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Low-intensity Conflict and Firm Level Investment in Ethiopia

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Abstract

This paper investigates the effect of low-intensity armed conflict on firm-level investment in a Sub-Saharan African country. We match firm level panel data from Ethiopian manufacturing with battle events at the town level. Using a more precise spatial identification of conflict exposure, we find that conflict reduces the investment rate significantly even when events are not extremely violent. The adverse investment effect increases with the geographic proximity of conflict and tends to decline with the capital intensity of production.

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1. Introduction

Economic analysis of civil war and armed conflict has increased significantly over the past two decades. Earlier studies focused mainly on cross-country analysis of the socioeconomic triggers of civil war (Collier and Hoffler, 1998; 2004; Ross, 2004) and its implication on economic growth (Collier, 1999; Murdoch and Sandler, 2002). Blattman and Miguel (2010) provide an extensive review of the conflict literature at the macro- and micro-level. Micro-level studies began to emerge only in the past few years and often address the responses of households and individuals to the intensity of conflict (Verwimp, Justino, and Bru¨ck 2009).[1] Armed conflict is prevalent mainly in developing countries (Wallensteen and Sollenberg, 2000) and its impact on entrepreneurship is presumably one of the mechanisms by which it affects economic development. The general perception is that conflict would undermine firm level activities of job creation, investment and other productivity enhancing activities. However, there is remarkably little research about firm performance and behavior in conflict zones. Most recently Guidolin and La Ferrara (2007) and Collier and Duponchel (2013) use post-conflict data to assess the firm level impact of civil wars in Angola and Sierra Leone, respectively. Camacho and Rodriguez (2013) use panel data from Colombia to examine firm exit rates due to violence. These firm level studies capture the impact of extremely violent armed conflicts and one wonders about the significance of other low-intensity armed conflicts.

[1] For more on household and individual level studies of conflict see the 'Households in Conflict Network' at http://www.hicn.org and the 'MICROCON' research program at http://www.microconflict.eu.

This paper contributes to this emerging field of research by combining firm-level data from Ethiopian manufacturing with geo-coded data on conflict. Ethiopia is an ideal case to examine conflict as it is one of the largest countries in the most conflict prone part of Sub-Saharan Africa with a long history of internal and inter-state conflicts. Our study covers the period 1996-2007 which includes the border war with Eritrea during 1998-2000 and infightings of government forces with different insurgent groups. While the country has gone through a full-fledged civil war during 1977-1990, our sample period captures a rather low-intensity armed conflict simmering between government and rebel forces.

Our response variable is firm-level investment and we intend to identify the investment effects of conflict by exploiting the panel nature of our data and the recurrence of infighting at different levels of intensity across towns. The firm level panel data provides the universe of formal sector manufacturing firms which is ideal for this investigation. For the incidence of conflict, we rely on the Armed Conflict Location and Events Dataset (ACLED) research project which provides highly disaggregated event data with detailed spatial referencing. Combining these two datasets allows us to identify the conflict exposure of economic agents, in our case firms, more precisely than in previous studies.

As a preview of our results, we find that conflict has a statistically significant negative effect on firm-level investment even when occurring at low intensity. The negative investment effect declines with the capital intensity of firms, possibly due to differences in the adjustment costs of capital and labor, as well as differences in the risk preferences of entrepreneurs. The investment effect is detected only for firms located outside the capital

city Addis Ababa and there is no major across industry variation in the investment response to conflict. Other aspects of firm behavior do not seem to be impacted by conflict.

The paper is organized as follows: Section 2 highlights the theoretical framework and the main empirical evidence. Section three describes the two datasets. Section four describes the investment model while measurement issues and descriptive statistics are discussed in section five. The regression results are presented in section six and conclusions in the last section.

2. Conflict and firm behavior: theoretical considerations and existing evidence

The role of investment for economic growth has been demonstrated adequately in theoretical (Solow, 1956) as well as empirical studies (Levine and Renelt, 1992). However, economists have been less successful in explaining the investment decisions of firms. The earlier neoclassical models of investment focused entirely on demand and the user-cost of capital (Jorgenson, 1967).[2] The contemporaneous user-cost would reduce the rate of adjustment of capital to the desired level if capital has a non-zero elasticity of substitution with labor; otherwise only demand matters. This framework perceives firms' investment decisions as independent of expected cash flows and the associated capital adjustment

[2] The user cost encompasses price of capital goods, interest rate and depreciation as well as taxes and investment incentives

costs. This static relationship holds under the unrealistic condition where the firm can reverse its investment decision instantaneously at no cost.

Subsequent theories of investment addressed this caveat by incorporating adjustment costs and expected payoff directly into the firm's objective function. This class of dynamic investment models assumes competitive markets and convex adjustment costs (Tobin, 1968). A key implication of these assumptions is a smooth investment process in response to expected returns. However, the theoretical appeal of dynamic investment models is overshadowed by their poor empirical performance (Chirinko 1993). Most importantly, these models fail to explain why most firms have long spells of zero investment followed by a burst of investment outlays (Doms and Dunne, 1998).

This observation prompted the relatively recent investment models under uncertainty (Dixit and Pindyke, 1994). Uncertainty based models recognize that investment is at least partly irreversible and hence firms would delay their investment decisions until more information on payoffs arrives. The larger the degree of uncertainty, the higher the 'option value of waiting' for more information, and hence the longer the period of investment inaction. The degree of investment discontinuity and lumpiness has since been shown to be pronounced in developing countries underscoring the role of uncertainty (Bigsten et al. 2005; Shiferaw, 2013).

While demand uncertainty remains the focus of empirical studies on the investment-uncertainty relationship, the role of conflict induced uncertainty has not been carefully investigated. The current paper examines armed conflict as a source of uncertainty for firms in developing countries. It is important to recognize that some impacts of civil war on firms are rather direct and relatively easy to observe. These include destruction of economic infrastructure and firms' physical assets, complete disruption of production activities and even loss of lives of employees, firm owners and their family members. Such outcomes often result from very violent armed conflicts which could in turn lead to more extreme ex-post decisions such as firm exit and/or relocation. The existing cross-country studies on civil war and economic growth in fact consider only violent conflicts with at least 1000 battle related deaths. Such extremely violent conflicts are fortunately on the decline (Harbom and Wallensteen, 2007; Themnér and Wallensteeen, 2011).

However, developing countries mostly exhibit internal armed conflicts of a much lower intensity whose effects could be just as significant but much harder to capture. Our conjecture is that the frequency of low-intensity conflict shrouds an invest project's expected payoff with uncertainty. This could be because of unpredictable disruption of transport and other infrastructural services which in turn disrupt production and distribution. Uncertainty could also arise from the underlying potential for a low scale conflict to escalate into a more violent one. Firms would thus reduce their exposure to this risk by reducing their investment rate. Since conflict is a covariate shock, it could also increase the irreversibility of investment decisions and hence undermines the attractiveness of the entire locality for business.

