The Long-Term Effects of War on Foreign Direct Investment and Economic Development: Evidence from Vietnam

Nguyen, Cuong and Tran, Tuyen and Vu, Huong

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Cuong Viet Nguyen[a]

Tuyen Quang Tran[b]

Huong Van Vu[c]

Abstract

In this study, we find that the negative effect of unexploded ordnance (UXO) on the geographical density of foreign direct investment and large firms is a new channel through which the war legacy impedes local development in Vietnam. A 1% increase in the proportion of UXO-contaminated area leads to a 0.78% relative decrease in the density of FDI firms within districts. Point estimates for the elasticity of the density of joint-venture FDI firms and state-owned enterprise (SOEs) due to UXO are smaller, equal to -0.56 and -0.54. Consequently, a 1% increase in the proportion of UXO-contaminated areas leads to a 0.46% relative decrease in the intensity of nighttime light.

Keywords: War; FDI, unexploded ordnance; local development; Vietnam.

JEL classification: R12; O12; O15

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[a] International School, Vietnam National University, Hanoi, Vietnam; Mekong Development Research Institute, Vietnam; and IPAG Business School, Paris, France.

[b] International School, Vietnam National University, Hanoi, Vietnam.

[c] VNU University of Economics and Business, Hanoi, Vietnam; Thang Long Institute of Mathematics and Applied Sciences, Thang Long University, Hanoi, Viet Nam

Email addresses of authors: cuongnv@isvnu.vn; tuyentranquang@isvnu.vn; huongvv@vnu.edu.vn

1. Introduction

The short-term consequences of war are terrible - the destruction of physical infrastructure, environmental deterioration, weakened economic and political institutions and, obviously, human casualties, among others (Barceló, 2021; Frost et al., 2017; Miguel & Roland, 2011). The combination of such factors has significant effects on later economic growth and development (Miguel & Roland, 2011).While the immediate effects of war are obvious, findings on the long-term effects of war on development are controversial (Barceló, 2021; Roland, 2016).

In this study, we explore the long-term effects of war in Vietnam through the legacy effect of unexploded ordnance (hereinafter referred to as UXO)[1]. During the 1965 to 1975 Indochina War, centered in Vietnam, the United Stated (US) Air Force dropped more than 6 million tons of bombs and other ordnance (Clodfelter, 1995). Vietnam War bombing is estimated to total "at least three times as much (by weight) as both European and Pacific and World War II bombing combined, and about fifteen times the total tonnage in the Korean War." (Miguel & Roland, 2011). Given the 30% bomb failure rate (Centre for Satellite Data in Environmental Science, 2021), Vietnam has been heavily contaminated with unexploded ordnance (Martin, Dolven, Feickert, & Lum, 2019). Using rich data sets on UXO intensity and firms, we find a negative UXO effect on the density of foreign direct investment (henceforth referred to as FDI) firms as well as large ones. A 1% increase in the proportion of UXO-contaminated areas within districts results in a 0.78% relative decrease in the density

[1] "Unexploded ordnance (UXO) is defined as military ammunition or explosive ordnance which has failed to function as intended. UXO is also sometimes referred to as Explosive Remnants of War (ERW) or 'duds' because of their failure to explode or function properly. UXO includes mines, artillery shells, mortar rounds, hand or rocket-propelled grenades, and rocket or missile warheads employed by ground forces. Aerial delivered bombs, rockets, missiles, and scatterable mines that fail to function as intended are also classified as UXO" (Martin, et al., 2019, p. 2).

of FDI firms, a 0.56% decrease in joint-venture FDI density, and a 0.54% decrease in SOE density within districts. Subsequently, we find that UXO has an effect on the local economic development of districts, and can be measured by nighttime light. Specifically, a 1% increase in the proportion of UXO-contaminated areas results in a 0.46% relative decrease in light intensity. Our study indicates that these long-term effects of war on economic development are due to UXO and its negative effect on the density of FDI firms.

Compared with previous studies on war in Vietnam and other countries, our study exploits several unique data sources. We are able to access data on the area contaminated with UXO at the district level. This data set comes from the UXO survey implemented and coordinated by the Technology Centre for Bomb and Mine Disposal (BOMICEN), Ministry of Defense of Vietnam. To measure outcome variables, we use very rich data sets from annual enterprise censuses from 2000 to 2017. The data set allows us to compute the density of firms of different types at the district level over time. We use satellite nighttime light detection to represent the economic development variable (the average nighttime light strength). Conventional economic statistics, such as gross domestic product (GDP), are unavailable at the district level, hence satellite images, which are deemed to be objective and have fewer measurement errors than observational data, are a better alternative to conventional economic statistics (Gibson, Olivia, Boe-Gibson, & Li, 2021; Hu & Yao, 2021; Pinkovskiy & Sala-i-Martin, 2016; Yamada & Yamada, 2021).

Due to the fact that conflict locations do not occur randomly, selection bias is a challenge in estimating the effects of war. If the unobserved factors that drove the intensity of the conflict also influenced the long-term outcomes of interest, an endogeneity problem arises. The literature has generally relied on the geography of conflicts to address this issue, utilizing distance from war sites as an exogenous variation in conflict intensity (Arcand, Rodella-Boitreaud, & Rieger, 2015; Miguel & Roland, 2011; Yamada & Yamada, 2021). Consequently, our study employs an instrumental variable method to address the endogeneity issue, following Miguel and Roland's (2011) empirical strategy. Specifically, we use the distance between each district center and the 17th parallel north latitude (where most bombing occurred) as the instrument for bombing and UXO density in that district. Our results are robust to different model specifications. We also verify this instrument using a balancing test and a series of instrument analyses, including bound estimation methods (Conley, Hansen, & Rossi, 2012; Nevo & Rosen, 2012) and heteroscedasticity-based instruments (Klein & Vella, 2010; Lewbel, 2012).

Our paper contributes to several factors discussed in the literature, the first concerning the body of knowledge about the war's effects on Vietnam and other countries, as well as identifying a vital area for policy intervention. Existing evidence in Vietnam (Miguel & Roland, 2011), Japan (Davis & Weinstein, 2002), Germany (Agyekum, Reddy, Wallace, & Wellalage, 2021; Brakman, Garretsen, & Schramm, 2004) and several capitalist and socialist countries (Kugler, Organski, & Fox, 1980; Organski & Kugler, 1977) demonstrates that wars have no long-term economic consequences. This result is partly explained by neoclassical models asserting that, to the extent that the primary effect of war is the loss of existing physical capital and a transient decline in human capital accumulation, strong postwar catch-up growth can be predicted as the economy returns to its steady-state growth rate, with no long-term consequences.

However, adverse effects can persist in the terrible UXO legacy of war, as is the case in several war-torn countries (Frost et al., 2017). Recently, Chiovelli et al. (2018) show that clearance of landmines and UXO in Mozambique can improve economic activities through transportation network linkages. Our study provides new evidence that UXO has resulted in a negative effect on local economic development through impeding the inflow of FDI as well as large-scale firms. While Miguel and Roland (2011) found no evidence of long-term consequences of US bombing in Vietnam 25 years after the Vietnam War ended, our research points to the negative effect of the war on later local economic development. Notably, we show that the war has had a long-term negative effect on economic development through UXO and its negative effect on the density of FDI firms as well as large firms. Such findings shed light on a new mechanism through which wars affect long-term economic development in Vietnam and possibly other nations with similar conditions.

Secondly, our study contributes to the literature on the determinants of firm density, especially FDI firms. Because of the important role of FDI, a number of studies have explored factors attracting FDI (e.g., Egger and Winner, 2006; Haufler et al., 2018; Azzimonti, 2019). Our research contributes to this literature by showing the long-term negative effect of war on local flows of FDI within a country. The influence of geographical attributes on a firm's choice of location has been studied primarily in neoclassical economics (John, Knyazeva, & Knyazeva, 2011; Papageorgiou & Thisse, 1985; Zheng & Shi, 2018). Firms are believed to seek the best site to maximize their profits in general. This fundamental assumption implies that local characteristics are appealing to firms because they have the potential to improve profits or lower production costs. In this sense, location theories have shown that transportation costs, market competition, land use, and industry placement are all linked (John et al., 2011; Papageorgiou & Thisse, 1985; Zheng & Shi, 2018). Our study points out that wars have led to long-run negative consequences on firm density because of the presence of UXO that discourage firms from locating on UXO-contaminated sites. This can be explained by the fact that finding and removing explosive war remnants is extremely expensive, requiring significant infrastructure investment. Consequently, firms are reluctant to make use of polluted areas because of UXO, especially for large projects that require substantial infrastructure.

Thirdly, our study contributes to the literature related to the role of FDI on economic development. The relationship between FDI and economic development is a hotly disputed topic in the literature (Figlio & Blonigen, 2000; Alfaro et al., 2004; Chen, Melachroinos, & Chang, 2010; Crescenzi et al., 2021; Ketteni & Kottaridi, 2019; Makiela & Ouattara, 2018; Meyer, 2004). On the one hand, it is frequently claimed that FDI promotes the economic growth of the host region by facilitating technology transfer, human capital development, the creation of new jobs, poverty reduction, the promotion of productivity and the expansion of exports (e.g., Anwar & Nguyen, 2014; Caves, 1974; Cipollina, Giovannetti, Pietrovito, & Pozzolo, 2012). On the other hand, FDI may have some potentially negative consequences for the host region, including reliance on foreign capital, instability in FDI inflows, specialization in low-tech sectors, the destruction of local firms, and the suppression of indigenous new firms (Borensztein, De Gregorio, & Lee, 1998; Chen et al., 2010). Our research findings support the positive role of FDI by presenting evidence that FDI density has a significant, positive effect on local economic development, as measured by nighttime light intensity across districts in Vietnam.

The rest of the paper is structured as follows. Section 2 discusses the data sets used in this study. Section 3 presents a theoretical and empirical literature review, followed by the study context in Section 4. Empirical strategy is discussed in Section 5, while results and discussion are reported in Section 6. Section 7 presents some concluding remarks.

