Impact of Crime on Firm Entry: Evidence from South Africa

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Abstract

In this paper, we analyse the relationship between crime and the entry of firms across local municipalities in South Africa. We use data on the incidence of crime, sourced from the South African Police Service, and a unique database of business registrations over the period 2003 to 2011, to show that crime reduces business entry. These results are robust to the use of rainfall shocks as an instrumental variable for crime, in order to control for potential bias arising from the fact that crime might be a consequence, rather than a cause of the entry of firms. This paper highlights the importance of strong local institutions that can lower the costs of doing business for business dynamism. Our study has implications for employment and economic growth at the regional level and hence for dealing with regional inequality.

JEL Codes: R12, O18, L11

Keywords: Crime, Business Activity, Regional Institutions

1 Introduction

Private sector development, and in particular entry of new firms is important for sustainable economic growth, job creation and poverty reduction (AFDB, 2013). Theoretical and empirical evidence links new business creation to growth and development. From a theoretical perspective, business creation is associated

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with innovation, new product varieties, improved product quality and the creation of new jobs (Wong, Yuen, and Autio (2005), Romer (1990), Grossman and Helpman (1991a), Aghion and Howitt (1992)). Empirical studies have shown that entry of firms is important for economic growth and job creation. Cross-country evidence has associated firm entry with economic growth (Wong, Yuen, and Autio (2005); van Stel, Carree, and Thurick (2005)). Country studies have underscored that new firms can contribute to new jobs (Haltiwanger (2012) for the United States and Klapper and Richmond (2011) for Cote d'Ivoire). Given low growth and high unemployment levels in many countries in Sub-Saharan Africa (SSA), entry of new firms and the economic dynamism it can generate is of considerable importance for the region.

The creation of new firms, however, depends on the business environment and on strong institutions, which can lower the costs of registering and conducting a business. Particularly, the literature has argued that simplified business registration procedures, economic freedom, property rights, freedom from corruption, infrastructure quality, flexible labour and credit markets are important determinants of business activity (Elhiraika and Nkurunziza (2006); Dyck and Ovaska (2011); Motta, Oviedo, and Santini (2010); Gathani, Santini, and Stoelinga (2013); Bigsten and Söderbom (2006), Eifert, Gelb, and Ramachandran (2008); Klapper, Lewin, and Delgado (2009); Klapper and Love (2010); Lall, Schroeder, and Schmidt (2014)).

Similarly, evidence suggests that crime has a significant deterring effect on economic activity. For example, Detotto and Otranto (2010), using monthly time series data from January 1979 to September 2002 and official police data on homicide rates, have shown that crime has a negative effect on Gross Domestic Product in Italy; Ashby and Ramos (2013), show that crime has a deterrent effect on Foreign Direct Investment (FDI) using a panel of FDI flows into 32 Mexican states coming from 116 countries and police reported homicide rates. Related evidence has also shown that the overall costs of violent crimes to the economy are higher than the cost of conflicts and civil-war (Hoeffler and Fearon, 2014). This is because the frequency of violent crimes is high as compared to that of conflicts. These studies highlight the importance of crime on aggregate economic indicators and do not consider the firm level impacts. Studies, have also examined the effect of crime on firm perfomance outcomes. For example, Kimou and Gyimah-Brempong (2012) show that crime has a negative effect on private sector investment, using cross-sectional data from World Bank Enterprise surveys and perception of crime data from the same survey; Gaviria (2002) also uses cross-sectional data from private sector surveys and self-reported crime rates to show that crime is negatively associated with firm sales, investment and growth. The disadvantage of these studies is that by using cross-sectional data, they are not able to control for time-invariant unobserved effects which are jointly related to crime rates and firm perfomance. Benyishay and Pearlman (2013), using panel data from microenterprise surveys and a fixed effects estimation techniques to control for time-invariant unobservables, show that crime has negative effect on the growth of microenterprises. World Bank (2010), also, using self-reported crime rates and a panel data from South African enterprise surveys, show that the incidence of crime has a negative effect on return on investment. In our study we use officially reported crime data to examine its effect on entry of firms. Similar studies have also shown that crime has a negative effect on firm outcomes using official crime data. For example, using panel data of US counties a Journal of Business Venturing Insights nd crime data from Federal Bureau of Investigations, Kahn (2010) found out that crime reduces the ability of firms to retain skilled labour and hence improve productivity. In a related study that examines the effect of violent crimes on entrepreneurship and location of business activity in U.S cities, Rosenthal and Ross (2010) show that increases in violent crimes during prime times will decrease number of restaurants in the area. However, another study has shown that areas with high violent crimes in the city of Memphis, Tennessee, attract restaurants entrepreneurs (Sloan, Caudill, and Mixon Jr., 2016). The major limitation of this study is that it controls for the endogeneity of crime by using past crime rates. This approach is unlikely to be valid given the fact that past crime rates are likely to be endogenous also. Our approach differs from this by using rainfall shocks as an instrumental variable for crime rates.

In this paper, we posit that crime can deter firm entry, resulting in a less dynamic industry. We employ regional variation in the incidence of crime and business registrations across local municipalities in South Africa to investigate the effect of crime on the entry of firms. To do this, we utilize a unique dataset of business registrations and the incidence of crime from the South African Police Service for 330 municipalities in South Africa. We believe that South Africa provides us a valuable case study for this analysis. The relationship between crime and business activity is well-established in the South African literature. The World Bank Enterprise Surveys of South African firms reveal that South African firms are far more likely to rank crime as a major constraint compared to similar upper-middle income countries. Consequently, the costs of crime as a percentage of revenue are higher in South Africa than in comparator upper-middle income countries (World Bank 2010). A survey of firms about constraints to private sector investment in the Johannesburg area highlighted crime and safety as one of the key constraints to doing business (Rogerson and Rogerson, 2010).

We argue that crime imposes a cost on firms and that this in turn might inhibit entry of less productive small firms by negatively affecting their expected profits[1]. Crime may increase firm costs in myriad ways. Firms may have to spend on security systems such as alarms, trackers on vehicles, electric fences or armed guards to keep their property and staff secure[2]. Available evidence at the firm level shows that crime may induce substantial costs in South Africa. Security costs accounted for about two-thirds and a third of the total costs of

[1] McDonald (2008) shows that about 74 percent of businesses in South Africa noted the increased costs of security brought about by the need to secure their interests, staff and public from increased crime.

[2] Crime induces fixed costs in terms of capital expenditures in security (cost of prevention), cost of hiring skilled workers. This makes the Melitz (2003) model suitable for this empirical analysis, since firms have to make an initial investment modelled as fixed/sunk entry costs.

crime in 2003 and 2008 respectively for the average firm (World Bank, 2005; 2010). World Bank (2005), reported the costs of crime for the median firm of about 5 percent of labour costs. In addition, firms may incur higher costs of recruiting or relocating skilled labour. Finally, they may be reluctant to invest in expensive equipment and machinery for fear of losses due to theft or vandalism, which might negatively affect productivity. Our empirical strategy relies on relating changes in firm entry, measured by business registrations, in a municipality over time, and changes in the incidence of crime, after controlling for municipality specific trends and other factors such as income, infrastructure quality and service provision. Thus we identify the effect of crime on firm entry after accounting for any economic shocks associated with municipality trends and average crime rates in a municipality.