Conflict induced uncertainty could also lead to inefficiency and a lower profit rate in addition to raising the variance of profit. This could arise from ex-ante risk mitigating measures the firm is obliged to take against uninsured risk. For instance, the firm may want to ramp up security features to prevent looting during an outbreak of conflict. Similarly, it may need to stockpile intermediate inputs if supply chains and transport services are susceptible to conflict. Such protective measures come at a cost and may lower the profit rate and curtail investment. However, it could also be argued that firms would only be willing to operate in a conflict prone locality if the average profit rate is much higher than elsewhere.

Firms in conflict zones may also be highly likely to be credit rationed because of lenders' perception of their creditworthiness. The high cost of credit or rejection rate of loan applications could force firms in conflict prone areas to rely on internal sources of finance for investment as compared to their counterparts in peaceful locations. This may reduce the frequency and rates of investment even when projects are deemed profitable.

The above mentioned effects of conflict may also result in a sub-optimal choice of production technology. Firms may choose a labor intensive production process over a capital-intensive one if capital is hard to acquire in the first place and subject to greater risk of destruction or underutilization during conflict. For instance, Hammermesh (1999) argues that workers are less likely to work night shifts in areas with high crime rates. The ability to adjust input proportions in response to conflict, however, may differ across firms depending on industry specific rigidities and the elasticity of substitution between capital and labor. If a firm with a capital intensive technology locates in a conflict zone, its investment decision

could be less responsive to conflict because the risk has already been assumed. For labor intensive firms, however, capacity expansion may be sensitive to conflict intensity.

As already indicated earlier, the conflict literature using micro data is sparse and focuses on effects at the household and individuals levels (Verwimp, Justino, and Brück 2009).[3] Rockmore (2011) shows that a large part of the welfare loss in conflict-affected societies does not come from the direct exposure to violence but from reactions to the risk of such exposure. Bundervoet (2010), using data from Burundi, finds that conflict increases the likelihood that a household grows low-risk crops with low returns.

While investment is primarily a firm level decision, very few studies capture its association with conflict. Pshisva and Suarez (2010) is perhaps the only study that relates firm level investment with insecurity. They find a negative impact of kidnappings of firm owners/managers on firm investment in Colombia where kidnappings often occur in connection with the armed conflict. Camacho and Rodriguez (2013) examine the effect of conflict on firm exit in Colombia using smaller administrative units. They find that an aggregate measure of different indicators of conflict increases the probability of firm exits in that particular district. This effect is shown to decline with firm size and age suggesting that large firms are better equipped to adjust to a conflict environment.

[3] At the macro-level, Barro (1991) and Alesina and Perotti (1996) show that political instability reduces aggregate investment and economic growth.

In the context of Africa, Guidolin and La Ferrara (2007) show that ending the civil war in Angola negatively impacted the stock prices of diamond mining firms. This perverse outcome seems to be associated with illicit advantages and abnormal profits those firms derive from the collapse of government regulation during the war. Collier and Dupchonel (2013) investigate the long-term effects of the civil war in Sierra Leone that ended in 2002 using firm level data in 2006. The authors find post-conflict firm size and income to be lower for firms in high intensity areas of this war-torn country as well as a negative effect on human capital. This suggests that violent conflict affects the technology and productivity of firms even after it is over. However, relaying on a single cross-section of surviving firms observed in post-conflict Sierra Leone makes is difficult to control for confounding factors.

Our study is also related to a small body of literature about the effect of crime on firms. Krkoska and Robeck (2009) find a negative impact of street crime on firm level investment using survey data from 26 transition countries. An interesting aspect of their finding is that it is the perception of crime, and not the actual loss of assets due to crime, that drives the negative investment effect. They also find that increased spending on security services lowers investment on machinery and equipment. Based on a survey of small and medium South African enterprises, McDonald (2008) reports: “a quarter of all respondents expressed reluctance or unwillingness to expand or invest in their business because of the threat of crime” (p. 54).

Summing up, the existing microeconomic literature shows that the perception of insecurity due to on-going conflict and crime affects firms’ decisions to invest and exit. The civil wars in

Sierra Leone and Angola were much more intense and devastating in terms of casualties and economic collapse than the conflict in Ethiopia during our sample period. That means dramatic effects such as firm exit or a large scale destruction of human and physical capital are unlikely to prevail in low-intensity conflicts. Our paper therefore contributes to the literature by investigating the impact of low-intensity conflicts on firm level investment through a sense of uncertainty.

3. Data

Firm level data

This paper uses firm level panel data from the formal manufacturing sector of Ethiopia over the period 1996-2007.[4] The data comes from the annual manufacturing census conducted by the Central Statistical Agency (CSA) of Ethiopia which covers all firms with at least 10 workers in all industries except the arms industry. The Federal Ministry of Trade and Industry its counter parts in regional states issue business licenses for manufacturing firms. The CSA updates its sampling frame based on the trade registries of those bureaus and dispatches enumerators to the firms' addresses to administer the questionnaire. All firms are obliged by law to cooperate with CSA's data effort.[5]

[4] In the analysis we only use the years 1997-2007 because we have no conflict data before 1997

[5] If enumerators cannot find a company for three consecutive rounds of the survey, it is considered to have exited, not contacted again and removed from the firm list.

Using a unique identification numbers assigned to each establishment by the CSA, we constructed an unbalanced panel dataset. The number of firms increases from 623 in 1996 to 1339 in 2007 and the data contains a total of 10,305 entries (firm-year observations). The dataset also contains the town where the firms are located. Figure 1 provides an overview of the geographical distribution of towns with formal manufacturing firms. About 60 percent of the companies are located in the metropolitan area of the capital city, Addis Ababa, and about 70 percent are producers with less than 50 employees.

Conflict data

There have been three main sources of conflict in Ethiopia during our sampling period: 1997 to 2007. The first one is the historically problematic relationship with Eritrea, which culminated with its secession from Ethiopia in 1993. The other two stem from the activities of two insurgent groups, the Ogaden National Liberation Front (ONLF) and the Oromo Liberation Front (OLF) who both fight against the Ethiopian government but pursue different goals.

The data on conflict intensity is obtained from the Armed Conflict Location and Events Dataset (ACLED). ACLED records incident level information on political violence including the type, location (as GPS coordinates), date, parties involved and the number of victims of each event (Raleigh et al., 2010). This allows researchers to track conflicts over time. The first category of events is on battles, which are confrontations between armed groups regardless of the number of casualties. They are distinguished in the data by whether or not there was

a territorial change and if so who gained territory. Another category is on violence targeting specifically civilians, which is coded as such if an armed group attacks unarmed civilians. The last category broadly refers to riots and protests. Protests are defined as non-violent gatherings of people with a political purpose, while riots are outbreaks of violence involving at least 3 persons that are gathered for a common purpose.