2. Data sets

In this study, we rely on four sets of district-level data. The first data set deals with bomb density, measured by the total number of bombs, missiles, and rockets dropped by allied forces per square kilometer. The information comes from a database put together by the US Defense Security Cooperation Agency, which provides the most thorough and precise record of every piece of ordnance dropped in Vietnam by US and allied planes and helicopters from 1965 to 1975. The data are aggregated at the district level for the whole 1965-1975 period, and are provided by Miguel and Roland (2011). This data set is the same as that used in several previous studies, such as those of Miguel and Roland (2011), Singhal (2019) and Palmer, Nguyen, Mitra, Mont, and Groce (2019). Panel A of Figure 1 shows bomb density in Vietnam at the district level.

The second data set contains data on unexploded ordnance at the district level, and is obtained from the UXO survey implemented and coordinated by the Technology Centre for Bomb and Mine Disposal (BOMICEN), Ministry of Defense of Vietnam, with the collaboration of the General Statistics Office of Vietnam, Regional Military Commands, Provincial People's Committees, and military offices from provincial to commune level in 63 provinces and cities across the country in 2015.

Data collection was carried out in two main stages. First, the survey teams conducted interviews with commune leaders with the participation of about four officials. The purpose of the interview was to collect basic information on the socio-economic situation, a preliminary understanding of UXO and its impact on socio-economic development, and information on bomb victims, mines and explosives, and clearance activities that have been carried out in the commune. Second, interviews were held with witnesses, followed by interviews with commune leaders (wards and towns). Each village or hamlet selected one witness to participate in these interviews. The witnesses who participated in the interviews are knowledgeable about the past and present local landmines and explosives. During the interview, information was collected about UXO, contaminated areas, and locations where local people have seen mines and explosives (marked on the map and detailed in the questionnaire). The investigation team used the questions available in the questionnaires to interview and record the responses of the witness group. The second step identifies villages that are considered to be areas contaminated with UXO.

While the surveys were conducted at the commune and village level, the BOMICEN allows us to access UXO data at the district level. One reason is that the administrative boundaries at commune level have changed a lot since 1975, so it is not feasible to accurately determine the contour of the mine-contaminated area in a commune. Battles could take place many times at one location, over different years, and the parameters of a battle are difficult to distinguish within a commune. Bombing positions are also difficult to locate exactly in a commune when suspected UXO sites are connected with neighboring communes in the district. More specifically, the BOMICEN provides us with data on the proportion of commune areas contaminated with UXO within districts. The proportion ranges from 0 for districts without UXO-contaminated communes to 100% for districts where entire communes are contaminated with UXO. Figure 1 presents the proportion of UXO-contaminated areas at the district level in Vietnam. It shows a strong correlation between bomb density and the UXO-affected area. Districts which were bombed heavily are more likely to be contaminated by UXO. The correlation coefficient between these two variables is estimated at 0.52.

It should be noted that we only have one-year data on UXO for 2015. We will merge the UXO data with data on firms and nighttime light during the 1992-2018 period to estimate the effect of UXO on firm density and nighttime light. We assume that the UXO variable remained unchanged during this period. According to the Vietnam Veterans of America Foundation (2021), it is estimated that only 740,000 acres (300,000 hectares), or 5% of the contaminated area, has been cleared. We also conduct a robustness check by limiting the period of analysis to the 2015-2017 period.

[Figure 1 about here]

The third data set is derived from the Enterprise Censuses 2000-2017, conducted annually by the General Statistical Office of Vietnam. The Enterprise Censuses cover all firms throughout the country, containing information about the types of firms, main business industries, the number of workers, and the turnover and profit of firms. Using this data set, we computed the number of firms of different types over the 2000-2017 period, including FDI firms, joint-venture FDI firms (firms with both domestic and foreign investment capital), state-owned enterprises (SOEs), and private firms for all the districts. Figure 2 presents the number of these firms over this period. The number of FDI firms increased over time, which is consistent with the increase in the FDI net inflows to Vietnam (Figure 3), especially after 2006. Figure 4 presents the geographical distribution of FDI firms, SOEs, and private firms in 2017. In general, firms tend to be concentrated in the delta regions (Red River Delta and Southeast) and coastal areas.

[Figure 2 about here]

[Figure 3 about here]

[Figure 4 about here]

The fourth data set has to do with nighttime light. We aim to estimate the effect of UXO on local economic development. However, data on per capita income or GDP are not available at the district level. In this study, we use nighttime light intensity, which can be regarded as a useful proxy for GDP (e.g., Chen & Nordhaus, 2011; Gibson et al., 2021;

Henderson, Storeygard, & Weil, 2011; Hu & Yao, 2021; Pinkovskiy & Sala-i-Martin, 2016).[2] The advantage of using nighttime light is the large coverage across time as well as space and that it is also less prone to the sampling errors of household surveys. Nighttime light data are obtained from the Defense Meteorological Satellite Program (DMSP)/Operational Linescan System (OLS) and the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership satellite. Nightscape recordings provided by DMSP (1992–2013) and VIIRS (2012–2018) are made available in various studies (e.g., Elvidge, Baugh, Zhizhin, Hsu, & Ghosh, 2017; Elvidge, Baugh, Kihn, Kroehl, & Davis, 1997). Li, Zhou, Zhao, and Zhao (2020) produce a consistent nighttime light dataset for the 1992–2018 period by harmonizing inter-calibrated nighttime light observations from the DMSP data and the simulated DMSP-like NTL observations from the VIIRS data.

In this study, we aggregate grid data on nighttime light to the district level. Figure 5 presents the yearly average district nighttime light for 2005 and 2017, showing a substantial increase in nighttime light between these two years. The level of nighttime light is higher in the Red River Delta and the Southeast, the two richest regions in Vietnam. Districts in coastal areas also have higher nighttime light intensity than others, while the Northern Mountains have the lowest level. We see a strong spatial correlation between the density of firms and nighttime light. In this study, we will use annual district-level data on nighttime light from 1992 to 2018 for regression analysis.

[Figure 5 about here]

[2] Nighttime light data can be considered a sort of geospatial data in which each data point has geographic information connected with it. A data point for a specific location at a specific time is represented by each pixel in a nighttime light satellite image. The pixel's value represents the intensity of light at night, as measured in radiance and then converted into a discrete digital number between 0 and 63 (Hu and Yao, 2021).

3. Economic framework and literature review

Insofar as the destructive short-term consequences of wars are the overwhelming issue, their long-term effects have received increasing attention (Barceló, 2021). Both neoclassical growth and Conflict Trap theories have all attempted to elaborate the relationship between external shocks, such as bombing during conflicts, and later long-term economic growth (Miguel & Roland, 2011; Yamada & Yamada, 2021). According to the traditional neoclassical growth theory, the economic growth of an impacted area eventually converges to form a stable state (Barro, 2015; Barro & Sala-i-Martin, 1992; Baumol, 1986; Blattman & Miguel, 2010). The orthodox neoclassical growth theory predicts that while conflicts cause a loss of both physical and human capital, they have no effect on the rate of technical advancement (Yamada & Yamada, 2021).

In addition, if a conflict results in the partial destruction of the physical capital stock but the production function remains unaltered, capital accumulation will temporarily increase until a steady state is reached. If a conflict destroys capital stock in certain places but not in others, the former will grow faster for a while. If capital is mobile, it will move to war-torn areas, equalizing marginal returns across regions. Postwar recovery trends are essentially similar for human capital (Miguel & Roland, 2011). Therefore, to the extent that the primary effect of war is the loss of existing physical capital and a temporary decline in human capital accumulation, neoclassical models anticipate strong postwar catch-up growth as the economy returns to its steady-state growth rate, with no long-term consequences (Miguel & Roland, 2011).

The validity of neoclassical economic growth theory is supported by some empirical evidence (Cavallo, Galiani, Noy, & Pantano, 2013; Davis & Weinstein, 2002; Miguel & Roland, 2011). For instance, Davis and Weinstein (2002) found that the bombings had no long-term negative effects on population growth in the Japanese cities of Hiroshima and Nagasaki. Both cities recovered their long-term population trend in 20 and 30 years, respectively. Miguel and Roland (2011) investigated the long-term effect of the Vietnam war (1965-1975) on local economic development at the district and provincial levels. Their study employed an instrumental variable estimator to account for the potential endogeneity of the bombings. They did not find any significant negative long-term effect of the bombings in terms of poverty (in 1999) and consumption levels (in 1992 and 1998), population intensity (in 1985 and 1999), access to electricity, and literacy rates (in 1999).

While such findings are in line with the neoclassical economic growth theory, the results can be explained to some extent by the strong efforts of the Vietnamese government to relocate and invest more resources in heavily damaged areas, yielding the fruit of the first years of the country's economic transition and reform (Miguel & Roland, 2011; Roland, 2016). Similarly, using the instrumental variable approach and village level data, a recent study in Laos by Yamada and Yamada (2021) also reveals that the intensity of the US bombing missions (1965-1973) had no long-term negative effects on population intensity (in 1990 and 2005) and nighttime light levels (in 1995, 2005 and 2013).

Wars, especially those with modern weapons, tend to cause enormous damage to human lives, human capital, material capital and infrastructure, the natural environment, and the social fabric, taking years to recover and rebuild. Any such devastation could have long-term detrimental consequences for a country's socio-economic development (Roland, 2016). Poverty Trap models, such as those proposed by Azariadis and Drazen (1990) and recently promoted by WB (2003) predict that serious war damage to capital stock may lead to a "conflict trap," in which a country can suffer from long-term underdevelopment. Thus, war can undermine a country's steady development if it falls into a poverty trap. This risk is much more likely to occur in a country whose initial condition was poor and that was heavily damaged by war. Specifically, the long-term negative effects of war have been pointed out in some studies. For instance, using the Basque country as a case study, Abadie and Gardeazabal (2003) found that since the conflict broke out in the 1960s, the country's per capita GDP dropped roughly 10 percentage points compared to a synthetic control region free of conflict. Earlier studies also found that conflicts resulted in long-term negative effects, increasing poverty (Merrouche, 2008) and impeding economic activity (Frost et al., 2017; Gibson et al., 2007), investment and savings (Alesina & Perotti, 1996; Venieris & Gupta, 1986), and economic growth (Barro, 1991; Mauro, 1995).