We find that an increase in crime rates, in particular, the property crime rate reduces business entry. A one percent increase in total crimes reduces business entry by 0.53 percent. Focussing on crime types, we find that a one percent increase in property crime is associated with a decrease in firm entry of 1.04 percent. We also show that the effect of property crimes is different across sectors. Results are also robust to using rainfall shocks as an instrument for crime, to control for the potential endogeneity bias that arises from the fact that crime might be a consequence rather than a cause of greater business activity.

This paper complements existing literature on the effects of a favourable business environment on private sector development, by considering crime as one important aspect of this environment and adds to the existing literature on crime and business performance. Our paper is also related to the studies examining the effect of conflict and civil war on firm performance in Africa (Collier and Duponchel, 2012) and firm exit in Latin America (Camacho and Rodriguez, 2012).

Our study has several policy implications. First, it highlights the importance of strong institutions such as policing and private security, particularly at the regional level, for economic growth and dynamism. This is particularly relevant for emerging economies like South Africa that grapple with concerns of regional inequality. Given the historical context of Apartheid, most economic activity in the country is concentrated in the three provinces of Gauteng, Western Cape and KwaZulu-Natal, which have contributed about two-thirds to overall economic activity since 1996 (StatsSA, 2012). However, 60 percent of the South African population resides in other marginalized areas (World Bank, 2014), suggesting that it is crucial to identify constraints to private sector development in such regions. Second, it suggests that the high costs that crime imposes is most likely to deter smaller firms from entering the market. This might have implications for the labour market, since smaller firms typically employ more unskilled labour relative to larger, more productive firms. Finally, by deterring entry, crime might be associated with reduced competition in the industry, and this can have welfare implications.

2 Crime and Business Activity in South Africa

Crime in South Africa is a key constraint to doing business and has elicited significant attention from policy makers in recent years. Stone (2006) shows that robbery and assault rates in all South African provinces are higher than crime rates in U.S. states with the highest rates of crime[3]. A recent survey of the business climate in South Africa documents that crime along with corruption ranks third as a constraint to registering a business in the country (Tutwa Consulting, 2014). However, South African Police Service (SAPS) crime statistics in Figure 1 in the appendix show a decline in most crime categories. Total crime declined by an annual average of 0.83 per cent during the period 2003 to 2011. Robbery[4] decreased on average by 3.2 percent per annum, whereas property related crime rates[5] and assault rates decreased by an annual average of 0.5 and 3.6 per cent respectively[6].

There is also significant variation in crime across regions in the country. Figure 2 shows the spatial distribution of mean crime rates over 2003-2011 in South Africa. Overall, total crime is high in municipalities in the Eastern Cape, Western Cape, Northern Cape and Gauteng. Some of these municipalities include Blue Crane Route Local Municipality, Makana Local Municipality, in the Eastern Cape; Bellville, and Mitchells Plain in the Western Cape; Mier and Khara Hais municipalities in the Northern Cape; and Germiston and surrounding areas, and Midvaal in Gauteng. These differences across regions may be attributed to the historical policies of Apartheid. During this period the government introduced homeland policies and the Group Areas Act, which encouraged deindustrialisation of some areas and industrialisation of others (Kaplan, Morris, and Martin, 2014). Thus, in regions with targeted industrialisation better infrastructure was put in place to support economic activity and these regions developed at the expense of other periphery regions. This resulted in high income inequality in the country that has led to high and differential levels of crime across regions (Demombynes and Ozler, 2002).

Figure 3 in the appendix looks at the spatial distribution of business entry and shows regional disparity. Municipalities in Cape Town, Pretoria and Johannesburg areas and some in the Eastern Cape have witnessed greater entry of firms. Eyeballing the figure reveals that some municipalities that showed high crime rates in areas in the Eastern Cape and Gauteng also show high firm activity, lending credence to the idea that often, and greater business activity might attract more crime. Alternatively, these regions might have compensatory attributes attractive to firms, like better service provision or better access to skills or a market. In our empirical analysis, we use an instrumental variables strategy and include control variables to account for such factors.

[3] Robbery and assault were only considered

[4] Robbery include: Common robbery, Robbery with aggravating circumstance, carjacking, truck hijacking, and robbery at residential and non-residential areas.

[5] Property and related include: Arson, Malicious damage to property, Burglary residential and non-residential, Theft out of motor vehicles, Motor vehicle theft.

[6] Assault include: Murder, total sexual crimes, attempted murder, assault with the intent to inflict grievous bodily harm, Common assault.

3 Conceptual Framework

This study relies on the Melitz (2003) framework that incorporates firm heterogeneity in productivity into a model of monopolistically competitive firms that use labour as the only factor of production. The model posits that firms enter as long as the expected discounted value of profits equals the initial sunk cost of entry denoted as $f_e > 0$ (measured in labour units). Upon entry a firm draws its random productivity μ from a probability distribution function $g(\mu)$ and cumulative density function $G(\mu)$. A firm, which considers production will anticipate discounted profits;

$$v(\mu) = \max\{0, \Sigma_{t=0}^{\infty}(1-\delta)^t \pi(\mu)\} = \max\left\{0, \frac{1}{\delta}\pi(\mu)\right\}, \tag{1}$$

Where δ is the probability of a bad shock in every period that would force a firm to exit and $\pi(\mu)$ is firm profit. Firm profit is defined as

$$\pi(\mu) = \frac{r(\mu)}{\sigma} - f \tag{2}$$

In words, firm profit equals variable profits minus a fixed cost of production. Note that variable profits depend positively on firm productivity. More productive firms make higher variable profits. μ^* denotes the cut-off productivity level above which a firm covers its fixed cost of production with variable profits and successfully produces. We posit that higher crime rates in the area raise the fixed and variable costs of production and hence raise μ^*. Intuitively, firms have to be more productive to make positive profits. Hence, denoting the crime rate by C we assume that

$$\frac{d\mu*}{dC} > 0 \tag{3}$$

Firms will enter the industry as long as the value from entry v_e, given by the expected discounted value of profits less the cost of entry exceeds zero. Or,

$$v_e = (1 - G(\mu^*))\Sigma_{t=0}^{\infty}(1-\delta)^t\bar{\pi} - f_e = (1 - G(\mu^*))\frac{\bar{\pi}}{\delta} - f_e > 0 \tag{4}$$

Here $1-G(\mu^*)$ is the probability of successful entry which is decreasing in μ^*, μ^* is the productivity cut-off and $\bar{\pi}$ is average profits per firm in the industry.