Between 1997 and 2007 the ACLED database for Ethiopia[6] contains more than 1100 incidents on Ethiopian territory as well as 130 incidents in Eritrea and a few in Kenya and Somalia, all of which relate to Ethiopia. Around 750 of the incidents in Ethiopia are classified as battles and are used as our main indicator for conflict intensity. The Ethiopian military was involved in more than 80% of all battle events and the data captures very well the different phases of elevated conflict between the Military Forces of Ethiopia and the three main other parties. Unfortunately the ACLED does not have battle related casualties for Ethiopia.

Figure 2 shows the geographical distribution of battles although some of the dots may represent more than one incident occurring in the same location. Figure 3 shows the same graph by identifying the various factions involved in the battles. This illustrates that the involved actors focus their activities in different parts of the country and there are more places with battle incidents than towns with manufacturing firms. That means incidents of armed conflict are more widely distributed without no clear pattern with the geographic distribution of manufacturing firms, with is rather concentrated. Since the independence of

[6] The dataset can be downloaded at: http://www.acleddata.com/data/africa. Last accessed on March 14, 2013.

Eritrea in 1993 following three decades of civil war, the relationship between the two countries has been tense culminating in a border conflict during 1998 and 1999. This shows up in more than 150 events in the northern parts of Ethiopia, mainly in the Tigray Region until the conflict ended in 2000.

The bulk of the conflict incidents in our database come from the two insurgent organizations. About 24% of the incidents involve the OLF which was established in 1973 and claims to be fighting for the liberation of the Oromo people from the rule of the Ethiopian government. The Oromo people constitute one of the larger ethnic groups in Ethiopia and the Oromia region stretches from the southern border of Ethiopia to the western border. OLF left the Transitional Government of Ethiopia soon after its establishment in 1991 under the leadership of the Ethiopian People Revolutionary Democratic Front (EPRDF) claiming that its members have been intimidated and imprisoned by EPRDF. The OLF has since been declared a terrorist organization by the Ethiopia government and armed struggle is one of its core strategies according to information provided on the OLF webpage. Judging from the ACLED data, the OLF was mainly active before 2003 where nearly 80% of (nearly 260) the armed conflicts occurred. Most battle incidents take place in the Oromia region and OLF is believed to be receiving support from the Eritrean government for its fight against the Ethiopian government.

The second insurgent organization is the ONLF, which was engaged in about 440 battle events with the Ethiopian military during 1997-2007 (41% of total battle incidents) according to the ACLED database. The ONLF was founded in 1984 to turn the Ogaden territory in the

southeast of the Somali region into an independent state. Although the ONLF was part of the Transitional Government of Ethiopia (TGE) which was established immediately after the overthrow of the Durg regime in May 1991, it dropped out of the political process by boycotting the 1995 national election and resumed its separatist movement (Abdullahi, 2007). Its tactics are essentially ambushes and guerrilla-style raids on government forces. The Ethiopian government considers ONLF as a terrorist organization although it is not listed as such by the US and EU governments. While ONLF has been militarily active over the entire sampling period, the frequency of armed conflicts has increased since 2002. This has to do mainly with the prospect of oil and natural gas in this otherwise arid and nomadic region. Some kidnappings of foreign workers in recent years is also connected with this energy prospects. While the ONLF is mainly active in the Somali region where manufacturing activities are quite limited, the ACLED reports confrontations with the Ethiopian armed forces in other locations as well.

The conflict intensity measure is constructed based on the geographic location of towns for which we have firm level data. The GPS coordinates for those towns are obtained from a GIS dataset compiled by UN-OCHA.[7] This data was counterchecked and complemented by a dataset of official foreign names for Ethiopian administrative units published by the GEOnet Names Server and developed by the National Geospatial-Intelligence Agency.[8] Since the ACLED data also contains the GPS coordinates of incidents, we are able to calculate the total

[7] This is part of the Common Operational Datasets and gives coordinates for populated areas in Ethiopia. The original data for UN-OCHA(United Nations Office for the Coordination of Humanitarian Affairs) comes from the CSA, the International Red Cross society and the Food and Agriculture Organization of the United Nations. It can be obtained at: http://cod.humanitarianresponse.info/sites/default/files/towns.zip. Last accessed on March 14,2013

[8] The dataset is available at: http://earth-info.nga.mil/gns/html/cntyfile/et.zip. Last accessed on March 14, 2013

number of events per annum for each event-type at the town level within a specific radius around the sample towns. The variable we mainly use in the empirical analysis is the annual count of battle events within a 50km radius around a town. To allow for different degrees of exposure to conflict, we also vary the radius within which the events are counted. Our approach allows for a more precise tracking of conflict intensity that firms encounter as compared to existing studies where conflict intensity is measured over much broader administrative areas.[9] The larger the spatial units of analysis the harder it becomes to measure the proximity of firms to the epicenter of conflict.

4. Empirical strategy

Since the violence in Ethiopia is by and large a low level conflict, large-scale destruction of property or changes of territorial control are hardly observed during the sample period. In addition, there are nearly no incidents of systematic attacks on civilians by the insurgent groups, who seem to concentrate their engagement with the Ethiopian army. As a result, direct effects of conflict involving destruction of firm assets or injury of employees are very unlikely. However, we presume that the incidence of armed conflicts within close spatial proximity could instill a sense of insecurity among firm owners and credit institutes reducing their propensity to invest in such locations. Therefore, we concentrate our analysis on investment, while we also check for other possible reactions of firms.

[9] Pshisva and Suarez (2010) measure kidnappings and armed confrontations for 32 federal states in Colombia that are very large in size. Camacho and Rodriguez (2013) rely on conflict data from Colombian municipalities, which are smaller than states but can still be very large particularly in remote areas, introducing substantial size variation across municipalities. Spatial identification of the conflict effects becomes problematic if the administrative units are very large and there is considerable size variation across administrative units. Two districts with comparable number of battle incidents could represent quite different firm level exposures to conflict depending on district size.

While about 60% of our firm-year observations are actually from the Addis Ababa metropolitan area, we excluded the city from our analysis for a number of reasons. Addis is not only the political capital and the largest city in Ethiopia with over 4 million inhabitants; it also hosts major regional and international organizations such as the African Union (AU) and the United Nations Economic Commission for Africa (UN-ECA). The political and international significance of the city implies that it enjoys a very high level of security. While the rebel groups are certainly not small, they are no matches for the Ethiopian military and pose no real threat to social and economic life in the capital although the ACLED data shows a few battle incidents close to the city. Therefore, our analysis focuses on the sample of towns excluding Addis Ababa, which contains about 4000 firm-year observations.