From another perspective, arguments have been made for the long-term positive effects of wars. This link has been put forward for a variety of reasons, including the historical importance of conflicts in state formation, national development, and technological advancement (Drèze, 2000; Roland, 2016). Military research and development are frequently said to stimulate technological progress, which may compensate in part for the harmful consequences of wars (Miguel & Roland, 2011; Roland, 2016). Furthermore, conflicts may have boosted state and national development in Europe (Kestnbaum & Skocpol, 1993), as well as social advancement, by promoting more popular engagement (Barceló, 2021; Ray, 2001) and by removing the authority of entrenched organizations that stifle pro-growth policies (Olson, 2008). As we have already discussed, there are arguments and evidence for both the long-term positive and negative effects of war. Thus, empirical research is vital to identify which effect is dominant and the net long-term effect (Miguel & Roland, 2011; Roland, 2016).

One of the terrible legacies that wars or armed conflicts have left is UXO or explosive remnants of war. This legacy not only causes numerous immediate negative consequences for human lives and infrastructure, but also has a detrimental effect on long-term development in most affected regions (Frost et al., 2017). Landmines, for example, have long-term harmful consequences on human capital. In Angola, landmines caused a reduction of 0.5-1 year in child educational achievement (Arcand et al., 2015) and in Cambodia likewise, landmine contamination caused a reduction of 0.5-1 year in child educational attainment (Merrouche, 2011). Another study in Laos by Guo (2020) similarly found that school-aged children exposed to the average amount of UXO contamination had 1.3 fewer years of education two decades after the US bombardment ended.

Vietnam, the country at the heart of the Indochinese wars, suffered from the world's most severe aerial bombing campaign in the 20th century, particularly in the US bombing campaign in Vietnam from 1965-1975. There are numerous reasons why the US bombing of Vietnam would have long-term consequences for the Vietnamese economy (Miguel & Roland, 2011). First, the destruction of local physical infrastructure may have hindered commerce and disrupted investment patterns for the future. Second, the US bombing displaced large numbers of people, which would have harmed local economic activity if many of those people never returned. Third, population dislocation and the loss of physical infrastructure, such as schools, disrupted schooling for millions of people, impairing the formation of human capital.

There has been an increasing number of empirical studies examining the long-term effects of the US bombing in Vietnam, mainly focusing on tangible factors, such as employment and education or intangible factors such as mental health and civic engagement. For instance, Singhal (2019) and Palmer et al. (2019) investigated the effect of intense bombing on people's health, while the effect on civic engagement was explored by Barceló (2021). As already mentioned, Miguel and Roland's (2011) study, among a few others, analyzed the causal effect of bombing intensity on local economic development as measured by poverty, consumption levels, access to electricity and population density at the district and provincial level.

While infrastructure, resources, population and other macroeconomic indicators can recover over time (Miguel & Roland, 2011; Roland, 2016; Singhal, 2019), UXO *or* explosive remnants of war, can have long-term consequences for local economic development (Miguel & Roland, 2011). Identifying the causal effects as well as understanding the mechanisms through which wars affect local economic development is critical for formulating effective development policies. Given the availability of UXO data at the district level, our study is the first to investigate the causal effect of the US bombing and UXO intensity on local economic development in Vietnam. Notably, differing from previous studies that often focus on the war's impact on education, mental health, poverty, or income/consumption levels, our study analyzes the effects on local economic development as measured by firm density and nighttime light intensity.

4. The country context

4.1. The war and unexploded ordnance

After years of conflict, the Vietnamese nationalist alliance, known as the Viet Minh, and the French agreed to a cease-fire with the signing of the Geneva Agreement in 1954. According to the provisions of the agreement, the Viet Minh would take control of the northern half of Vietnam above the 17th parallel north and establish a communist state. After US-backed President Ngo Dinh Diem won a referendum to take over the power, the State of Vietnam took control of the south, which shortly thereafter was renamed the Republic of Vietnam. Without consulting the Vietnamese, world powers such as the United States, the Soviet

Union, France, and the People's Republic of China decided on the 17th parallel demarcation line, a border which had no socioeconomic basis (Miguel & Roland, 2011). In 1955, the government of North Vietnam (officially named the Democratic Republic of Vietnam (DRV)) launched the campaign, known as the “War Against the Americans to Save the Nation” in Vietnam or “the Vietnam War” in the West, against the government of South Vietnam (the republic of Vietnam) and its principal ally, the US (Spector, 2020). This war lasted for 30 years and came to an end in 1975, when the government of South Vietnam collapsed, and the two sides of Vietnam were officially reunited in 1976.

In 1965, US President Lyndon Johnson ordered a military intervention in which the US air force bombed South Vietnamese territory in addition to North Vietnam to prevent the "expansion of communism." From 1965 to 1975 during the Indochina War, centered in Vietnam, the US air force dropped almost 6 million tons of bombs and other ordnance, making it the most extensive aerial bombardment in military history. Specifically, between 1964 and August 15, 1973, the air force dropped a total of 6,162,000 tons of bombs and other ordnance in Indochina. Another 1,500,000 tons were dropped in Southeast Asia by US navy and marine corps aircraft (Clodfelter, 1995)[3]. Thus, ordnance used in the Vietnam War accounted for at least three times as much (by weight) as ordnance deployed in the European and Pacific theaters combined during World War II, and roughly fifteen times the total tonnage in the Korean War (Miguel & Roland, 2011).

Figure 1 depicts the distribution of US bombing and its intensity (number of bombs, missiles and rockets per km^2) throughout mainland districts. The 17th latitude demarcation line and the district to the west of South Vietnam, where communist forces entered the

[3] During World War II, the United States Air Force used 2,150,000 tons of munitions (1,613,000 tons in the European theater and 537,000 tons in the Pacific theater) and 454,000 tons in the Korean War) (Clodfelter, 1995).

country from Cambodia, were the most frequently attacked locations. Bombing was carried out in North Vietnam with the goal of damaging infrastructure, production units, and supply lines to the south, while the goal of the US and its South Vietnamese partner in South Vietnam was to put an end to communist operations and prevent civilian support for the communists (Dell & Querubin, 2018). Bombing extended to most parts of the country over 9 years (1964-1973), with the exception of a "buffer" zone along the Chinese border (Dell & Querubin, 2018).

Given the 30% bomb failure rate (Centre for Satellite Data in Environmental Science, 2021), Vietnam has been severely contaminated by UXO, mostly from the Vietnam War (Martin et al., 2019). UXO remains have been located in most regions, including the plains, forests, and mountains, as well as below water. According to official statistics from the Vietnam National Mine Action Centre [VNMAC] (2021), around 800,000 tons of UXO remain in all regions, contaminating or potentially contaminating about 6.1 million hectares, or about 18.71 percent of the country's total territory (see more detail in Figure 1). It should be noted that there are some differences between Panels A and B of Figure 1. As shown in Panel A, Figure 1, while most provinces in the Northwest and Northeast regions were not attacked by US bombing, Panel B of Figure 1 indicates that many of these provinces suffered from the consequences of UXO resulting from the other two wars. The first began in 1945 and lasted until 1954, when the French were defeated, effectively ending their authority in Indochina. The other is the Sino-Vietnamese war, which erupted on Vietnam's northern border in February and March 1979.

For more than 40 years after the Vietnam wars ended, UXO from numerous conflicts has caused long-term harmful consequences in people's lives, in the form of casualties (Martin et al., 2019) and adverse mental health effects (Phung, Viet, & Husum, 2012).

Specifically, the data on UXO casualties in Vietnam by Landmine and Cluster Munition Monitor (2021) show that 38,978 were killed and 66,093 injured by UXO from 1975 to 2017. Importantly, in most contaminated locations, UXO could be a substantial impediment to long-term development. It is estimated that only 740,000 acres (300,000 hectares), or 5% of the contaminated area, has been cleared. Recently the Vietnamese government made plans to clear an additional 1.2 million acres (500,000 hectares) over the next five years, at a cost of $595 million (Vietnam Veterans of America Foundation, 2021).

Mine clearance aims to overcome the consequences of mines and explosive ordnance after the war in the territory of Vietnam, a responsibility to be met by project investors (according to Decree 18/2019/ND-CP 46). All localities in Vietnam's territory have signaled the presence in varying degrees of explosive remnants of war, and therefore all projects implemented in the territory of Vietnam are required to carry out this work, unless the land for the project has already been cleared of bombs and mines (Decree 18/2019/ND-CP 46 and Circular 1952019/TT-BQP). At a time when Vietnam's economy is developing rapidly, the cost of discovering and removing explosive remnants of war is tremendous, and requires large infrastructural and industrial projects to prepare for costly clearing operations (Landmine and Cluster Munition Monitor, 2021). The existence of UXO not only inhibits businesses and individuals from using contaminated land, but also discourages the expansion of local economic activity, particularly sizable projects that require large premises.

4.2. Foreign Direct Investment

Since the economic reform in 1986, Vietnam has achieved high economic growth at an average annual rate of around 6.4% for 1986-2020 (WB, 2021a). Also, Vietnam has become an increasingly attractive destination for foreign direct investment since its entrance into the global economy in the early 1990s. Indeed, the importance of foreign investment to the

Vietnamese government was acknowledged in the promulgation of the 1987 Foreign Investment Law. The law has been revised several times since then, in 1990, 1992, 1996, 2000, 2005, 2010 and 2015. Changes were made to expand foreign investors' rights and improve the business climate, spanning from registration procedures and decentralization of investment licensing to land access, trade policy, foreign exchange control, and tax policies (Vo & Nguyen, 2012; WB, 2020).

FDI inflows into Vietnam have increased steadily since 2006. In particular, Vietnam's entrance to the WTO in 2007 improved the country's prospects for growth, resulting in a faster increase in FDI inflows. FDI net inflows increased rapidly, rising from about USD 2.4 billion in 2006 to around USD 9.6 billion in 2008 (Figure 3). Figure 2 also shows how the number of FDI firms has increased over time. Since late 2008, the pace of new FDI registration and the implementation of various FDI projects, particularly large ones, have slowed dramatically, due to the detrimental impact of the global financial crisis and Vietnam's domestic economic downturn. Total FDI net inflows fell even more steeply in 2011, totaling only USD 7.43 billion. Vietnam's FDI net inflows, on the other hand, have been on a long-term rising trend, with some short-term swings. The net inflows of FDI to Vietnam came to USD 16.12 billion in 2019 (Figure 3). Figure 4 shows that FDI firms tend to be concentrated in the Red River Delta and the Southeast and coastal areas. FDI in Vietnam and its capacity for export have emerged as two major contributors to the country's growth and economic development (PWC & VCCI, 2020).