Proposition 1: Higher crime will lead to fewer firms entering the market, because only more productive firms will have expected profits high enough to justify paying the entry costs.

We note that

$$\frac{dv_e}{dC} = \frac{dv_e}{d\mu*}\frac{d\mu*}{dC} < 0 \tag{5}$$

Since the value of entry decreases with crime, high crime will be associated with fewer firms entering the market.

The literature shows that the cost imposed by crime varies by sector. Costs of battling crime are relatively low for firms in the manufacturing sector (2.8%)

and high for wholesale and retail firms (3.9%) (World Bank, 2010). Other studies also confirm that the costs of security are higher in the wholesale and retail sector as compared to other sectors, such as services and manufacturing. About 72 % of businesses in wholesale and retail sectors indicated that crime is a major constraint in their business operations, as compared to about 67 % in the construction sector, and lower for other services and manufacturing sectors (McDonald, 2008). Given this heterogeneity in costs imposed by crime across sectors, we also examine the hypothesis that the effect of crime on entry will differ across sectors.

Empirically, we estimate entry of firms as a function of crime and other regional factors that are likely to be associated with firm costs and profitability such as market size (population and income), and institutional factors (infrastructure, service provision and access to skills).

4 Data

This paper uses data from different sources to analyse the impact of crime on firm entry. The sources include the Business Registration database obtained from the Companies and Intellectual Property Commission (CIPC) of South Africa, crime statistics from the South African Police Service (SAPS), population censuses (StatsSA), National Aeronautics and Space Adminstration (NASA)'s Tropical Rainfall Measuring Mission (TRMM) data, Quantec's Standardadized Regional Database. We have information on 330 municipalities observed over the 2003-2011 period.

Business Register

Analysis using the Business Register data from CIPC constitutes an important contribution to the literature on private sector growth in South Africa. The registration database has information on enterprise name, a unique enterprise registration number, company status (e.g. in business, deregistered, dissolved, etc.), date of registration, Standard Industrial Classification at both the one digit and three-digit level, physical and postal address as well as the postal code. This database was obtained from CIPC during the first quarter of 2012 and reflects the most up-to-date information on the enterprise at the time of download. It provides a rich set of information on business entities in South Africa and is extensive[7]. It contains data for over 3 million enterprises and registration dates going as far back as the year 1801.

The major limitation of this data is that it is available at the enterprise level and not at the subsidiary plant level, and this is a major issue for most of the major supermarket chains. The implication of this for our study is that it may distort the regional concentration of industry. However, these problems are common in most firm level databases of emerging economies and besides, our results still confirm that firms do not register in high crime areas. Also, the advantages of using head office or enterprise level data is that they reflect the level

[7] Business entities can be registered as companies, close corporations (new registrations discontinued from 1 May 2011) and cooperatives.

at which important decisions in the organisation are made, such as, research and development, innovation, product advertising, and expansion. Most concerns for policymakers are in understanding the factors affecting business success and these factors are closely linked to operational control, which is available at the head office level. The other advantage of head office data is that, it may reflect the activities of small and medium enterprises (SMEs), since the majority of small and medium enterprises have only one establishment. Our results will be important since most policymakers are interested in factors constraining development of the SME sector.

A considerable effort was spent on 'cleaning' and preparing the data. The register data provide details on the enterprise address and postal code. These postal codes were used to map each enterprise to different spatial units. Unfortunately, the spatial units of the postal codes do not perfectly correspond with those of the Censuses[8]. Where possible, postal code areas were mapped to the 497 spatial units using place name of each postal code obtained from the South African Postal Office and main place names of spatial units in the Population Census. However, many postal codes areas overlap provincial, municipal and main place boundaries. It was therefore not possible to uniquely map each postal code to the 497 spatial units. An aggregated set of 330 spatial units was then constructed.

Crime

We use crime data from the South African Police Service (SAPS). SAPS have data on the number of cases reported in a particular police station. They also provide contact details of each police station, including physical and postal codes. The data has information on various crime categories at a disaggregated level, including contact crime against a person, car and truck hijacking and theft of motor vehicles. We aggregate the various crime types into 'contact' and 'property' crimes, since economic theories of crime provide strong predictions for property crimes (Becker, 1974). We exclude crime categories such as crimes heavily dependent on police detection, neglect and ill-treatment of children, kidnapping and crimen injuria.

Table 1 shows a list of crime categories used in this paper. The data we use covers the period 2003 to 2011 and about 1132 police stations. Since we know postal codes for each police station, we map each police station to the corresponding local municipality using a postal code mapping for Quantec municipalities from Edwards and Sundaram (2013). We use data on population from the Population Census 2001 to construct crime rates normalized by thousands of people in each spatial unit[9].

Rainfall

[8] See Lombard, M. (2005) "South African Postcode Geography" Paper presented at the seventh Africa GIS conference, CSIR International Convention Centre, Tshwane (Pretoria), South Africa, 31 October to 4 November 2005.

[9] We obtain spatially disaggregated data for the 497 municipal units from the census. The spatial units follow those of Quantec's Standardized Regional Database. The municipal units are made up of 252 local municipalities and 245 main places within 6 metropolitan municipalities.

As a source of exogenous variation we rely on rainfall data obtained from NASA-TRMM for the period 2003 to 2012. The TRMM data is reanalysis data that combines data from ground rain gauge stations and satellites, to get estimates of rain rates at 0.25 latitude and longitude degree intervals. The advantage of this database over other databases like the Global Precipitation Climatology Project (GPCP) database is the finer spatial resolution which allows us to get rainfal estimates at a lower disaggregated spatial level, like a police station area. This data also has the advantage of correcting for errors by not using values which are distant from any gauges and employing a method called inverse error variance weighting (Huffman and Bolvin, 2014). With police station spatial data (latitudes and longitudes in grid points) obtained from South African Police Service (SAPS), we get an average rain rate for the area covered by the police station in mm/hr.

The data are then converted to mm/day by multiplying the rain rate by the number of hours in a day to obtain the average daily rainfall in a year for each region. We also compute monthly and annual rainfall, by multiplying the daily rate by the number of days in a month and summing over the year to get annual rainfall. To aggregate the data to municipality level we get the unweighted average for the police station areas falling within each municipality. Following debate in the literature on whether to use rainfall levels or shocks as instruments (Miguel and Satyanath, 2011), we also experiment with other measures of rainfall shocks as robustness checks[10]. Our primary measure is the average daily rainfall in a municipality and year. Since we use municipality fixed effects in our preferred specificaitons, we argue that we exploit the variation across years within each municipality for identification – in other words, we use rainfall shocks for identification.