Taking advantage of the panel structure of our firm and conflict data, we use the panel fixed-effects model to estimate firms' response to armed conflict. This approach controls for unobserved and time-invariant firm and location specific factors and minimizes some possible sources of unobserved heterogeneity. Some firms could, for instance, be owned by individuals who are sympathetic to the rebel movements and may not reduce their investment activities as conflict intensifies.

The basic model is specified as follows:

$$Y_{ijt} = \delta + \beta C_{jt} + \sum_{k} \alpha_k X_{ijt}^{k} + v_i + u_{ijt} \qquad (1)$$

Where Y_{ijt} is a firm level outcome variable of interest, in this case the investment rate, C_{jt} measures the intensity of conflict (e.g. number of battles) at the town level, X_{ijt}^{k} is a vector of firm level control variables, v_i is the firm fixed effect and u_{ijt} is a time varying firm level random error term. The subscripts *i, j* and *t* denote firms, towns and year, respectively, while δ, β and α are parameters to be estimated.

A major concern with econometric studies that rely on spatial identification strategies is the existence of unobserved factors that drive both the dependent and explanatory variables. Since we use a fixed-effects approach, time-invariant firm and location factors would be differenced out from the model. Only time varying unobserved factors could cause an endogeneity problem in this setup. One possibility is feedback from manufacturing performance to conflict. However, since manufacturing accounts for less than 10% of GDP and a much less percentage of employment in Ethiopia, it is unlikely that poor performance in manufacturing such as slow investment would fuel conflict intensity. As indicated earlier, the overall geographic distribution of armed conflicts, regardless of the identity of the fighting groups, is more widespread and fairly random as compared to the locational distribution of manufacturing firms, which is a predominantly urban-based activity. This gives us further assurance that the incidence of violence is not endogenous to the intensity of manufacturing activity. The territorial interests of the fighting parties are also not changing over time. Therefore, we believe that the panel-fixed effects estimator addresses major concerns about the endogeneity of conflict.

5. Variable definitions and summary statistics

Table 1 provides summary statistics for the sample of towns excluding Addis Ababa. The most important indicator of violent incidents is the number of battles within a certain distance of a town regardless of territorial changes as a result of the battle. Since the ACLED does not provide casualties or any other measure on the intensity of battles in Ethiopia, we rely on the number of such events. Within a 50km radius, the sample towns have about one battle per annum on average with a maximum of 21 battles. The majority of cases, about 70% of our town-year observations, have no recorded battle events within 50km and only less than 1 % experienced more than 10 events. Expanding the area of influence to 100km around a town, the battle incidents more than double and the battle-free observations drop to 43% of total. Other forms of conflict such violence against civilians, riots and protests are much less frequent than battles.

The key outcome variable is the investment rate which is defined as the ratio of net investment to lagged capital stock: $(I_t - S_t)/K_{t-1}$ where I_t is total investment spending and S_t is capital sales. Observations with investment rates larger than 5 are excluded as outliers (only 22 observations).[10] The average investment rate is 11 % per annum (the corresponding rate in Addis Ababa is about 14 %). Figure 4 shows a non-parametric regression line of average investment rate which declines sharply with the number of battle within 50km.

To account for the possibility that firms in conflict zones are more likely to be credit rationed and rely on internal sources of finance for investment purposes, the investment model

[10] The capital stock series is generated using the perpetual inventory approach: $K_t = (1-\delta)K_{t-1} + I_t$ where $\delta = 10\%$ is the depreciation rate.

controls for the profit rate. The profit rate is calculated as the ratio of current gross profit (value added minus wages) to lagged capital stock. The average profit rate is quite high at about 60%. As discussed in the theory section, the investment model controls for demand uncertainty or market fluctuation through the Coefficient-of-Variation of firm level sales. The coefficient of variation is calculated over a sliding widow of three years.

Since public investment on infrastructure is believed to crowd-in private investment, we control for the road connectivity of the town in which the firm is located. The road networks variable measures the area accessible by road during a one-hour drive from the center of town using all roads that serve a town. The area accessible is calculated by taking a 5km buffer zone on each side of a road. The other advantage of including infrastructure quality in our model is that it allows for some unobserved political economy considerations that affect firm level investment while causing economic grievance that in turn fuels conflict. For instance, government can exclude areas with rebel activities from the allocation of road projects which in turn could undermine firm level investment.

6. Empirical results

Table 2 contains the results from our basic model. Without other control variables, the number of battles within a 50km radius has a negative and statistically significant coefficient. It suggests that one additional battle incident within 50km of a town reduces the average investment rate of firms in that town by 1 percentage point. This is a sizable reduction considering the fact that the average investment rate is only 11 %. Introducing other control

variables in the second column only reduces the coefficient on battle incidents by one-third of a percentage point while it remains highly significant.

In columns 3 and 4 of Table 2, we test for the sensitivity of firm level investment to the proximity of armed conflicts. We capture this by re-estimating the model using battle counts within a radius of 30km and 100km around a town. This exercise shows that the reduction in the average investment rate is larger the closer the firm is to the epicenter of an armed conflict. While the likelihood of a battle incident rises with the area over which it is measured (see Table 1), firms seem to be less startled by distant events. For instance, the average investment rate will decline by about 5 percentage points if a town encounters six battles within a 30km radius or 12 battles within a 100km radius. This points to a highly localized effect of low-intensity armed conflicts and it is consistent with our presumption that it is the sense of insecurity rather than the direct effect of violence that drives the association between low scale conflict and firm level investment.

While all firm level control variables have the expected sign, only the profit rate turns out to be statistically significant. The latter underscores that firms in our sample are credit rationed, assuming firms would normally prefer outside credit to internal funds for investment purposes. The significance of this result is that it allows us to control for the perception of financial institutions on the creditworthiness of firms in our sample, which may partly be influenced by the conflict proneness of a location. Therefore, the coefficient on conflict captures its direct effect on entrepreneurs' sense of insecurity (and hence desired capital stock) after taking into account the indirect effect of conflict on access to credit (i.e.

ability to realize a desired capital stock). Although one intuitively expects a negative correlation between conflict and profit, no correlation exists between them in our sample either in a bivariate or multivariate setup (regression results not reported here). This gives more credence to the suitability of our model and the preceding interpretation. A positive coefficient on current profit could also suggest that entrepreneurs invest more on profitable firms because it signals future profitability. Using the lagged profit rate (not reported here) leaves the results unchanged.