5. Econometrics modeling

In this study, using district-level data we explore the effect of UXO on the density of firms. Firm density is assumed to be a reduced function of UXO and other explanatory variables:

$$Log(Firm_{dpt}) = \beta_0 + Log(UXO_{dp})\beta_1 + X_{dpt}\beta_2 + P_p + T_t + u_{dpt}, \qquad (1)$$

where $Log(Firm_{dpt})$ is the log of the density of firms in district i of province p in year t. We measure firm density by the number of firms within a district divided by the area of the district.[4] For robustness check, we also measure the density of firms by the number of workers and revenue of firms per km2. $Log(UXO_{dp})$ is the log of the current proportion of UXO-contaminated areas in district i of province p. There is no variation in the UXO variable over time. X_{dpt} is the vector of exogenous control variables. P_p represents province dummies, while T_t represents the year dummies and u_{dpt} is the error term. Equation (1) is not a panel data model, since our main variable of interest, $Log(UXO_{dp})$, does not vary over time.

A main problem in estimating the effect of UXO is endogeneity bias. As shown in Figure 1, there is great variation in UXO across districts. As discussed in the previous section, the US bombing in North Vietnam was carried out with the goal of destroying infrastructure, production units, and supply lines to the south, while in South Vietnam, the goal of the US and its South Vietnamese partner was to put an end to communist operations and prevent civilian support for the communists (Dell & Querubin, 2018). As a result, the proportion of UXO-contaminated areas is not random. To address selection bias, we adopt Miguel and Roland's (2011) approach, in which the distance between the center of each district and the 17th parallel north is used as the instrumental variable for UXO density. As shown in Miguel and Roland (2011), this instrumental variable is strongly correlated with bomb density. Since UXO mainly results from bomb density, we expect a strong correlation between the distance

[4] We measure the density of firms within relatively small areas, i.e., districts. Thus we do not use definitions of firm agglomeration, which incorporate variation in industries and geographical clusters within an area (e.g., Ellison & Glaeser, 1997; Ellison & Glaeser, 1999).

to the 17th parallel north and the proportion of UXO-contaminated districts. Thus, the first-stage is expressed as follows:

$$Log(UXO_{dp}) = \alpha_0 + Log(Distance\_17_{dp})\alpha_1 + X_{dpt}\alpha_2 + P_p + T_t + \varepsilon_{dpt}, \qquad (2)$$

where $Log(Distance\_17_{dp})$ is the log of the distance from the centroid of district d of province p to the 17th parallel north. The fact that the 17th parallel was determined arbitrarily as a result of Cold War negotiations between the US and the Soviet Union is a key point in the identification approach (Miguel & Roland, 2011).

There are several points that should be noted with the instrumental variables. Unobserved factors that may be correlated with the instrument can introduce bias into our estimates. A problem is the correlation between the distance to the 17th parallel north and bombing density. The instrumental variable can affect exploded bombs, which also influence firm density. However, Miguel and Roland (2011) show that there are no significant effects from US bombing on local poverty, consumption, infrastructure, literacy, and population density through 2002. Thus, the effect of the instrumental variable on firm density would occur as a result of UXO rather than the destructive effect of bombing. As a robustness check, we also try to estimate Equation (1), controlling for bombing density (see the empirical section). In addition, we conduct a series of robustness analyses, including estimation of imperfect instrument bounds (Conley et al., 2012; Nevo & Rosen, 2012) and heteroskedasticity-based instruments.

Another possible source of concern is the correlation between the instrument and the distance to Vietnam's major metropolitan areas. The 17th latitude is closer to Da Nang and lies between the capital of Vietnam and Ho Chi Minh City, the country's three largest cities. To address this issue, we control for province fixed effects and distance from districts to the nearest town. With a province, the variation in UXO density is expected to be more exogenous. In addition, we control for exogenous variables which can affect firm density (see the next section for discussion of the control variables).

The panel data on districts suggest that the error terms can be correlated within districts over time. Thus, the standard errors should be clustered at the district level (Bertrand et al., 2004). Although we control for province fixed effects, the error terms can still be spatially correlated between districts within a province. We adopt the multiway clustering technique of Cameron, Gelbach, and Miller (2011), which allows us to deal with the correlation of error within a district over time and between districts within a province simultaneously. For sensitivity analysis, we also try a one-way cluster at the district level and find that the results are very similar. For interpretation, we use the results from two-way clustered standard errors.

6. Empirical results

6.1. The first-stage regressions

We start with the first-stage regressions of the log of the proportion of UXO-contaminated areas on the distance from districts to the 17th parallel north and other explanatory variables. We tend to use exogenous control variables, which are not affected by UXO (Angrist & Pischke, 2008; Heckman, Lalonde, & Smith, 1999). The control variables in a so-called small model include district area and elevation, distance to the nearest town and nearest port, annual rainfall and mean temperature, and province and year dummies. Distances to the town and ports are important factors for firms to determine their locations (Gries, Naudé, & Matthee, 2009; Guimaraes, Figueiredo, & Woodward, 2000). As we will show in a later section, our estimates are robust to different model specifications, including models without control variables and large models with additional control variables. The additional control variables in the large models include the proportion of urban population, the percentage of people above 22 with tertiary education, and population density.

Table 1 presents the first-stage regression. We conduct both small and large model specifications. The table shows a strong correlation between the instrument and the level of UXO contamination. Districts which are far from the 17th parallel have a small percentage of UXO-contaminated areas. We also regress bomb density on the instrument. There is a strong negative correlation between the instrument and the log of bombs, missiles, and rockets. The instrument is statistically significant at the 1% level in all regressions. We perform a weak instrument test. The Cragg-Donald Wald F statistic is equal to 198 and 205 for the small and large models, respectively, which are extremely high, indicating that the instrument is very strong (Cragg & Donald, 1993; Kleibergen & Paap, 2006; Staiger & Stock, 1997).[5]

[Table 1 about here]

Another important property of the instrument is the exclusion assumption, i.e., the instrument is not correlated with the error terms conditional on the control variables. Although we cannot test this assumption without another valid instrument, we can examine whether the instrument is correlated with other exogenous variables. In Table 2, we can conduct a balance test, which is recommended by Pei, Pischke, and Schwandt (2019), running a regression of the exogenous variables on the instrument 'the distance from districts to the 17th parallel north.' Column 1 presents the coefficient estimate of 'the distance from districts to the 17th parallel north' in regression of each dependent variable on this instrument. There is only 'the distance from districts to the 17th parallel north' as the single explanatory

[5] As a rule of thumb, if a test is under 10, the instruments might be weak (Staiger and Stock, 1997).

variable. There are 10 regressions corresponding to 10 dependent variables, showing that the instrument is statistically significant at the conventional level in most regressions. In column 2, we control for province fixed effects in regression of the dependent variables on the instrument. The instrument is now insignificant in all the regressions, which suggests that the instrument is more random once the province fixed effects are controlled for. Within the same provinces, the distance from districts to the 17th parallel north is still strongly correlated with UXO but with no other explanatory variables, indicating the validity of the instrumental variable in our study.

[Table 2 about here]

6.2. The effect of UXO on firms

Table 3 presents the instrumental variable regressions of firm density on UXO intensity and other control variables. The results show significant effects from UXO on the density of FDI firms, joint-venture firms and SOEs. Specifically, a 1% increase in the proportion of UXO-contaminated areas leads to a 0.78% relative decrease in the density of the FDI firms within districts. The point estimates for the elasticity of density of joint-venture FDI firms and SOEs relative to the UXO proportion are smaller, and equal to -0.56 and -0.54. The effect of UXO on the density of private firms is positive but not statistically significant. The UXO effect on the density of all firms is not statistically significant. This means that UXO does not reduce the total number of firms within a district, but reduces the number of FDI firms, joint-venture FDI firms, and SOEs.

[Table 3 about here]

In Table 4, we examine the effect of bomb density on firm density. Our argument is that US bombing affects firm density because of UXO. Similar to UXO, bomb density reduces the density of FDI and joint-venture FDI firms, and SOEs. A 1% increase in the number of bombs, missiles, and rockets per km^2 results in a 0.34% relative decrease in the density of FDI firms. A 1% increase in bomb density also reduces the density of joint-venture FDI firms and the density of SOEs by 0.25% and 0.24%, respectively. The elasticity of firm density relative to the bombing is smaller than the elasticity of firm density relative to UXO. This implies that UXO has a direct effect on firm density, while bombing has an indirect effect on firm density through UXO. As we will show in the robustness analysis, the effect of UXO on firm density remains significant when we control for bomb density.

[Table 4 about here]

One issue in our estimation above of the effect of UXO is that we cannot separate this effect and that of exploded ordnance from the US bombing since we have only one instrumental variable ‘distance to the 17th parallel north.’ The US bombing resulted in both exploded and unexploded ordnance. In this study, we argue that US bombing affected the density of FDI firms, joint-venture FDI firms, and SOEs because of UXO. Firstly, there are no long-term effects of US bombing on local economic development in Vietnam before 2000, according to Miguel and Roland (2011). In the case of Laos, US bombing has also had an insignificant effect on economic development in the long term (Yamada and Yamada, 2021). FDI inflow in Laos is very small compared with that in Vietnam. For instance, in 2019 FDI inflow in Vietnam was around 60 times greater than that in Laos (WB, 2021b). Thus, we expect that exploded bombs have no effect on the density of FDI firms and SOEs in Vietnam.

Secondly, we try to estimate the effect of both UXO and US bombing density using the heteroscedasticity-based instrument approach. In addition to the distance to the 17th parallel north, we have to find more instrumental variables for UXO and bombing density. The heteroscedasticity-based approach is developed in several studies (e.g., Klein & Vella, 2010; Lewbel, 2012). With the assumption that exogenous explanatory variables and error terms are heteroskedastic, Lewbel (2012) derives internal instruments.