Other Variables

We also use data obtained from Quantec's Standardadized Regional Database. This is a spatially disaggregated database of regional indicators available up to local main place area as defined by the South African census. We use data on disposable current household income, population, total households in a region, total number of households with electricity, with access to telecommunications, with access to utilities such as toilets, water and refuse collection. In order to capture access to skills in a region we use the number of households with; no school, primary, and tertiary education. We convert these variables to

[10] We also compute a measure of rainfall shocks following the approach used by (Hidalgo, Naidu, Nichter, and Richardson, 2010);

$$x_{it} = \Sigma_{m=1}^{12} \frac{x_{mit-\bar{x}im}}{s_{im}},$$

where x_{mit} is monthly rainfall for each municipality, $\bar{x}_{im}$ is the average monthly rainfall for each municipality for the 2003-2011 period, and s_{im} is the monthly standard deviation for each municipality over the period. We also experiment with other measures like the absolute value of the standard deviation of each municipality, standised z –scores, a dummy variable with value 1 for positive deviations around the mean and 0 otherwise. However, most of these measures havea relatively low correlation with various crime categories as compared to average rain. Also, when we use these rainfall shocks instead of the average rainfall as an instrument, our main results do not change.

a share of households with access to the relevant utility by dividing the total number of households with access by the corresponding population in the region. We divide total household income by the number of households in a region to get average household income in a region.

Table 2 shows summary statistics of the variables used in our empirical analysis. Descriptive statistics show that there is some variation in rainfall in the sample used for estimation. Entry of firms averaged 660 firms in a year with some municipalities such as Gqebera, Alexandra and Central Karoo recording zero entries in some years and Pretoria Akasia in Gauteng province recording a maximum entry of about 30058 in 2005. Total crime rates averaged 77 per 1000 individuals with wide variation of total crime rates between zero and 5045 crimes per thousand individuals. Property and contact crime averaged 45 and 32 per 1000 individuals

5 Econometric Model and Identification Strategy

In this study we are interested in estimating the causal relationship between crime and entry of firms across municipal regions in South Africa. We specify our model as a simple log-linear model,

$$InEntry_{it} = \beta_0 + \beta_1 InCrime_{it} + \alpha_i + \alpha_{i*t} + \varepsilon_{it} \tag{6}$$

Firm entry, which is the dependent variable, is measured as the log of the number of firms registering in a particular municipality (i) and year (t)[11]. Crime is measured as a crime rate (divided by thousands of 2001 population) in a municipality. We expect $\beta_1 < 0$. To identify the effect of crime on firm entry, we control for other factors potentially correlated with crime that also affect profitability and hence the incentive to enter the market. We rely on municipality fixed effects (α_i) and municipality-specific time trends (α_{i*t}) to account for both observed and unobserved factors potentially correlated with crime and firm entry.[12] We also estimate other models were we include per capita household income and infrastructure variables, and we notice that our results are qualitatively similar. This estimation strategy allows us to identify β_1 using

[11] Some municipalities report zero entry of firms and zero crime rates in certain years. We tackle this by adding one to each value before taking the natural logarithm. The other issue is that since the dependent variable is the count of firms entering, one has to use poisson models. However, we notice that the number of zero values is small (about 1 percent) and this enabled us to transform the data into natural logarithms. The distribution of firm is not skewed to the right and it approximates a normal distribution (figure 4). This allows us to estimate equation (6) using ordinary least squares.

[12] We note here that including time fixed effects in our estimation results in imprecise estimates on all our variables across the board. One potential explanation is that that between-municipality variation in crime is low in our data. We hence follow previous studies including Miguel, Satyanath and Sergenti (2004), Dinkelman (2011) and Dell, Jones and Olken (2013) to include municipality-specific time trends.

within-municipality variation in crime rates, after controlling for municipality fixed effects and time shocks (α_{i*t}).

One of the major problems of identifying the relationship between crime and entry of firms is endogeneity arising from reverse causation. The direction of causality may run either way, since firm entry may attract more criminals as potential returns from crime rise with increased business activity. Measurement error is also a big concern when it comes to crime data, because crime suffers from serious under-reporting in South Africa like in many other countries.

To address this potential endogeneity, we instrument the crime rate by rainfall shocks in the municipality. We explore the relationship between crime and firm entry using a two-stage least squares estimation method as shown below;

$$InCrime_{it} = \alpha_0 + \alpha_1 InZ_{it} + \delta_i + \delta_{i*t} + \mu_{it} \tag{7}$$

$$InEntry_{it} = \beta_0 + \beta_1 InCrime_{it} + \delta_i + \delta_{i*t} + \varepsilon_{it} \tag{8}$$

We argue that rainfall is correlated with crime, since high rainfall, by restricting movement of people (both criminals and victims), is expected to reduce crime rates. There is evidence that high rainfall is negatively related to crime levels. Theoretical models of crime from sociology, such as the 'routine activities' theory suggest that rainfall could significantly influence criminal behaviour and hence crime rates. The theory postulates that for most types of crime to occur, three things need to converge in space and time; "*(1) likely offenders, (2) suitable targets and (3) the absence of capable guardians against crime*" (Cohen and Felson, 1979). Capable guardianship can be the police or friends. The idea behind the theory is that individuals follow routine activities in their everyday life which creates opportunities for criminal behaviour. Rainfall has the potential to change the routine activities of individuals, since high rainfall, for example, may force people to stay indoors, thus reducing the potential for criminal activity.

Empirical evidence also suggests a negative relationship between rainfall and crime rates. For example, an article in the Los Angeles times has indicated that property and violent crimes dropped by 25 % and 23% respectively in days when it was raining (LA Times, 2005). A study in India shows that negative rainfall shocks are associated with an increase in the incidence of crime, suggesting that there is a negative relationship, with stronger results for property crimes (Blakeslee and Fishman, 2014). Some studies have shown that heavy rainfall limited movement of armed militia in Rwanda (Rogall and Guariso, 2013). Finally, Miguel (2005) show that negative rainfall shocks increased murder rates in rural Tanzania.

More importantly, we argue that it is highly unlikely for rainfall shocks to directly impact entry of firms in a region, especially after controlling for a municipality-specific fixed effect that captures general rainfall propensity in the region. Since rainfall shocks are random, we use this variable to isolate the random portion of crime that firms observe and base their decision on. Studies have also shown that rainfall shocks in poor countries have no direct effect on industrial production (Dell, Jones, and Olken, 2012). This argument may not apply for retail and service firms, where movement of customers might be important for business. However, since we also estimate the impact of crime on entry separtely for these sectors, we are able to test if results hold for non-retail and non-service sectors. One other concern is that high rainfall in some days may result in criminals postponing their activities, implying that warmer days following rainy days will experience more crimes. This has the effect of reducing the effect of rainfall on crime. However, this is not a big problem since we use average daily rainfall in a year and also empirically, we still show that rainfall has a negative effect on crime. Next, we perform our IV estimation for urban municipalities alone to tackle the concern that rainfall might affect incomes in rural municipalities and also firm entry. We find that our results remain qualitatively robust. Finally, we also check if rainfall is correlated with service provision or other institutional variables, and find no evidence for such a relationship. Conditional on the validity of our instrument, $\beta_{1,IV}$ captures the Local Average Treatment Effect (LATE) of crime on firm entry.