An important dimension of the investment-conflict relationship is how long the effect of a shock lasts. To capture this dynamic effect, we experimented with an investment model with different time lags of conflict. The results are reported in Table 3. The results in Column 1 and 2 show that recent incidents of conflict have the expected negative association with investment but the coefficients are statistically insignificant. The latter suggest that once contemporaneous battles are controlled for, conflicts in the recent past are not given much weight in investment decisions. This can be extended to imply that low-intensity conflicts may not necessarily reduce the steady-state performance of the manufacturing sector.

Heterogeneous effects of conflict on investment

To gain further insight into the investment response to conflict and its variation across firms, we look deeper into factor proportions and sub-groups of industries. The issue is to identify industries that may be more susceptible to conflict than others and whether capital- and labor-intensive firms respond differently to conflict. The empirical approach is to interact

the conflict measure with dummy variables that indicate firms' choice of capital intensity and industry.[11]

To capture industry specific effects of conflict, firms are assigned into four broadly defined industrial groups. The food industry comprises food and beverage producers while the textile industry comprises textiles, leather, clothing and footwear manufacturers. The non-metal industry includes wood, furniture, paper, chemicals, plastic and rubber while the metal industry refers to production of iron, steel, metal products and light machinery.

We consider a firm to be capital intensive if the capital stock per worker is greater than Birr 50,000; an amount close to the 70th percentile of the distribution of capital per worker and about twice the median. While this is an arbitrary value, experiments with other thresholds (e.g., the median value) give qualitatively the same results.

The results are presented in Table 4. It is important to notice that the coefficient on conflict has nearly doubled with a more than one percentage point reduction in average investment rate for one additional battle incidence. Column 1 includes the interactions of conflict with industry dummy variables where the food industry is the reference category. The coefficient on battle counts reveals a strong and highly significant effect of conflict in the food industry and with no significant variation across industries. Adding control variables in column 2 shows practically no adverse effect of conflict on investment in the textile industry and a milder negative effect in the non-metal industry. The relatively strong effect on the food

[11] Since the dummies for industry and capital intensity are time invariant, their coefficients cannot be estimated in a fixed effects regression. We can only estimate the coefficients on their interactions with conflict.

industry may have to do with the strong backward linkage of this industry with agricultural inputs which are in turn more likely to be impacted by armed conflicts.

In columns 3 to 5 we introduce capital intensity with and without the industry dummies. The interaction with capital intensity has a positive and statistically significant coefficient in all specifications except for a slight loss of precision in column 5. This suggest that capital intensive firms are much less sensitive to conflict induced uncertainty when making investment decisions as compared to labor intensive firms. Although large firms tend to be capital intensive, firm size is already controlled for and cannot explain the differential effect of conflict on capital intensive firms. As indicated earlier, possible explanations include differences in the adjustment costs of capital and labor, and in the risk preferences of entrepreneurs. Since capital is largely irreversible, a large capital stock per worker already reflects a tendency to take risk. Conversely, risk-averse entrepreneurs would be inclined to adopt labor intensive production processes as adjusting the workforce is less costly that adjusting capital. This is similar to Booth (1991) where both the risk and cost of capital decline with the capital-labor ratio. A related aspect is the need to maintain the capital stock in capital intensive firms to preserve profit in the face of depreciation. Failing to make the necessary investment would disrupt production significantly if the firm is capital- rather than labor-intensive. For the former, the potential loss from reducing investment might outweigh the perceived risk of capacity underutilization due to conflict.

Other measures of insecurity

The ACLED data provides other indicators of social unrest that could potential increase insecurity and hence undermine investment. To examine this effect we include 'Riots and Protests', 'Violence against civilians', and the total number of incidents. The results are reported in Table 5. It is perhaps not surprising that riots and protests have no significant effect on firm level investment partly because they include non-violent protests and could occur for a variety of reasons. Even violence against civilians, which according to the ACLED are often perpetrated by either the military or police forces, do not seem to increase the sense of business uncertainty. In general we conclude that only armed rebel activities affect firms' investment decisions.

7. Conclusions

This paper examines the firm-level impact of low intensity conflict using longitudinal data and a unique spatial identification strategy that gauges firms' exposure to armed conflict. Our results show that armed confrontations with insurgents groups, even those that are deemed to be 'minor', can have important consequences on firms' investment behavior. Firms in our sample reduce the exposure to battle induced uncertainty by lowering their investment activities. The paper therefore identifies a microeconomic mechanism for the adverse effects of armed conflict working through business uncertainty. This is different from previous macro-level studies on high-intensity civil wars which work through systemic and rather direct mechanisms including diversion of financial resources to a war effort, destruction and deterioration of infrastructure, accumulation of debt and reduced FDI flows.

We go further to show that the firms' investment response to armed conflict grows stronger with the proximity of an incident, indicating the highly localized yet significant effects of low-intensity conflicts. Firms' investment response to armed conflict is also conditional on the capital-labor ratio – being higher among labor intensive firms. Since the adverse effect of conflict on investment is observed only for firms outside the capital city, a peaceful resolution of on-going conflicts could speed-up the deconcentration of manufacturing in and around Addis Ababa.