Specifically, in the first-stage regression we first regress the UXO variable and bombing density on the traditional instrument (i.e., distance to the 17th parallel north), exogenous explanatory variables, X (i.e., district area and elevation, distance to the nearest town and nearest port, annual rainfall and mean temperature), and province and year dummies. Then, the effect of UXO and bombing density on an outcome variable is estimated using 2SLS with the instruments for UXO and bombing density constituted by the distance to the 17th parallel north plus $(X - \bar{X})\varepsilon$, where ε is residuals from the first-stage regression. A condition for instruments $(X - \bar{X})\varepsilon$ is heteroscedasticity in errors in the first stage regression, i.e., $cov(X, \varepsilon^2) \neq 0$, which can be tested using a Breusch-Pagan test. In our study, this test statistic is estimated at 3,619 and 2,809 in regressions of UXO and bombing density, respectively. It indicates strong rejection of the homoscedasticity assumption. The Cragg-Donald Wald F statistic also suggests very strong instruments.

Table 5 presents the results from the heteroscedasticity-based instrument approach. Panel A of the table presents 2SLS regressions which use the instrument 'distance to the 17th parallel north' plus heteroskedasticity-based instruments, while Panel B shows 2SLS regressions which use only the heteroskedasticity-based instruments. Both panels show that the effects of the UXO variable on the density of FDI firms, joint-venture FDI firms, and SOEs are all negative and statistically significant at the 1% and 5% levels. The effect of bombing density on the density of SOEs is statistically significant but only at the 10% level. However, the effect estimates of bombing density on the density of FDI and joint-venture FDI firms is very small and not statistically significant. Thus, these findings confirm the negative effect of UXO on the density of FDI firms, joint-venture FDI firms and SOEs, even controlling for bomb density.

[Table 5 about here]

6.3. Robustness analysis

In this study, we conducted a series of robustness analyses to examine the sensitivity to model specifications of the estimates of the effect of UXO on firm density. We also try to validate the estimates using IV bound methods and a heteroscedasticity-based instrument approach.

First, we examine whether the estimates of the UXO effect are sensitive to different sets of control variables. We investigate the effect of UXO using a model controlling only for province and year fixed effects, without controlling for other explanatory variables. Table A.1 in the Appendix shows that the effect estimates of UXO on the density of FDI and joint-venture firms are very similar to those in Table 3. The estimate of UXO on the density of SOEs is positive but not statistically significant. We then included additional explanatory variables (the percentage of urban population, the number of people 22 and over with tertiary education, and population density). The results from the large models, reported in Table A.2 in the Appendix, are also very similar to those estimated from the small models (in Table 3).

Secondly, we control for province-year fixed effects instead of province fixed effects. Including province-year fixed effects allows for controlling not only for province fixed effects but also province-specific time trends. In our study, since the UXO variable does not vary across years, we do not need to control for province-specific time trends. However, we still try to control for these variables for the robustness check. The results, reported in Table A.3 in the Appendix, are very similar to the main results in Table 3.

Thirdly, we examine whether the estimates are sensitive to different definitions of dependent variables. The dependent variable is the log of the density of firms, which is equal to the number of firms per 100 km2. In Table A.4 in the Appendix, we use the log of the number of firms instead of the log of firm density. The effect estimates of the UXO variable are negative and significant for the log of FDI firms and joint-venture firms. The effect on the log of the number of other firms is not statistically significant.

Fourthly, we use the number of firms per district and the inverse hyperbolic sine transformation as the dependent variables. A problem with the log of firm density or log of the number of firms is that there are no FDI firms or SOEs in several districts, and we have to convert the log of zero to zero. To examine this issue, Table A.5 in the Appendix estimates regressions on the number of firms. It shows a significant negative effect of UXO on the number of FDIs and joint-venture firms but an insignificant effect on the number of SOEs. In addition to these linear variables, we use the inverse hyperbolic sine transformation ($\mathrm{arsinh}(x) = \ln(x + \sqrt{1 + x^2})$), which has a similar interpretation as the log function but can avoid a zero value of the dependent variable.[6] The results are also similar to those using other transformations of the dependent variables (Table A.6 in the Appendix).

Fifthly, we use the number of workers and revenues of firms per km2 as the measurement of firm density. Table A.7 in the Appendix shows the negative effect of UXO on the density of workers of FDI, joint-venture FDI firms, and SOEs. The point estimates of UXO on the density of revenue of firms are all negative but only statistically significant in regressions of the density of revenue of FDI and joint-venture FDI firms.

Sixthly, as mentioned in the data section, the UXO data are measured for the year 2015, while our analysis sample is from the 2000-2017 period. Although UXO has changed little over time (Vietnam Veterans of America Foundation, 2021), we conduct a robustness

[6] Discussion of the arsinh transformation and its application can be found in several studies, such as Pence (2006) and Card and DellaVigna (2020).

check by limiting the sample of firms to 2015-2017, i.e., the period after UXO levels were assessed (Table A.9 in the Appendix). In addition, we try to use a five-year period sample from 2013 to 2017 (Table A.10 in the Appendix). For comparison, we also run the same regression model using the data before 2013 (Table A.11 in the Appendix). In all the samples, the UXO effect on the density of FDI firms, joint-venture FDI firms, and SOEs is negative and statistically significant at conventional levels. The point estimates of the UXO effect using the 2015-2017 sample and the 2013-2017 sample are larger than those using the 2000-2012 sample, but the differences are not statistically significant (according to conventional Hausman tests).

Eighthly, we relinquish the assumption of the exclusion of the instrumental variable and estimate bounds of the UXO effect. We follow Nevo and Rosen's (2012) approach, which drops the zero-covariance assumption between the instrument and error. Under the assumption regarding the sign of the covariance between the instrument and the error term, they derive estimable bounds in the linear IV model. Table A.12 reports these bound estimates and shows that the bounds for the effects on the log of the density of FDI firms, joint-venture FDI firms, and SOEs are all negative, confirming the negative effect of UXO on these outcomes.

Another bound method is suggested by Conley et al. (2012), and allows for some degree of correlation between the instrument and the outcome. Putting it differently, the method allows for the direct effect of the instrument on the outcome even after controlling for the endogenous variable. Following this approach, we first estimate the observed correlation between the dependent variable and the instrument and allow the direct effect of the instrument on the dependent variable to vary within a range from the negative to positive correlation coefficients. In Table A.12 in the Appendix, we use larger ranges, which are equal to two and three times the correlation. All the bounds for the effect on the log of density of FDI firms and joint-venture FDI firms are negative. However, the upper bound for the effect on the log of SOE density is positive.

Finally, instead of using the distance to the 17th parallel north as the instrument for the amount of UXO, we use the heteroscedasticity-based instrument approach, described in the previous section. Table A.13 in the Appendix presents the results of this approach. The Breusch–Pagan test statistics of heteroscedasticity in errors in the first stage regression using the small model specification are estimated at 3432, indicating strong rejection of the homoscedasticity assumption. The P-values of the Hansen J statistic (overidentification test of all IVs) are all larger than 0.1, indicating that the validity of the instruments is not rejected. In both small and large model specifications, the effects of the UXO variable on the density of FDI and joint-venture FDI firms are negative and significant. However, the effect of UXO on the density of SOEs is not statistically significant at conventional levels.

[Table 5 about here]

6.4. Mechanism

In this section, we discuss potential mechanisms through which UXO intensity has reduced the density of firms, especially FDI firms. As discussed in the third section, UXO clearance is a requirement for project investors (according to Decree 18/2019/ND-CP 46). The expense of identifying and removing explosive relics of war is enormous, at a time when Vietnam's economy is rapidly expanding, necessitating huge infrastructure and industrial investments to prepare for costly cleanup operations (Vietnam National Mine Action Centre [VNMAC], 2021)**.** Hence, the cost of discovering and removing explosive remnants is tremendous for FDI firms, since they are often very large and affect a large area.

A recent example is a bomb which was found in Hanoi; hundreds of people had to be evacuated to defuse it (Hải, Huy, & Chính, 2020). If a bomb is found in an industrial zone, the cost of removing it is very great. As a result, industrial zones in general and FDI firms in particular select locations with less UXO-contaminated area. We examine this issue further by estimating the effect of UXO on the density of firms of different sizes, seen in Table 6. It shows that large-scale firms are less likely to be located in districts with higher amounts of UXO. A 1% increase in the proportion of UXO-contaminated area leads to a 0.73% relative decrease in the density of firms with at least 300 workers. For firms with 50-299 workers, this estimate is equal to 0.43 and significant only at the 10% level. The effect of UXO on the density of small firms is positive and not statistically significant. Thus, a plausible explanation for the negative effect of UXO on FDI as well as large-scale firms is that these firms tend to avoid areas with higher amounts of UXO.

[Table 6 about here]

Another channel through which UXO can influence FDI density is its effect on infrastructure. The construction of roads and bridges also requires the clearance of UXO. In addition, bomb density can be associated with public investment during and after the war. It is reasonable to assume that public investment in areas of intense war activity was relatively low during the war years. However, state investment can be greater in these areas in the post-war period. Miguel and Roland (2011) show that in comparison with other regions, heavily bombed areas received 30% more government investment per capita. Thus, bombing does not have a long-term effect on infrastructure.

To validate this result, our study also estimates the effect of UXO on road density and does not find a significant result. In estimating the UXO effect on FDI firms, we tried different models with and without controlling for infrastructure variables and the results are not sensitive to controlling for infrastructure variables. Thus, infrastructure is not a channel through which UXO affects the density of firms.

However, UXO can affect the density of FDI and large-scale firms via the effect on human capital. Singhal (2019) and Palmer et al. (2019) document the long-term negative effect of US bombing on health. Bombing, and the resulting UXO, also affect population density through migration. During the conflict, a large proportion of the Vietnamese population was displaced, and massive migration occurred after the war. People were able to move out of war-affected areas, and as a result these areas are less attractive for FDI investment. However, Miguel and Roland (2011) demonstrate that bombing had no consistent effect on the number of people not born in their current village of residence, and had no effect on population density growth rates from 1985 to 2000. In our study, we regressed on the UXO variable several variables as proxies for human capital, including proportion of urban population, the number of people with tertiary education, and population density. The results, reported in Table A.14 in the Appendix, show an insignificant effect from UXO on these human capital variables.