6 Results

Baseline Results

We present basic results for our specification (6) in Table 3, were in the first three columns we pooled the data of all municipalities over the 2003 to 2011 period. In this case, we use cross-sectional variation in crime rates across municipalities to identify the relationship between crime rates and entry. In columns (4) to (8), we only include municipality fixed effects and municipality-specific time trends and do not include controls. Municipality fixed effects account for unobserved and time-invariant municipality level shocks including policies and programs which may affect both crime rates and business entry. Municipality-specific time trends, captures differential trends across municipalities, such as regional income, quality of infrastructure, and the quality of policing and the judicial system, which may be correlated with both crime rates and business entry.

Our estimates using pooled OLS in columns (1) to (3) show that there is a positive and significant relationship between total crime, property crimes and business entry, whereas the effect of contact crime is not significant. This results points to the potential endogeneity of crime, emanating from reverse causation, where crime follows business activity. Pooled OLS results are likely to be biased because they treat crime rates to be exogenous and also do not control for omitted variables which affect crime and entry jointly. Controlling for fixed effects shows a negative and significant relationship between total crime, contact crime, and property crime rates and firm entry (columns 4 to 8). Overall, the effect of total crime on entry is negative and significant; suggesting that a percentage increase in total crime rates reduces business entry by 0.53 percent (column 4). The effect of property crimes is higher than that of contact crime (columns 5 and 6). A percentage increase in property crime rates reduces business entry by

0.68 percent, whereas a same increase in contact crime rates reduces business entry by 0.41 percent. Including contact and property crimes in one regression (column 7), we see that only property crime has a negative and significant effect on business entry, suggesting that property crime matters most for business activity. The estimate is higher in this case, implying that a percentage increase in property crimes is associated with a 1.04 percent decline in business entry.

Since, we would expect that prospective businesses make their entry decision in the previous period, we included lagged crime rates as the explanatory variable of interest. Results are still negative and significant for property crimes. These findings are consistent with the predictions of our conceptual framework and the hypothesis that higher costs of operation in regions with more crime will lead to fewer firms entering the market, because only more productive (large) firms will have expected profits high enough to justify paying the entry costs. The perceived risk of high crime rates and the uncertainty of generating enough profits to cover the high entry costs may act as a deterrent to business formation.

Coefficients of other control variables included are mixed (columns 1 to 3). Per capita household income has a negative sign and insignificant. To capture infrastructure and institutional quality, we use variables such as the share of households with access to telecommunication, electricity and a principal component of the share of households with toilet, access to water and refuse collection. The variables have the expected positive and significant relationship with firm entry in most specifications, with the exception of access to electricity.

We now look at differential effects of crime on business entry in sectors such as manufacturing, wholesale and retail, and services. Results in columns (1) to (3) of Table 4 show that property crime has a bigger effect on business entry in the wholesale and retail sector, with an estimate of -1.63, compared to -1.58 and -0.69 in the manufacturing and services sectors respectively. This is expected since the wholesale and retail sector are expected to suffer most from crime because of their valuable stock. Firms in this sector are most vulnerable to crime and hence the perceived risk of entering high crime regions is very high.

Robustness Checks-Instrumental Variables (IV) Estimation

Fixed effects estimates discussed above may be biased due to the problem of endogeneity in our crime variable as discussed earlier. For instance, crime may follow businesses, implying that there is reverse causation between crime and firm entry. The other potential bias may arise from measurement error in our crime variable due to under-reporting. These problems will result in our modelling strategy underestimating the effect of crime on firm entry, that is, our estimates will be biased downwards. We hence instrument for crime with rainfall shocks and employ a two-stage least squares estimation technique.

The first stage relationship between rainfall and crime is shown in Table 5. Results show that there is a negative and significant relationship between rainfall and crime. These findings are consistent with the existing literature and predictions of economic models of crime. The strength of the first-stage as measured by the F-statistic indicates that the F-statistics is very high for property crime (54.84) and total crime (28.87), and low for contact crime rates (6.87). Rainfall is a weak instrument for contact crime rates in this framework and is a strong instrument for property crimes and total crimes since the F-statistics are greater than 10 (Stock, Wright, and Yogo, 2002). Reduced form estimates are shown in column (4), and these results show a positive and significant relationship between rainfall and firm entry. High rainfall levels are associated with significantly more firm entry, with an estimated coefficient of 0.44. These results indicate that higher rainfall induces entry of firms. We assume that this effect is through its effect on crime rates as shown in columns (1), (2) and (3). As discussed earlier, higher rainfall reduces crime because movement of people is limited, and this reduction in crime increases business registrations in the region.

While rainfall variable is exogenous, it must satisfy the exclusion restriction that it should affect business registration only through its effects on crime rates, not through other channels. First, some studies have hypothesized that the main channel through which rainfall affect crime in rural agricultural areas is through income, where negative rainfall shocks may lead to a decline in agricultural productivity and may in turn affect incomes in rural agricultural areas. Also, negative rainfall shocks in rural areas will induce migration of people into urban areas, which could in turn affect crime and firm performance in urban areas. To tackle this concern we also estimate our model to a restricted sample of urban municipalities. Our results remain qualitatively robust. Recently, evidence has also shown that the effect of rainfall on income is not strong, suggesting that its effect on crime may be through other means (Sarsons, 2011).

Another potential threat to the exclusion restriction is that rainfall might have an effect on business activity independent of crime, through its effect on institutional quality. For example, high rainfall may reduce the capacity of municipalities to provide services such as refuse collection, building toilets and may also destroy telecommunications and electricity infrastructure. We rule out these possibilities in our study by showing that there is no relationship between rainfall and various institutional variables at the municipality level, after controlling for factors such as schooling, household income, population and fixed effects (Table 6). The coefficients on the relationship between rainfall and infrastructure variables are very small and insignificant. Also, we note that it is unlikely that high rainfall was associated with damage to infrastructure or service provision in the municipality since if this were true, we would not see a strong positive relationship between rainfall and firm entry in our reduced form estimation (column 4 of table 5).

Second-stage results are presented in Table 7. Our results are robust to using rainfall as an instrumental variable for crime; however, the coefficients are significantly larger than fixed effects estimates. In Table 8 we also see that our results are robust when we instrument lagged crime with lagged rainfall and also when we restrict our sample to urban municipalities. The differences between IV and fixed effects estimates suggest a downward bias in our fixed effects estimates. Thus, not controlling for endogeneity of crime rates underestimates the impact of crime on firm entry. Another possible explanation for the huge difference may be measurement error in crime rates as a result of under-reporting of most crime types. Our results suggest that, an increase in total crime and in particular property crime of one percent will reduce business entry by 5.36 and 3.96 percent respectively. Also, our results show that the effect is higher in wholesale and retail sector compared to other sectors, confirming heterogeneity in the effect of crime on firm entry.

