123.15*	-197.78***	-199.2***	-166.07*
	(68.32)	(71.29)	(70.81)	(73.38)	(93.66)
rich1	565.83*				
	(302.10)				
dummyterror*rich1	-870.68***				
	(321.57)				
rich2		12.44			
		(142.6)			
dummyterror*rich2		-369.29**			
		(165.20)			
familysize1			-113.88		
			(108.92)		
dummyterror*familysize1			441.95**		
			(172.07)		
familysize2				-122.32	
				(99.74)	
dummyterror*familysize2				145.45	
				(161.66)	
border					-279.02**
					(128.31)
dummyterror*border					-269.04*
					(141.44)
Other controls	Yes	Yes	Yes	Yes	Yes
R-squared	0.40	0.40	0.39	0.39	0.29
Observations	510	510	510	510	510

*** p<0.01, ** p<0.05, *p<0.1. Robust standard errors are clustered at the village level and are in parenthesis.

Notes:

1) rich1 and rich2 are dummies that take value 1 for farmers above the 95th and 90th percentile of per capita farm income level and 0 otherwise.

2) familysize1 and familysize 2 are dummies that take value 1 for households above the 95th and 90th percentile of total household members and 0 otherwise.

3) border is a dummy for the three bordering districts.

4) Other controls for regressions (1)-(4) include district fixed effects, year dummies, within district trends, rainfall at the farm level (measured by the nearest weather station to the farm village), soil quality of farm (5 types), crop and intensity.

5) Other controls for regression (5) are year fixed effects, soil quality, net rainfall, total family members and crop intensity.

that smaller and medium-sized families reduce their investment in wells much more than very large families. In both cases, the estimate for β always remains negative and significant.

Geography in terms of proximity to international borders can also have an effect on investment. However, it would be interesting to know if there is an additional effect of being close to the border and having terrorism over and above the effect of terrorism in a non-border district and being a border district not experiencing terrorism. We define three districts (Amritsar, Gurdaspur and Ferozepur) as bordering districts because they share a border with Pakistan. After controlling for trends in these districts, we observe a negative interaction coefficient in column (5) implying that investments in bordering areas are particularly sensitive to terrorism.

10 Policy implications and conclusion

The World Bank report (2004) hypothesized that the agricultural growth rate plummeted from 6 percent to 2 percent during 1987-1992 because of a decline in long-term investment associated with the uncertainty surrounding militancy activities. I find that presence of terrorism in a district in a year reduces long-term fixed investment by around 17% after controlling for time trends, district fixed effects, within-district time trends and a range of other controls. These results are consistent with the results found adverse effects of violence on long-term investments in education in Peru (Leon, 2009) and health in Burundi (Bundervoet et al, 2009). There is also evidence for a reduction in income of the farmer due to terrorism a year after the effect on investments.

In table 5, we see that terrorism has a negative lagged effect on net income per hectare after controlling for year and district fixed effects as well as within-district trends. I find that on average a farmer affected by terrorism in his district loses Rs. 3084 on an average income in 1981 of Rs. 33482. This is a 9.2% loss. However, the probability of an attack in a district between 1981-90 is 42.85%. This implies that an average farmer in the state loses 3.94% of his income annually because of the Punjab insurgency during 1981-90. It is consistent with evidence which shows that irrigation is associated with a decrease in rural poverty and an increase in agricultural growth in India (Bhattarai and Narayanmoorthy, 2003).

We also see that richer farmers are more responsive to terror attacks and very large families tend to be less responsive. Wang et al. (2006) provide evidence for the higher likelihood of richer farmers in China to be water sellers from tubewells in the groundwater market because of higher fixed costs for the poor farmer. If this is also the case in Punjab, a drop in tube well investment by the richer farmers would also have spillover effects on poorer farmers distorting their decisions.

Concrete policy implications would depend on the channels. On the demand-side, there could be an effect on the wealth of the farmer through a decrease in the returns to investments or an increase in their variability. Policy rec-

ommendations would depend on finding the quantitative significance of each mechanism. Similarly, on the supply side, price of inputs (wages or cost of capital) could increase leading to a decline in investment. The price and availability of diesel and electricity could have been affected. However, at least in the short-run, Bhargava et al (2009) report that farmers in Punjab have an inelastic price elasticity of demand for electricity, though this may not be true during conflict. Also, violence could have resulted in credit becoming more expensive due to greater uncertainty. This would again lead to a decline in investment for farmers who needed to borrow for their production. If the credit channel is important, then the government could consider setting up a centralized microfinance scheme wherein other states pool in to compensate for correlated shocks (like floods, drought or terrorism) in all districts in a state.

In line with our finding that long-term investments of farmers living in border districts were differentially affected by terrorism, the Planning Commission Report (2002) observes that generation of additional employment was adopted as the core concern of the State's Eighth Plan (1992-97) with the border districts of Gurdaspur, Amritsar and Ferozepur receiving special focus as they were major victims of the militancy.

Although, we may conclude that investment into long-term equipment was affected more, this does not necessarily imply that governments should have subsidized the equipment. For example, it may be the case that water table did not decline by as much during conflict because digging deeper tubewells was a long-term investment. Wang et al. (2006) show that increased use of tube wells in China was correlated with an increase in income and productivity but also contributed to a fall in groundwater levels. This would imply a trade-off between agricultural productivity during conflict and after it. Future studies could potentially look at the impact of conflict on the environment that takes place through changes in human behavior.

In terms of the contribution of the paper, I show a unique but intuitive result whereby farmers reduce long-term investments more relative to short-term investments in response to terrorism and this effect is greater for the richest farmers and those from bordering districts. The significance of the channels is yet to be properly evaluated and this seems like a promising area for further research.

11 Appendix

Table A1: Effect of terrorism on investment using the Arellano-Bond estimation procedure

	Wells			Fertilizers		
	(1)	(2)	(3)	(4)	(5)	(6)
dummyterror	-212.8**			-52.70		
	(83.63)			(68.97)		
log terrorist		-84.29***			-26.20	
		(31.24)			(26.58)	
log intensity			-108.9***			0.761
			(38.49)			(33.58)
Constant	161.1	100.3	190.4	-350.5	-392.0	-306.1
	(574.9)	(566.3)	(565.2)	(548.5)	(545.9)	(549.7)
Observations	401	401	401	401	401	401
Number of sub-districts	46	46	46	46	46	46

*** p<0.01, ** p<0.05, *p<0.1.

Notes:

1) log terrorist is log of all positive killings by terrorists in a district in a year. If killings are 0, this variable takes the value of 0. Non-zero killings are always greater than or equal to 3 by definition of a major terrorist incident.

2) There are 12 district dummies (1 for each district) and 10 year dummies (1981-1990)

3) Other controls in the background include annual district income, rainfall at the farm level (measured by the nearest weather station to the farm village), soil quality of farm (5 types), total family members, crop intensity and area held.

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