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Tables and Figures

Figure 1: Town Level Distribution of Manufacturing Firms in Ethiopia

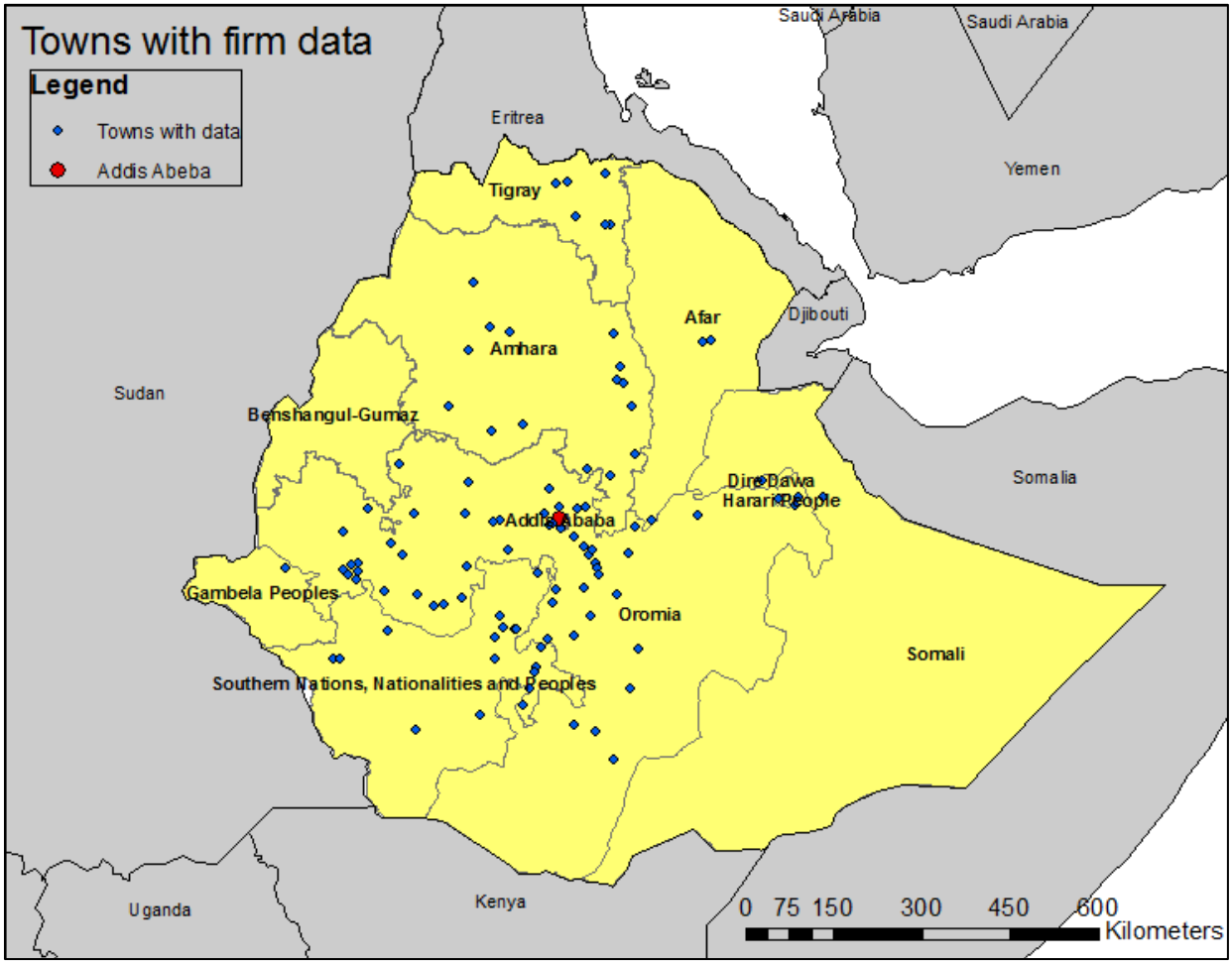

Figure 2: Town Level Distribution of Battles and Manufacturing Firms in Ethiopia

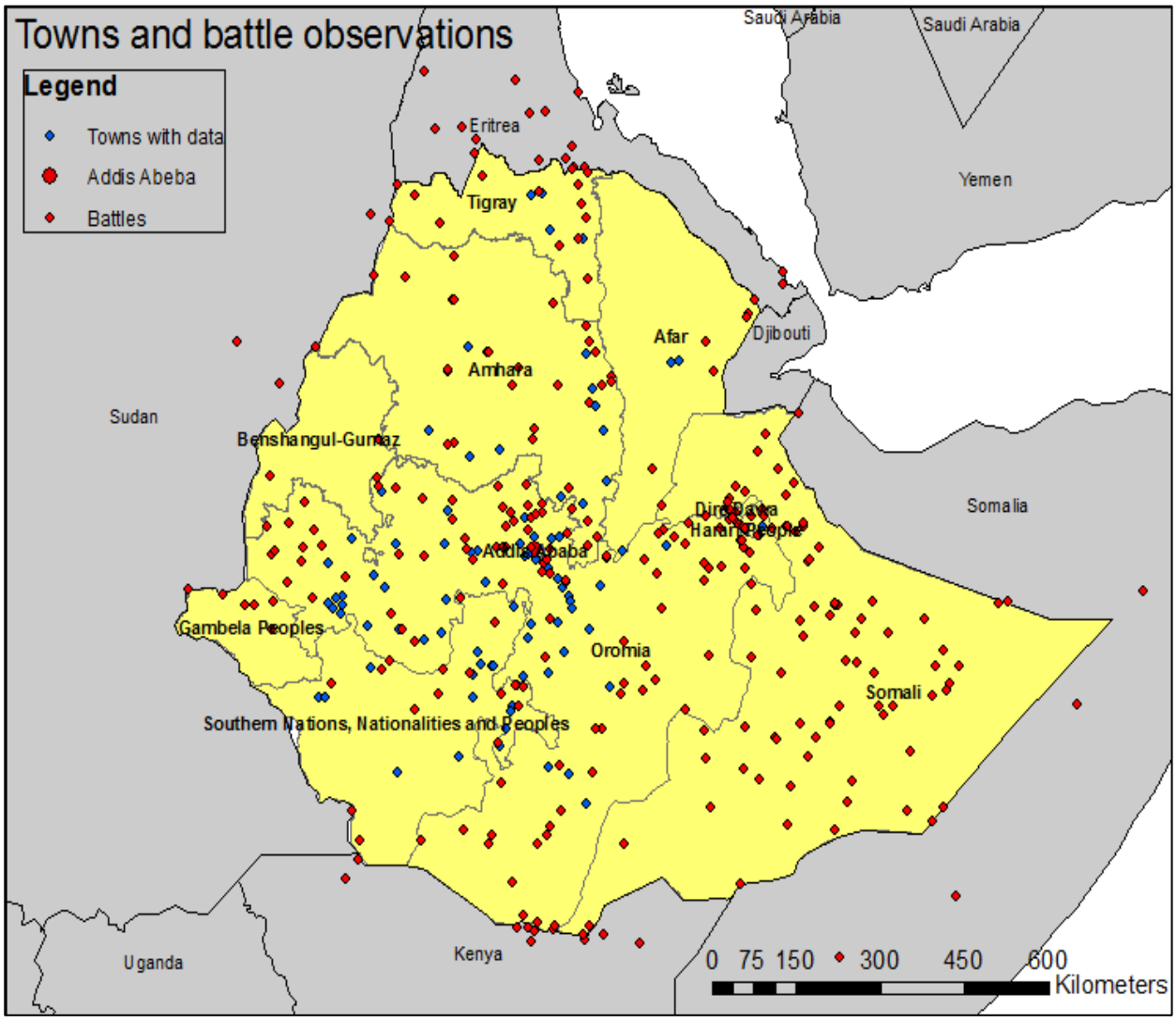

Figure 3: Town Level Distribution of Battles and Manufacturing Firms in Ethiopia: Identified by Fighting Groups