7 Conclusions

Improving the business environment, particularly reducing crime rates, is important for the development of the private sector. This study examines the effect of crime on business registration across local municipalities in South Africa. Our results show that increased crime rates reduce business entry. Results suggest that property crimes matter most for business registration and that these effects differ by sector. These results are robust to controlling for the potential endogeneity of crime by using rainfall as an instrumental variable. Overall, our results are consistent with findings from business climate surveys and other related literature, which highlights the dampening effect of crime on business dynamism.

Our study suggests that any industrial policy aimed at improving local economic growth and job creation should also consider strategies for improving policing and security in the country in order to reduce crime rates. The study also documents the importance of the 'hidden' cost associated with crime that of hindering business growth and expansion plans in South Africa.

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Table 1: Crime Categories

CRIME CATEGORY	CRIME TYPE
Contact Crime (Crimes Against the Person) And Related	Murder
	Total Sexual Crimes
	Attempted murder
	Assault with the intent to inflict grievous bodily harm
	Common assault
	Common robbery
	Robbery with aggravating circumstances
	Carjacking
	Truck hijacking
	Robbery at residential premises
	Robbery at non-residential premises
Property-Related Crimes	Burglary at non-residential premises
	Burglary at residential premises
	Theft of motor vehicle and motorcycle
	Theft out of or from motor vehicle
	Stock-theft
	Arson
	Malicious damage to property
	All theft not mentioned elsewhere
	Shoplifting

Source: South African Police Service (SAPS) Database

Table 2: Summary statistics for variables used in the estimation

Notes: Crime is measured as crime rates per 1000 of 2001 population. Water and Sanitation is a principal component measure of share with access to toilets, refuse collection and water.

	2003-2011				
VARIABLES	N	Mean	SD	Min	Max
Entry	2,970	660.0	1,868	0	30,058
Log Rainfall-mm/day	2,970	0.55	0.42	-1.95	1.57
Log Household income	2,970	0.07	0.03	0.0008	0.27
Water and Sanitation	2,970	-0.00	1.52	-4.74	7.77
% with electricity	2,970	21.17	7.60	1.60	97.31
% with telecomms	2,970	27.27	5.89	8.96	100
% with primary	2,970	69.89	5.27	42.61	81.39
% with tertiary	2,970	18.62	5.01	11.97	53.80
Property crime	2,970	45.36	154.0	0	2,851
Contact crime	2,970	31.72	144.2	0	2,295
Total crime	2,970	77.07	292.8	0	5,045
Number of municipalities	330				

Table 3: Pooled OLS and Fixed Effects Regression: Crime and Firm Entry, 2003-2011

	Pooled OLS			Fixed Effects				
	Entry	Entry	Entry	Entry	Entry	Entry	Entry	Entry
Dependent Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Log Total Crime	0.201***			-0.530*				
	(0.0493)			(0.307)				
Log Contact Crime		0.0787			-0.413*		0.432*	
		(0.0556)			(0.239)		(0.243)	
Log Property Crime			0.262***			-0.675**	-1.039***	
			(0.0480)			(0.339)	(0.197)	
Log Contact Crime *(t-1)*								0.0212
								(0.170)
Log Property Crime *(t-1)*								-1.363***
								(0.149)
Log Household Income	-0.933	-0.478	-1.151					
	(1.064)	(1.050)	(1.071)					
% with electricity	-0.0256**	-0.0259**	-0.0255**					
	(0.0110)	(0.0111)	(0.0110)					
% with telecomms	0.0285**	0.0278**	0.0289**					
	(0.0115)	(0.0114)	(0.0116)					
% with primary	0.0379***	0.0392***	0.0355***					
	(0.0121)	(0.0122)	(0.0120)					
% with tertiary	0.0945***	0.0948***	0.0925***					
	(0.0135)	(0.0136)	(0.0134)					
Water and Sanitation	-0.00199	0.00684	-0.00627					
	(0.0494)	(0.0491)	(0.0496)					
Observations	2970	2970	2970	2970	2970	2970	2970	2640
R-squared	0.0547	0.0450	0.0637	0.497	0.485	0.509	0.514	0.472
Number of municipalities				330	330	330	330	330

Notes: Fixed effects estimates include municipality fixed effects and municipality specific time trends. Fixed effects estimates do not include controls. Dependent variable is natural log of (1+ entry). Contact crime rates include, robbery and assault crimes. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Fixed Effects estimates (Crime and Firm Entry): Sectorial, 2003-2011

	Manufacturing	Wholesale and Retail	Services
Dependent Variable	*Entry*	*Entry*	*Entry*
	(1)	*(2)*	*(3)*
Log Contact Crime	0.335	0.535	0.227
	(0.242)	(0.368)	(0.200)
Log Property Crime	-1.576***	-1.633***	-0.685***
	(0.191)	(0.316)	(0.163)
Observations	2808	2952	2970
R-Squared	0.478	0.341	0.605
Number of municipalities	312	328	330

Notes: Municipality fixed effects and municipality specific time trends are included in all estimations. Controls are not included. Dependent variable is the natural log of (1+ entry). Contact crime rates include robbery and assault. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: IV-First Stage (Rainfall and Crime) and Reduced form estimates: All sectors, 2003-2011

	First Stage			Reduced Form
Dependent Variable	*Total Crime*	*Contact Crime*	*Property Crime*	*Entry*
	(1)	*(2)*	*(3)*	*(4)*
Log Rainfall-mm/day	-0.0821***	-0.0410***	-0.111***	0.440***
	(0.0153)	(0.0158)	(0.0150)	(0.0353)
Observations	2,970	2,970	2,970	2,970
R-squared	0.484	0.480	0.478	0.496
Number of municipalities	330	330	330	330
F-test	28.87	6.784	54.84	
Prob>F	0.00	0.00962	0	

Notes: Municipality fixed effects and municipality specific time trends are included in all estimations. Controls are not included. Dependent variable is the natural log of (1+ crime rates). Contact crime include robbery and assault. Total crime includes contact and property crimes. Total number of observations is 2970. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Effect of Rainfall on Institutions, 2003-2011[1]

Dependent Variables	*Water and Sanitation*	*Telecomms*	*Electricity*
	(1)	*(2)*	*(3)*
Log Rainfall-mm/day	0.00553	0.0113	0.0160
	(0.00352)	(0.0146)	(0.0185)
Observations	2,970	2,970	2,970
R-squared	0.934	0.974	0.991
Number of municipalities	330	330	330

Notes: Fixed effects estimates of institutional variables on rainfall and controls such as schooling, household income, and population. We also include municipal fixed effects and time trends. In column (1), the outcome variable is principal component of (access to water, access to total refuse collection, access to toilets). In column (2) and (3), outcome variable is percent with access to telecommunications and electricity as a control. Total number of observations is 2970. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[1] We also estimated equations were we do not control for household income, and our results are the same.