6.5. The effect of unexploded bombs on local development

In this section, we measure the effect of UXO on local economic development, which is measured by nighttime light during the 1992-2018 period. Table 7 shows the negative effect of UXO on nighttime light. The elasticity of nighttime light with respect to the UXO variable is estimated at -0.46. This means that a 1% increase in the proportion of UXO-contaminated areas leads to a 0.46% relative decrease in light intensity. Our estimates are robust to models which include a large set of control variables (see Table A.15 in the Appendix). We also estimate the UXO effect on nighttime light using bound methods and a heteroscedasticity-based instrument approach. The results, reported in Table A.12 and A.13, confirm the negative effect of UXO on local nighttime light. Our study is consistent with Chiovelli et al. (2018) which show clearance of UXO help improve local economic activities (also measured by nighttime light), especially in populous areas in Mozambique.

In the following, we argue that the negative effect of UXO on local nighttime light can be seen in the reduced number of FDI firms and FDI joint-venture firms. FDI has been found to be positively correlated with local development in Vietnam (e.g., Bui, Nguyen, & Pham, 2019). In Table 6, we split the sample into two periods — 1992-2005, and 2006-2018. FDI inflows into Vietnam have been increasing since 2006 (Figure 3). If UXO affects nighttime light through FDI, we expect the effect on nighttime light to be greater after 2006 than in the previous period. Column 2 of Table 6 shows a small, insignificant effect of UXO on nighttime light in the 1992-2005 period, while column 3 in Table 6 shows a very strong effect from UXO in the 2006-2018 period.

In columns 4 to 6, we estimate the UXO effect on nighttime light, controlling for the density of FDI firms, joint-venture FDI firms and SOEs. The UXO effect on nighttime light is statistically significant only at the 10% level and is smaller than that estimated from the models without controlling for firm density. The regression results also show a strong correlation between FDI firms and nighttime light. Combined, these findings suggest the FDI channel through which UXO hinders local development.

[Table 7 about here]

6.6. Heterogeneous effects

Finally, we explore the heterogeneous effects of UXO on the log of the density of FDI firms by including interactions between the UXO variable and several district characteristics. The instruments for these interactions are interactions between the distance to the 17th parallel north and the interacted characteristics. Tables A.16 and A.17 in the Appendix present the heterogeneous effects of UXO on the log of the density of joint-venture FDI firms and SOEs, respectively. We do not find significant heterogeneous effects of UXO on the density of SOEs. However, there are heterogeneous effects from UXO on the density of FDI and joint venture FDI firms. For interpretation, we use results from the heterogeneous effects of UXO on the log of density of FDI firms. We find a larger effect from UXO intensity in districts with higher road and population density (Table 8). On the other hand, the effect of UXO on FDI density is lower in districts that are far from a province's center. Probably, the cost of clearance of UXO in districts that have a higher density of infrastructure and population and that are close to provincial centers is greater, making firms less likely to locate in these districts.

[Table 8 about here]

7. Conclusions

Understanding the mechanism of the long-term effect of war on development is an important issue not only for policy makers, but also for researchers. In this study, we find that as a legacy of war, UXO has a long-term negative effect on the local development of districts not contaminated by UXO in Vietnam. We find that the negative effect of UXO on FDI and the density of large-scale firms constitutes a new channel through which the war legacy has impeded local development. Our estimation shows that a 1% increase in the proportion of UXO-contaminated areas leads to a 0.78% relative decrease in the density of FDI firms within districts. Point estimates for the elasticity of density of joint-venture FDI firms and SOEs in relation to UXO are smaller, equal to -0.56 and -0.54. Subsequently, a 1% increase in the proportion of UXO-contaminated areas leads to a 0.46% relative decrease in light intensity.

Our study illustrates a mechanism through which wars have had long-term effects on economic development in Vietnam. While Miguel and Roland (2011) find no evidence of long-term effects of US bombing on local poverty rates, consumption levels, or population density in Vietnam 25 years after the end of the Vietnam War, our study reveals that UXO intensity has undermined local economic development (measured by nighttime light) because it has had the effect of reducing the density of FDI and large-scale firms.

To some extent, the differential results between the two studies might be explained in several ways. First, the variables of interest and outcomes in our study are not fully similar to those in Miguel and Roland's (2011) study. Secondly, and more importantly, compared with their study, our investigation covers a later period, after the end of the Vietnam war. Specifically, our study includes the years after 2000, when Vietnam became deeply integrated into the world economy. This is also the period when foreign direct investment has played an increasingly important role in Vietnam's socio-economic development. By contrast, although there is also a serious problem with UXO in Laos (Guo, 2020), there have been no significant long-term effects from US bombing on economic development (Yamada and Yamada, 2021). FDI inflows into Laos are very small compared with those into Vietnam.[7] Thus the negative effect of the war and UXO on FDI is not found in Laos.

[7] In 2019, FDI inflow in Vietnam was around 60 times that in Laos (WB, 2021b).

As previously mentioned, since our empirical strategy compares more heavily bombed as well as more densely UXO-polluted areas with other areas, we are unable to quantify directly the nation-wide consequences of war on Vietnam's economic development. It should be noted that while UXO reduces FDI inflow into given areas, it may not affect total FDI in Vietnam. FDI firms and large-scale firms may simply move from more highly UXO-contaminated areas to less contaminated, though this movement may be associated with higher transaction costs for them. Finally, our findings point to a critical policy issue that must be addressed. At a time when Vietnam's economy is booming, the cost of finding and removing explosive war artifacts is immense, necessitating massive infrastructure investment. The presence of UXO prevents businesses and individuals from accessing contaminated areas, in particular blocking huge projects that need large infrastructure. This in turn discourages the development of local economic activity. From the viewpoint of policy making, more effort and resources should be set aside to speed up the clearance of UXO.

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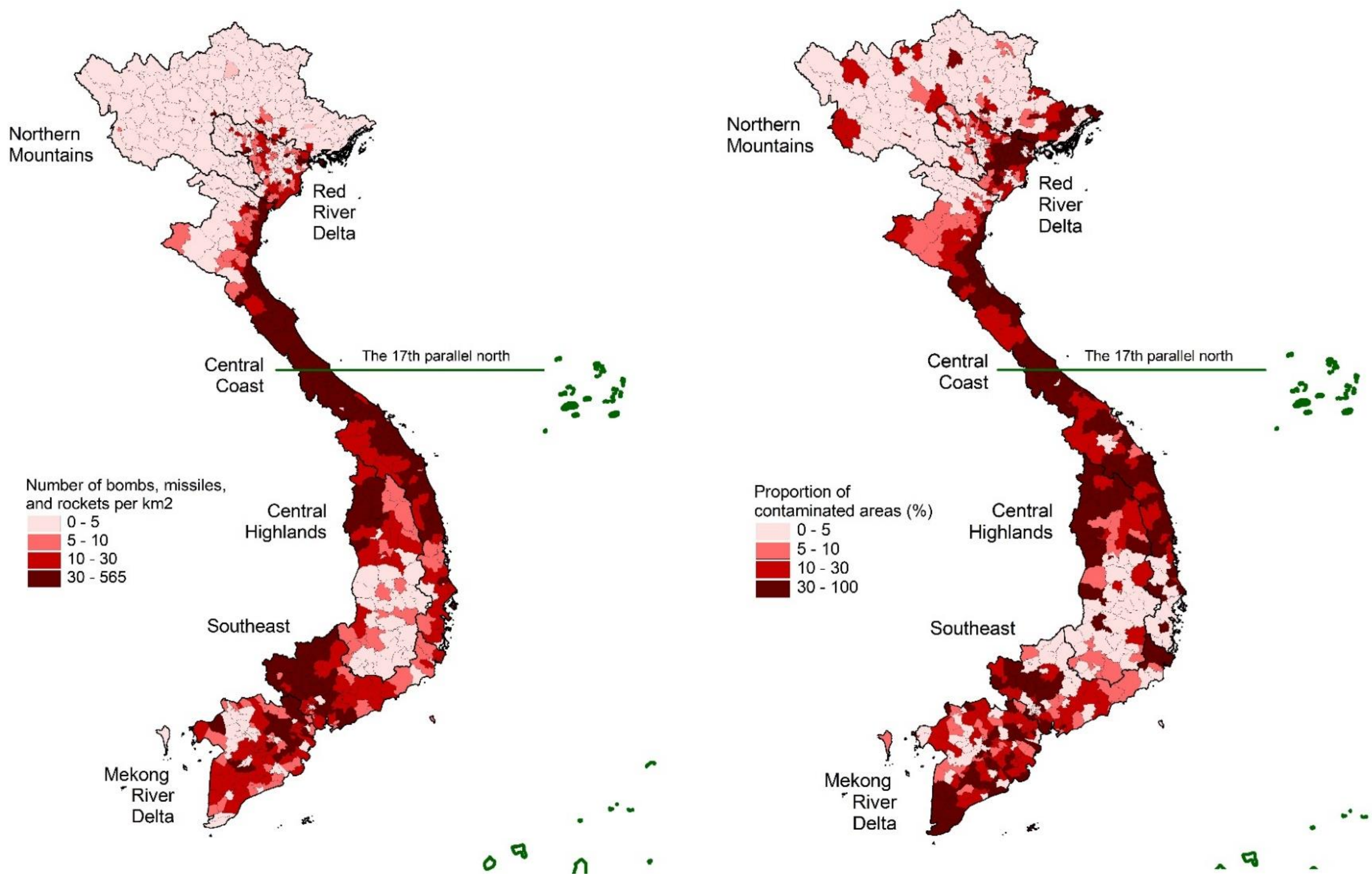
Figures and Tables