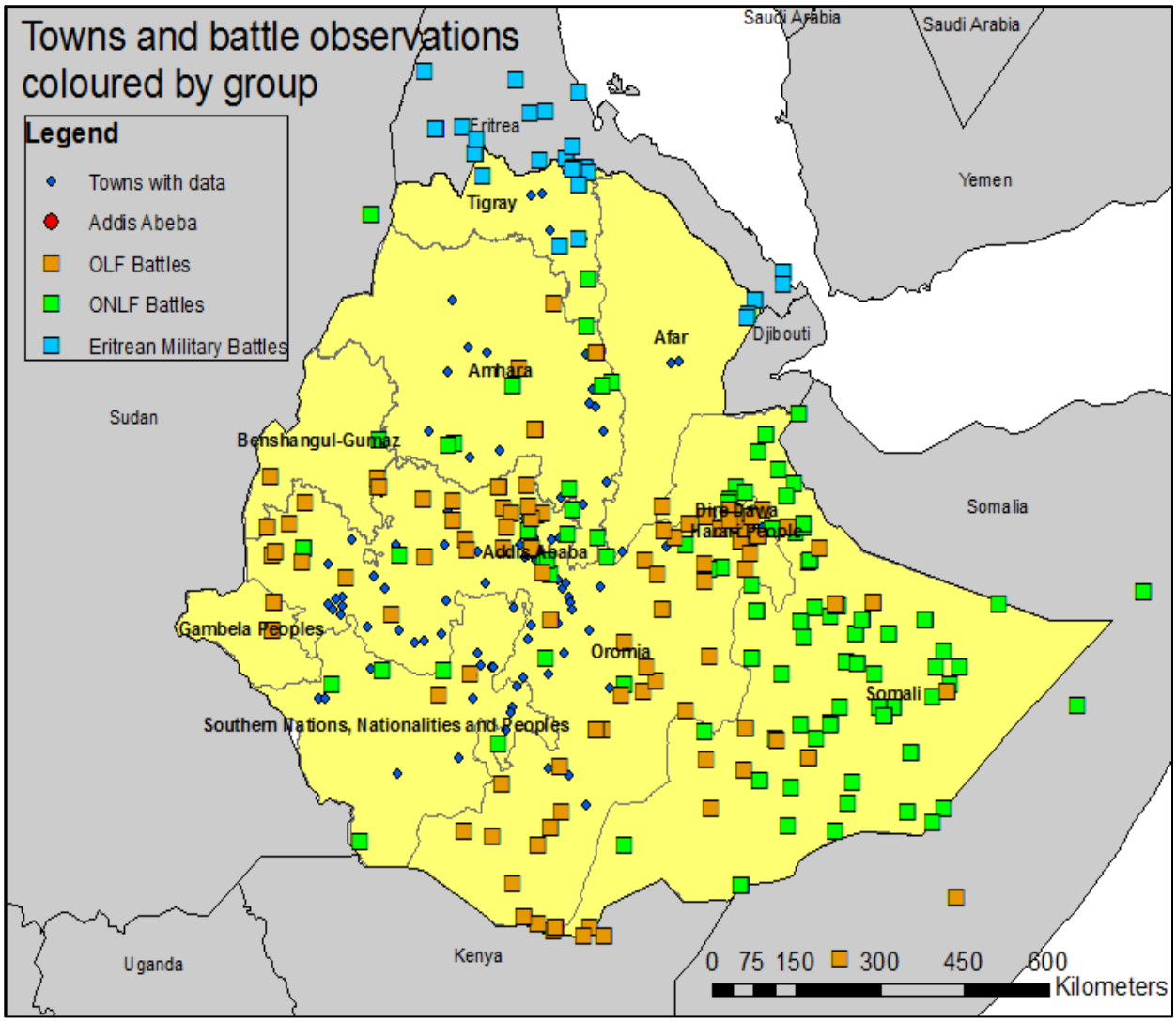

Figure 4: Firm Level Investment and Number of Battles within 50km of Town

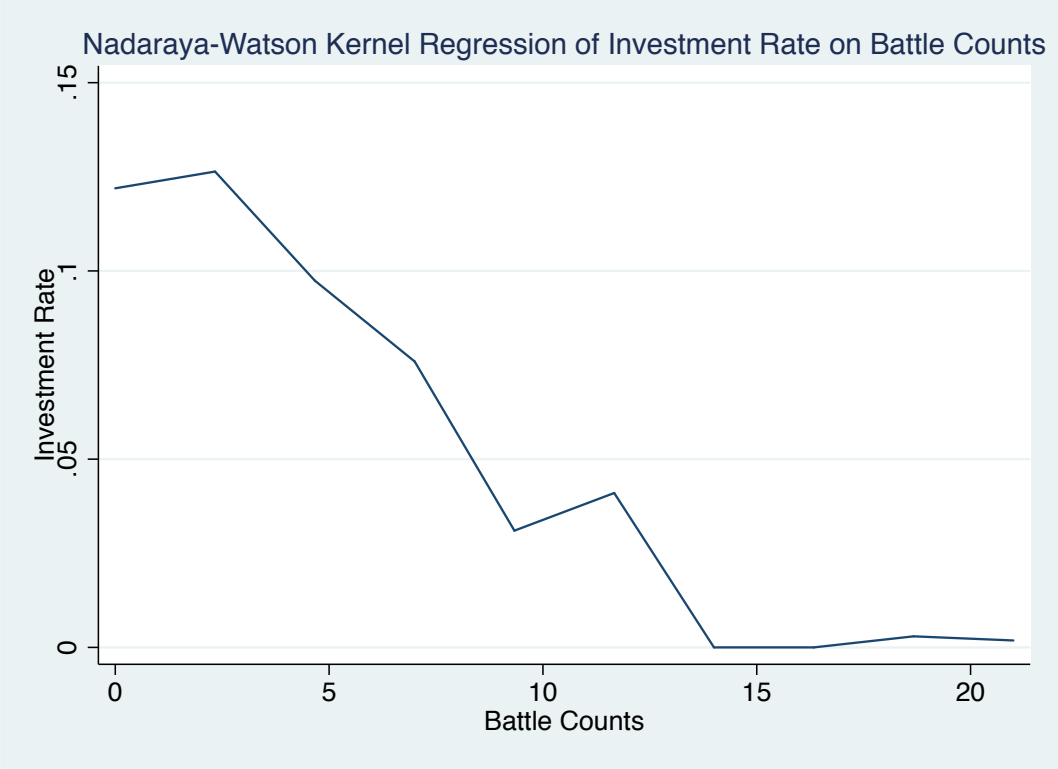

Table 1

Descriptive statistics of observations with investment

Variable	No. Obs.	Mean	Std. Dev.	Min	Max
Battles 50km	2580	0.943	2.123	0	21
Battles 30km	2580	0.495	1.396	0	16
Battles 100km	2580	2.324	3.463	0	24
Riots/Protest 50km	2580	0.575	2.014	0	13
Violence against civilians 50km	2580	0.768	1.751	0	9
Total no. of incidents 50km	2580	2.286	4.789	0	28
Investment rate	2655	0.116	0.348	-0.359	4.322
Profit Rate	2344	0.579	1.081	-2.485	4.965
Output variance	2493	0.399	0.317	0	1.719481
Road Connection	2575	1416.503	610.337	201.69	2900
Total labour	2522	148.473	392.995	0	4629.5
Private	2655	0.778	0.416	0	1
Total sales (M. Birr)	2655	16.714	62.764	0	1082.416
Newly hired personnel	1880	5.796	8.264	1	52