Table 7: Impact of crime on firm entry: IV-2SLS regression estimates, 2003-2011

	All Sectors		Manufacturing		Wholesale and Retail		Services	
Dependent Variable	*Entry*	*Entry*	*Entry*	*Entry*	*Entry*	*Entry*	*Entry*	*Entry*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Log Total Crime	-5.359***		-5.377***		-8.878***		-3.957***	
	(0.915)		(0.833)		(1.492)		(0.721)	
Log Property Crime		-3.960***		-5.509***		-6.453***		-2.848***
		(0.510)		(0.795)		(0.833)		(0.418)
Observations	2970	2970	2808	2808	2952	2952	2970	2970
Number of municipalities	330	330	312	312	328	328	330	330

Notes: Municipality fixed effects and municipality specific time trends are included in all estimations. Dependent variable is the natural log of (1+ entry). Total crimes include robbery, assault and property crimes. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: IV-2SLS regression estimates for lagged crime and urban municipalities, 2003-2011

	Whole Sample		Urban Municipalities	
Dependent Variable	*Entry*	*Entry*	*Entry*	*Entry*
	(1)	*(2)*	*(3)*	*(4)*
Log Total crime (t-1)	-6.501***			
	(0.789)			
Log Property crime (t-1)		-4.839***		
		(0.463)		
Log Total crime			-4.733***	
			(1.014)	
Log Property crime				-3.751***
				(0.615)
Observations	2,640	2,640	1,899	1,899
Number of municipalities	330	330	211	211

Notes: Municipality fixed effects and municipality specific time trends are included in all estimations. Dependent variable is the natural log of (1+ entry). Total crimes include robbery, assault and property crimes. Controls as in table 3 above are also included in all estimations. Lagged crime is instrumented with lagged rainfall. Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 1: South Africa wide average crime rates (crime per 1000 population) over time

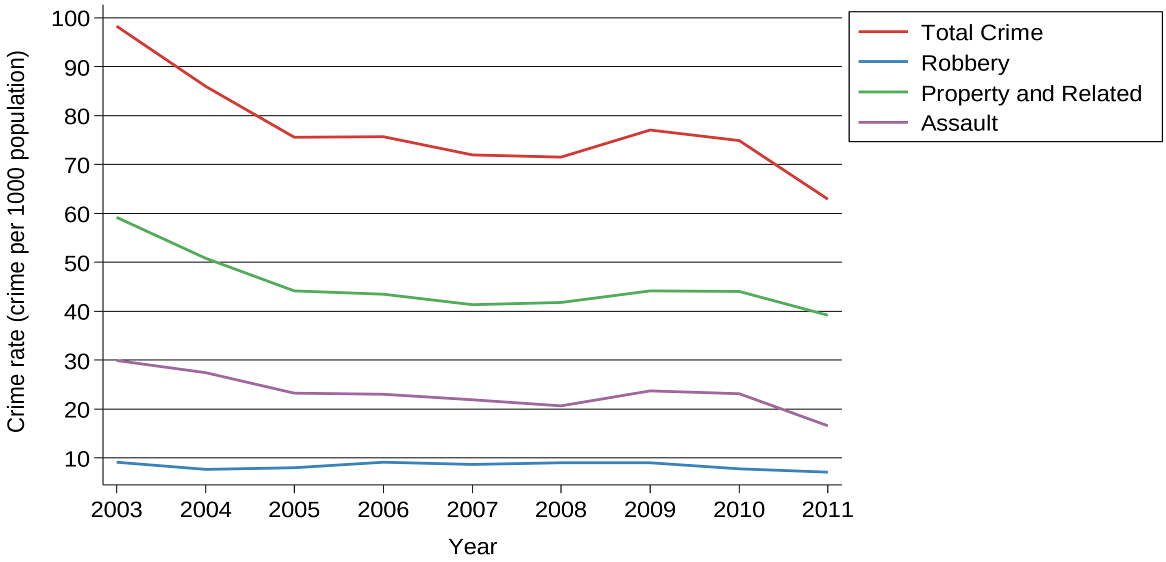


Figure 2: Spatial Distribution of average 2003-2011 total crime rates

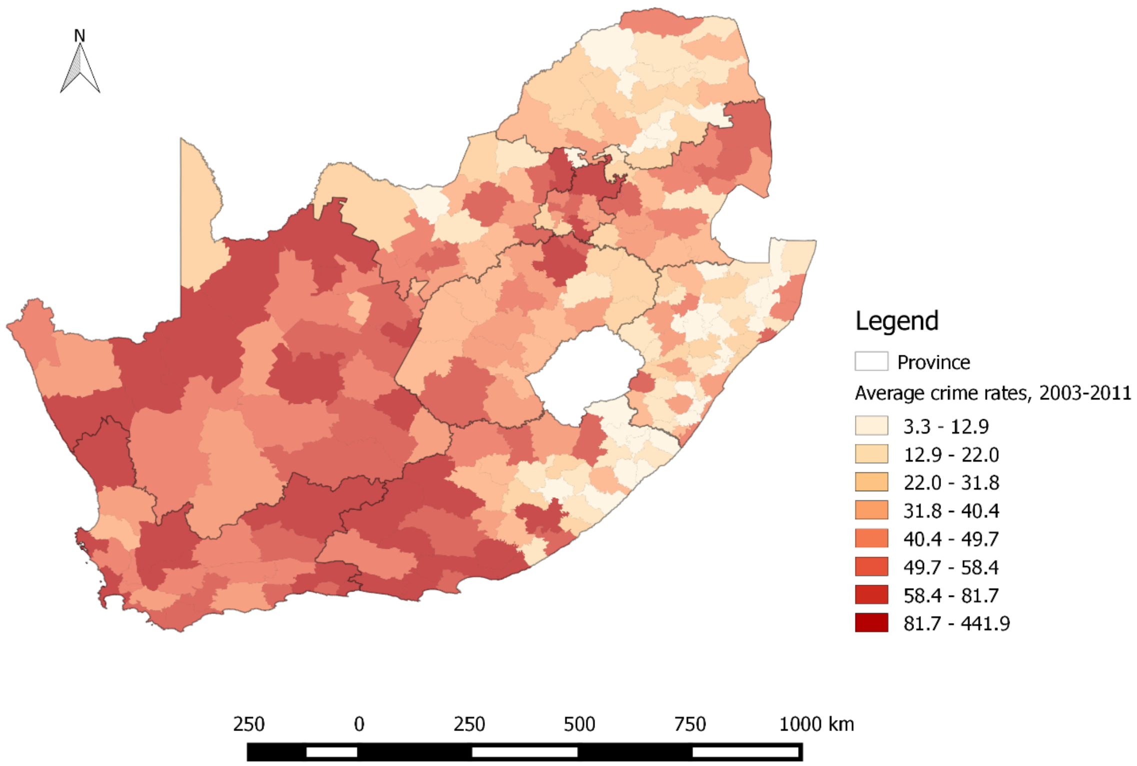


Figure 3: Spatial Distribution of Firm Entry (average over the period)[2]