Figure 1: Maps of areas with unexploded bombs and bomb intensity

Panel A. Bomb intensity

Panel B. Proportion of contaminated areas

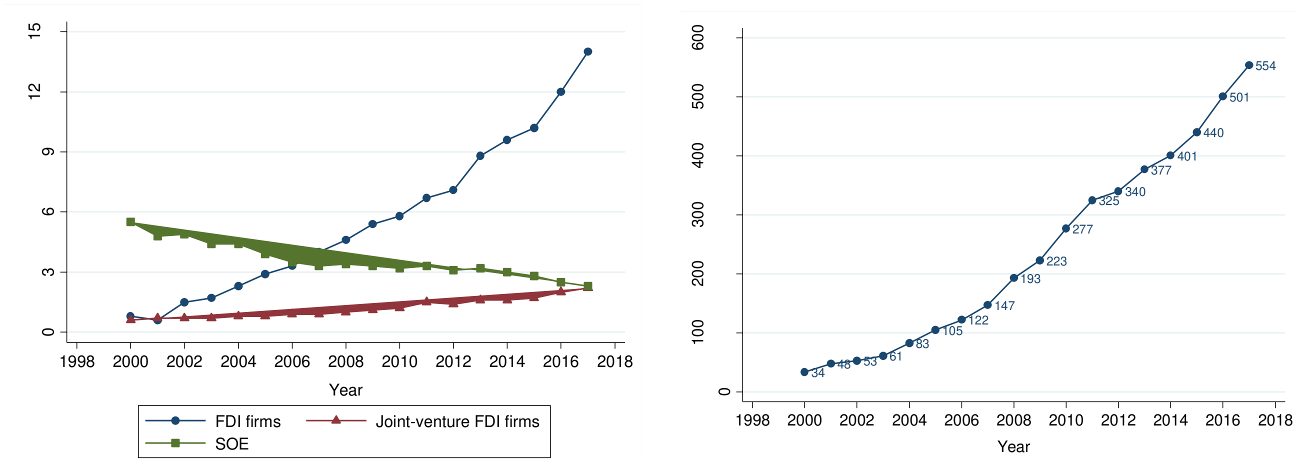


Note: Figure 1 depicts US bombing distribution and intensity (number of bombs, missiles and rockets per km2) and the percentage of UXO-contaminated area at district level in Vietnam. Heavily bombed districts are more likely to be contaminated by UXO. The correlation coefficient between these two variables is estimated at 0.52.

Figure 2. Number of firms over the 2000-2017 period

Panel A. Number of FDI firms, joint-venture firms and SOEs

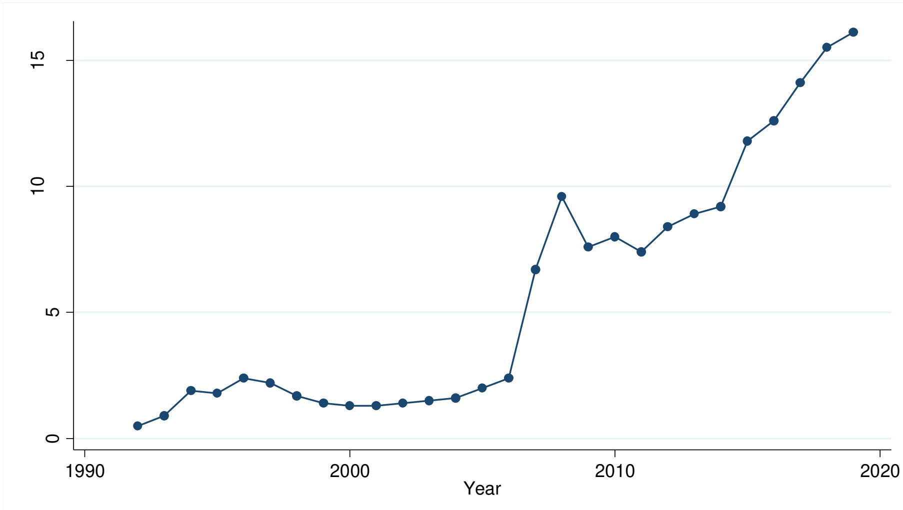
Panel B. Number of private (domestic) firms



Note: Figure 2 presents the number of firms over the 2000-2017 period. The number of FDI firms increases over time.

Source: Authors' estimation using the Vietnam Enterprise Censuses 2000-2017.

Figure 3: FDI net inflows into Vietnam (billion, current USD)



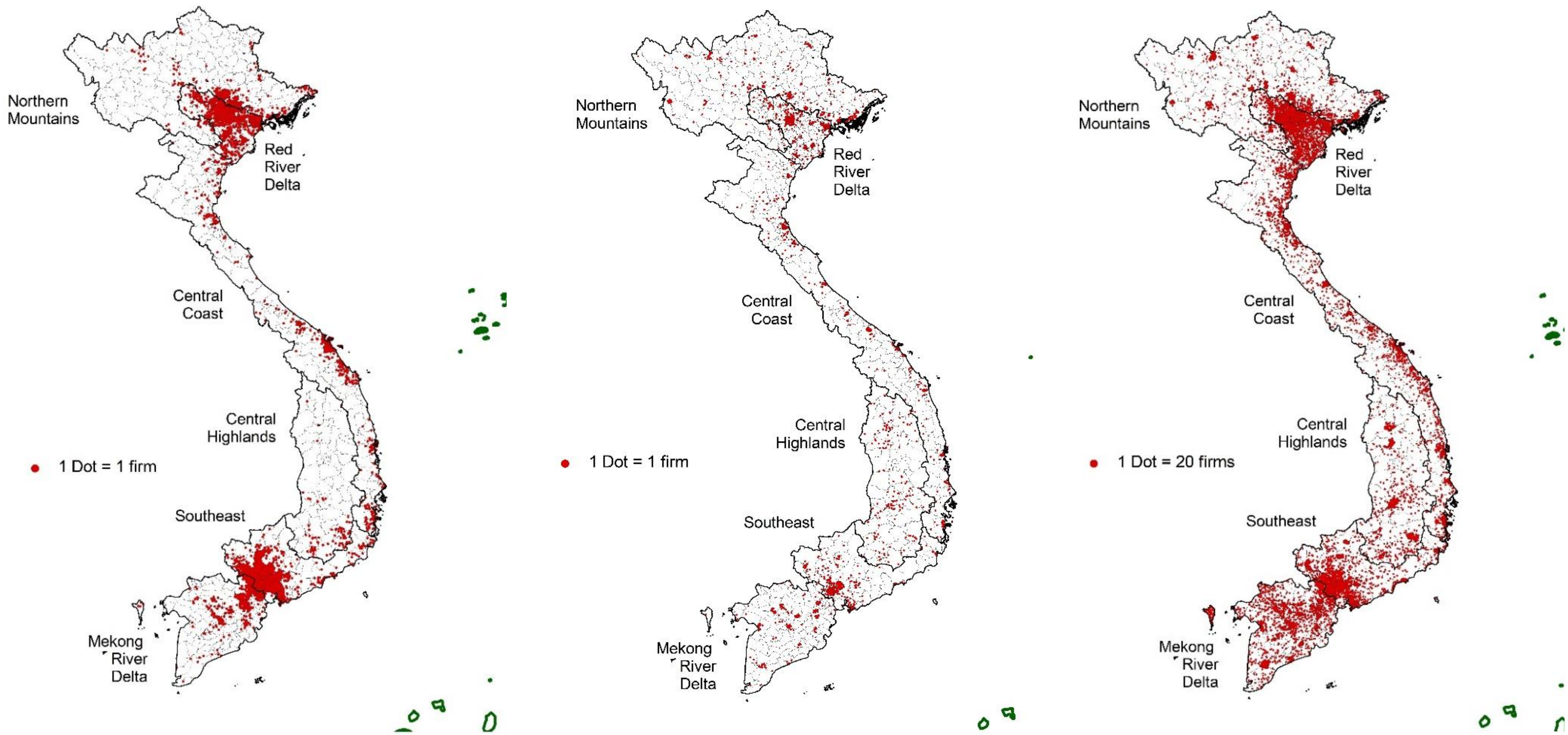
Source: Authors' graph using data from the World Bank (2020)