Table 2: Conflict and Firm Level Investment: Panel Fixed Effect Estimates

	1	2	3	4
Battles 50km	-0.010***	-0.007***		
	(0.003)	(0.003)		
Battles 30km			-0.008*	
			(0.004)	
Battles 100km				-0.004**
				(0.002)
Profit rate		0.044***	0.044***	0.044***
		(0.012)	(0.012)	(0.012)
Output variation		-0.019	-0.018	-0.019
		(0.039)	(0.039)	(0.039)
ln(Road connection)		0.018	0.015	0.013
		(0.030)	(0.030)	(0.030)
ln(Firm size)		0.032	0.033	0.031
		(0.021)	(0.021)	(0.021)
No. of observations	2581	2060	2060	2060
No. of firms	631	540	540	540
R-squared	0.003	0.024	0.022	0.023

Note: Robust standard errors in parenthesis. ***, **, * represent statistical significance at the 1%, 5% and 10%, respectively.

Table 3: Investment Effects of Lagged Conflict: Panel Fixed Effect Estimates

	1	2
$(\text{Battles 50km})_t$	-0.007**	-0.005**
	(0.003)	(0.003)
$(\text{Battles 50km})_{t-1}$	-0.003	-0.002
	(0.002)	(0.002)
$(\text{Battles 50km})_{t-2}$		-0.000
		(0.002)
Profit rate	0.044***	0.042***
	(0.012)	(0.012)
Output variation	-0.018	-0.015
	(0.039)	(0.042)
ln(Road connection)	0.019	0.019
	(0.030)	(0.031)
ln(Firm size)	0.031	0.045**
	(0.021)	(0.021)
No. of observations	2060	1921
No. of firms	540	528
R-squared	0.024	0.025

Note: Robust standard errors in parenthesis. ***, **, * represent statistical significance at the 1%, 5% and 10%, respectively.

Table 4: Heterogeneous Effects of Conflict on Investment: Panel Fixed Effect Estimates

	1	2	3	4	5
Battles 50km	-0.015***	-0.016***	-0.013***	-0.022***	-0.020***
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
Textile*Battles50km	0.017	0.019*		0.013	0.017
	(0.011)	(0.011)		(0.011)	(0.011)
Non-metal *Battles50km	0.005	0.010*		0.004	0.010*
	(0.006)	(0.006)		(0.006)	(0.006)
Metal *Battles50km	0.005	0.009		0.004	0.009
	(0.008)	(0.011)		(0.008)	(0.011)
Capital-			0.009*	0.014***	0.008+
Intensity*Battles50km			(0.005)	(0.005)	(0.005)
Profit rate		0.044***	0.044***		0.044***
		(0.012)	(0.012)		(0.012)
Output variation		-0.018	-0.019		-0.018
		(0.038)	(0.038)		(0.038)
ln(Road connection)		0.015	0.015		0.013
		(0.030)	(0.031)		(0.031)
ln (Firm size)		0.032	0.032		0.032
		(0.021)	(0.021)		(0.021)
No. of observations	2581	2060	2060	2581	2060
No. of firms	631	540	540	631	540
R-squared	0.004	0.026	0.025	0.006	0.026

Note: Robust standard errors in parenthesis. ***, **, * represent statistical significance at the 1%, 5% and 10%, respectively. + shows statistical significant at 12%.

Table 5: Investment and Other Indicators of Insecurity: Panel Fixed Effect Estimates

	1	2	3	4	5	6
Riots and Protests	0.003	0.004				
	(0.004)	(0.004)				
Violence against			0.001	0.000		
Civilians			(0.005)	(0.005)		
Total Incidents					-0.001	-0.001
					(0.002)	(0.002)
Profit rate		0.044***		0.044***		0.044***
		(0.008)		(0.008)		(0.008)
Output variation		-0.017		-0.018		-0.019
		(0.030)		(0.030)		(0.030)
ln(Road connection)		0.005		0.013		0.017
		(0.038)		(0.038)		(0.038)
ln(Firm Size)		0.032*		0.033*		0.033*
		(0.017)		(0.017)		(0.017)
No. of observations	2581	2060	2581	2060	2581	2060
No. of firms	631	540	631	540	631	540
R-squared	0.000	0.022	0.000	0.021	0.000	0.021

Note: Robust standard errors in parenthesis. ***, **, * represent statistical significance at the 1%, 5% and 10%, respectively.

Technical Notes

As mentioned in the text, the data on the location of towns was obtained using two different datasets. The first is a data compilation done by UN-OCHA, which is a part of the so-called Common Operational Datasets and gives coordinates for populated places in Ethiopia. The original data was gathered by the CSA, the International Red Cross and the Food and Agriculture Organization of the United Nations. The data is contained in a GIS Dataset in the ESRI Shapefile format. This data was complemented and counterchecked by a dataset of official (US-American) foreign names published by the GEOnet Names Server and developed by the National Geospatial-Intelligence Agency. The data is a text-file containing the name, type and some more information about each listed location as well as the GPS coordinates.

In the firm data a variable indentifies the town only by a number and a list was obtained from the webpage of the CSA, giving the names of the 107 towns belonging to the numbers. The list contains no further information like regions or other political divisions. Ethiopian town names are problematic because quite often there is more than one town with the same name and there are different ways of transcribing Ethiopian names. To identify the correct town, further information from the firm survey was used, which identifies more detailed administrative units where the firm is located, although that information is not always completely consistent. This additional information was then compared to the different entries in the two above databases, finally identifying the GPS coordinates of all towns except for three (with a negligible number of firm-observations or no observations at all).

The resulting table was converted to a point-shapefile (ESRI shapefile format) using ArcGIS and with the same program, a polygon-shapefile containing the buffer-zones of various sizes were produced. The ACLED data is contained in a point-shapefile that identifies the incident locations and contains information about the year and type of incident in the file's attribute table. The counting exercise was not done in ArcGIS but with a Python script using the Python bindings of the OGR library (part of the GDAL library: http://www.gdal.org/ogr/index.html). The OGR library provides methods for manipulation and analysis of shapefiles. Among others it allows to set filters according to the geography (spatial extent) or the feature attributes of such objects. This was done with the shapefiles containing the buffer zones and the one containing the ACLED data. Using the filters for years and event-types, the ACLED features falling into each of the buffer zones were counted and the results saved in a SQLite database. The resulting dataset could then be merged with the firm data, using the town identifier.