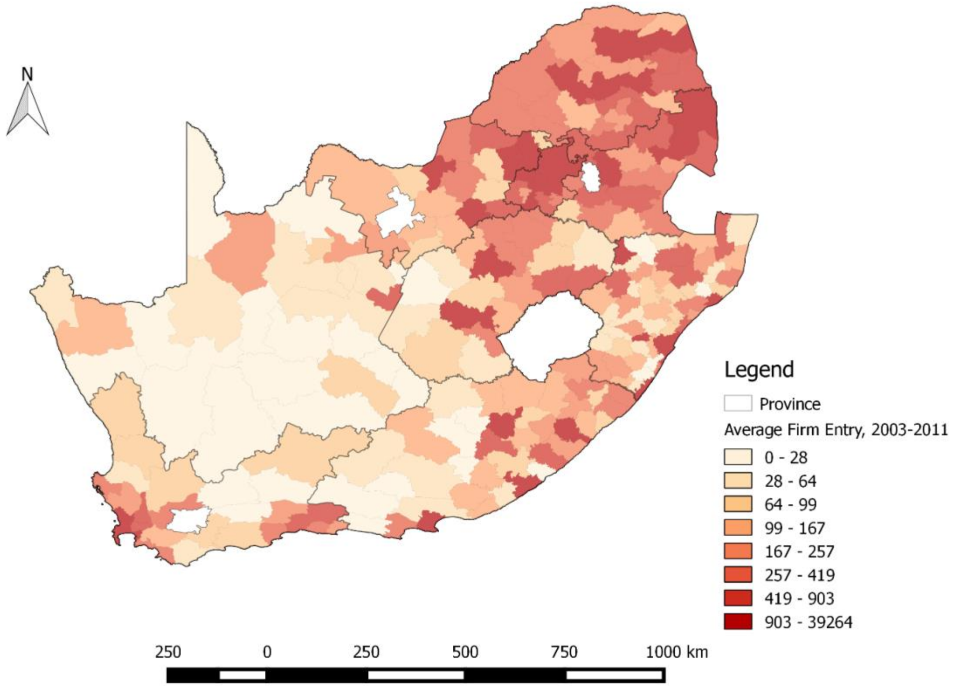
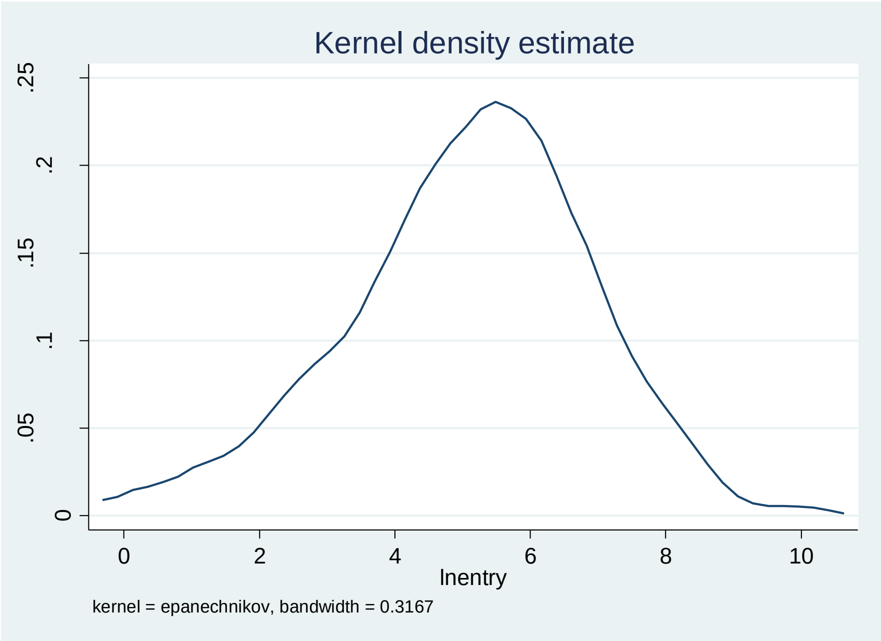
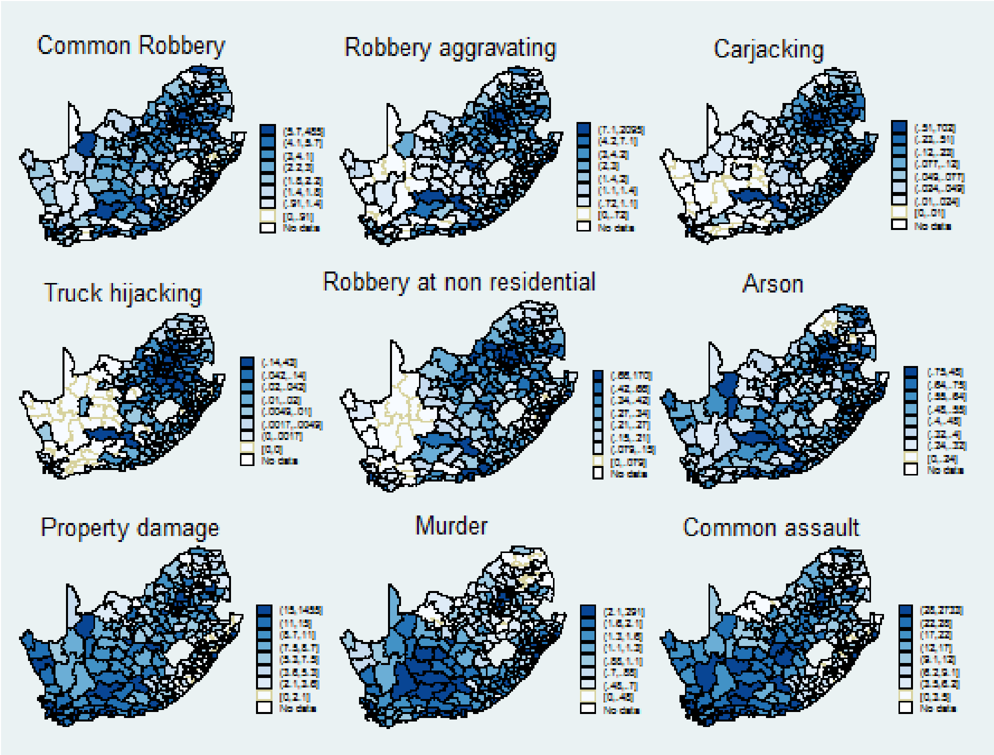


Figure 4: Distribution of firm entry data, 2003-2011



[2]We use Geographic Information Systems (GIS) data like police boundaries and coordinates (longitudes and latitudes) obtained from SAPS website. GIS data for municipalities is obtained from Municipality Demarcation Board. Entry data is classified into four quantiles

Figure 3: Spatial distribution of average 2003-2011 crime rates (crime per 1000 population) [3]



[3] Crime data is classified into four quantiles