Figure 4. Density of firms in 2017

Panel A. FDI firms

Panel B. Stated-owned enterprises

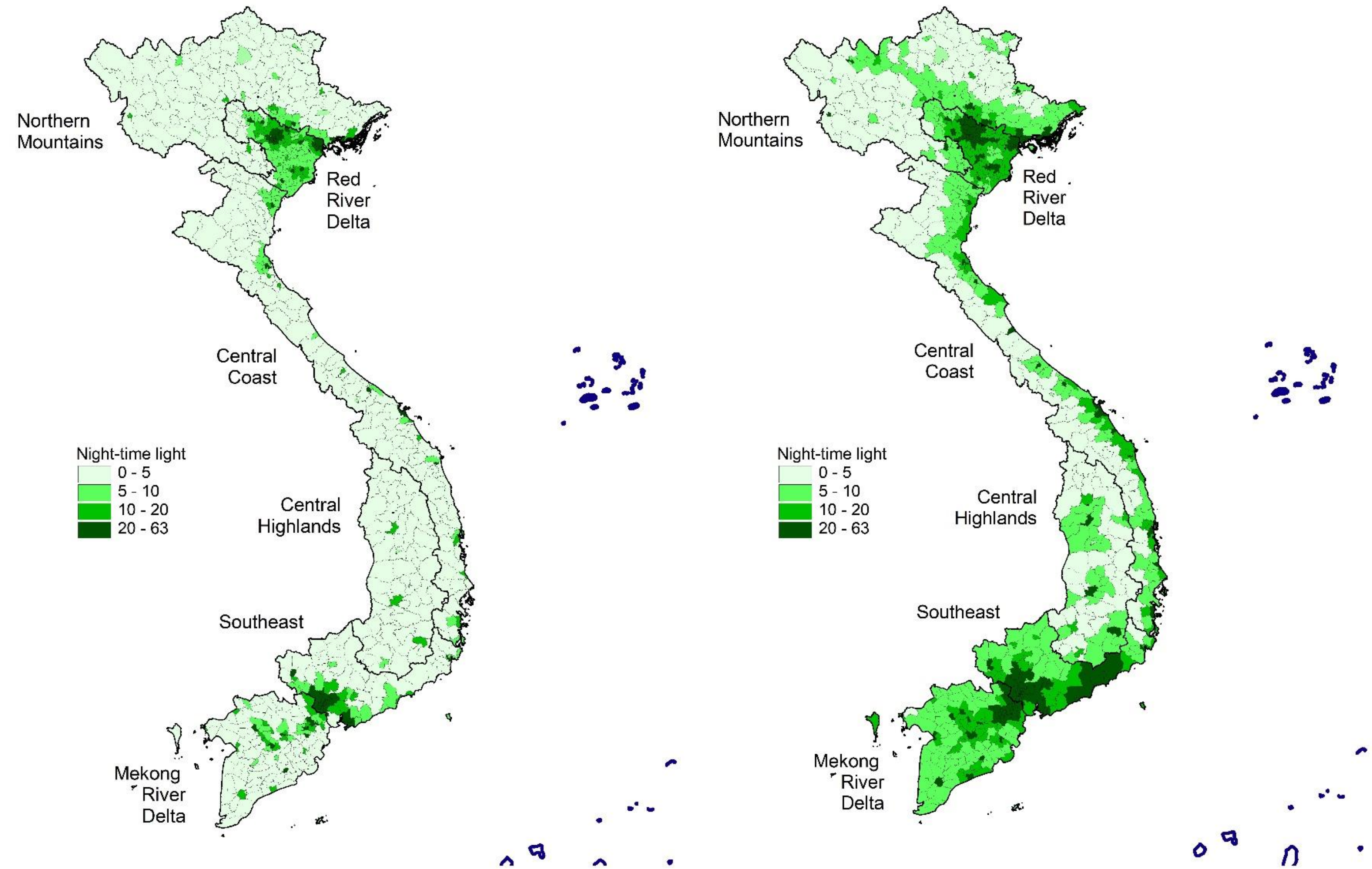
Panel C. Private firms



Note: These figures indicate the number of firms in districts of Vietnam in 2017. In this figure, FDI firms and joint-venture FDI firms are combined and shown in Panel A. Panels B and C show SOEs and private firms, respectively. We know the districts to which firms are allocated, but not the coordinates of firms. The ArcGIS software randomly assigns firms within a district.

Figure 5. Nighttime light maps

Panel A. Year 2005 Panel B. Year 2017



Note: This figure presents the yearly average nighttime light of districts for 2005 and 2017. Nighttime light varies from 0 to 63, a higher value indicating a higher density of light.

Table 1. First-stage regressions

Explanatory variables	Log of proportion of area with UXO		Log of bombs, missiles, rockets per km2	
	Small model	Large model	Small model	Large model
	(1)	(2)	(3)	(4)
Distance to the 17th parallel north latitude	-0.0060***	-0.0059***	-0.0136***	-0.0136***
	(0.0018)	(0.0018)	(0.0025)	(0.0025)
Log of district areas	0.0802	-0.1515	0.0197	0.0354
	(0.0948)	(0.1192)	(0.1185)	(0.1532)
Log of mean elevation	-0.1244*	-0.1052	-0.1612	-0.1388
	(0.0736)	(0.0816)	(0.1016)	(0.1090)
Log of distance to the provincial town	-0.0130	-0.1514	-0.2866**	-0.2797*
	(0.0814)	(0.0928)	(0.1285)	(0.1538)
Log of distance to the nearest port	-0.0571	-0.0763	0.0212	0.0234
	(0.0522)	(0.0477)	(0.0650)	(0.0646)
Log of annual rainfall	-0.0111	-0.0086	-0.0035	-0.0037
	(0.0081)	(0.0080)	(0.0100)	(0.0100)
Log of mean temperature	0.1742	0.2201	0.5578***	0.5399***
	(0.1405)	(0.1367)	(0.1813)	(0.1845)
Log of road density		0.1897		-0.0524
		(0.1155)		(0.1541)
Proportion of urban population		-0.0096**		-0.0014
		(0.0039)		(0.0055)
Proportion of people with tertiary education		0.0215		-0.0005
		(0.0249)		(0.0474)
Log of population density		-0.2469**		0.0817
		(0.0990)		(0.1120)
Province fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Constant	2.3434	4.4399	2.0732	1.9988
	(3.6413)	(3.9481)	(4.6802)	(4.9776)
Observations	10,776	10,776	10,776	10,776
R-squared	0.602	0.614	0.692	0.693
Weak identification test (Cragg-Donald Wald F statistic)	191.7	205.4	505.3	571.3

Note: This table presents the first-stage regression of the log of the amount of UXO-contaminated area and the log of bombs, missiles, rockets per km2 on the instrumental variable ‘Distance to the 17th parallel’ and other control variables.
Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table 2. Instrumental variables balancing test

Dependent variables	Model 1: Without province fixed effects	Model 2: With province fixed effects
	(1)	(2)
Log of district areas	-0.0009***	0.0006
	(0.0002)	(0.0016)
Log of mean elevation	-0.0032***	0.0004
	(0.0004)	(0.0020)
Log of distance to the provincial town	-0.0006***	0.0022
	(0.0002)	(0.0014)
Log of distance to the nearest port	0.0015***	0.0017
	(0.0003)	(0.0027)
Log of annual rainfall	-0.0016***	0.0042
	(0.0004)	(0.0031)
Log of mean temperature	-0.0015***	-0.0008
	(0.0003)	(0.0008)
Proportion of urban population	0.0004***	-0.0005
	(0.0001)	(0.0012)
Proportion of people with tertiary education	-0.0041	-0.0229
	(0.0049)	(0.0364)
Log of population density	0.0013*	-0.0031
	(0.0007)	(0.0047)
Log of road density	0.0015***	-0.0013
	(0.0003)	(0.0022)

Note: This table presents an estimate of the instrument 'distance from districts to the 17th parallel north' in regressions of dependent variables on this instrument. The 'distance from districts to the 17th parallel north' is the single explanatory variable. In each column, there are 10 regressions corresponding to 10 dependent variables.
Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table 3. IV regressions of density of firms on UXO

Explanatory variables	Dependent variables				
	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of areas with UXO	-0.7836**	-0.5650***	-0.5426**	0.0996	0.1690
	(0.3123)	(0.2174)	(0.2679)	(0.2374)	(0.2401)
Log of district areas	-0.5910***	-0.5938***	-1.1298***	-1.2269***	-1.2289***
	(0.0904)	(0.0724)	(0.0696)	(0.0603)	(0.0618)
Log of mean elevation	0.1061	0.0999*	0.1844***	0.0165	0.0231
	(0.0736)	(0.0512)	(0.0600)	(0.0629)	(0.0642)
Log of distance to the provincial town	-0.2719***	-0.0964	-0.7141***	-0.6854***	-0.6996***
	(0.0890)	(0.0704)	(0.0665)	(0.0632)	(0.0637)
Log of distance to the nearest port	-0.1148**	-0.0496	-0.0493	-0.1084**	-0.1032**
	(0.0545)	(0.0415)	(0.0454)	(0.0423)	(0.0434)
Log of annual rainfall	-0.0172	-0.0142*	-0.0011	0.0128*	0.0134*
	(0.0110)	(0.0074)	(0.0083)	(0.0074)	(0.0075)
Log of mean temperature	0.1872	0.0420	-0.0063	0.2219**	0.2462**
	(0.1582)	(0.1044)	(0.1188)	(0.1071)	(0.1104)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	4.8818	5.2297**	15.9980***	13.5491***	13.2017***
	(3.4640)	(2.3374)	(2.7363)	(2.4827)	(2.5466)
Observations	10,776	10,776	10,776	10,776	10,776

Note: This table presents the instrumental variable regressions of firm density on the amount of UXO and other control variables. The instrumental variable for the amount of UXO is 'the distance from districts to the 17th parallel north.'
Robust standard errors in parentheses. Standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table 4. IV regressions of the density of firms on bomb intensity

Explanatory variables	Dependent variables				
	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of bombs, missiles, rockets per km2	-0.3462***	-0.2496***	-0.2397**	0.0440	0.0747
	(0.1135)	(0.0826)	(0.1064)	(0.1028)	(0.1022)
Log of district areas	-0.6470***	-0.6342***	-1.1685***	-1.2198***	-1.2168***
	(0.0757)	(0.0695)	(0.0571)	(0.0545)	(0.0545)
Log of mean elevation	0.1478**	0.1300***	0.2133***	0.0112	0.0141
	(0.0629)	(0.0484)	(0.0463)	(0.0565)	(0.0570)
Log of distance to the provincial town	-0.3610***	-0.1606**	-0.7758***	-0.6741***	-0.6804***
	(0.0914)	(0.0754)	(0.0775)	(0.0708)	(0.0702)
Log of distance to the nearest port	-0.0627	-0.0121	-0.0132	-0.1150***	-0.1144***
	(0.0459)	(0.0373)	(0.0403)	(0.0387)	(0.0390)
Log of annual rainfall	-0.0097	-0.0087	0.0041	0.0119*	0.0117*
	(0.0088)	(0.0064)	(0.0072)	(0.0066)	(0.0067)
Log of mean temperature	0.2438*	0.0828	0.0329	0.2147*	0.2340**
	(0.1388)	(0.0932)	(0.1141)	(0.1140)	(0.1154)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	3.7633	4.4232**	15.2234***	13.6913***	13.4430***
	(3.0746)	(2.1215)	(2.5380)	(2.5440)	(2.5810)
Observations	10,776	10,776	10,776	10,776	10,776

Note: This table presents the instrumental variable regressions of firm density on bombing density and other control variables. The instrumental variable for bombing density is 'the distance from districts to the 17th parallel north.'
Robust standard errors in parentheses. Standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table 5: 2SLS regressions using heteroskedasticity-based instruments

Explanatory variables	Panel A. Instruments include the distance to the 17th parallel north and heteroskedasticity-based instruments			Panel B. Instruments include heteroskedasticity-based instruments		
	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs
	(1)	(2)	(3)	(4)	(5)	(6)
Log of proportion of area with UXO	-0.3702***	-0.5841***	-0.3789***	-0.3425**	-0.6140***	-0.3474***
	(0.1396)	(0.1482)	(0.1347)	(0.1454)	(0.1628)	(0.1265)
Log of bombs, missiles, rockets per km2	-0.0442	-0.0210	0.1087*	-0.0249	-0.0419	0.1035*
	(0.0855)	(0.0805)	(0.0651)	(0.0964)	(0.0950)	(0.0603)
Log of district areas	-0.6262***	-0.5913***	-1.1488***	-0.6294***	-0.5877***	-1.1514***
	(0.0727)	(0.0716)	(0.0561)	(0.0730)	(0.0735)	(0.0551)
Log of mean elevation	0.1483***	0.0946*	0.2196***	0.1544***	0.0880	0.2225***
	(0.0550)	(0.0526)	(0.0481)	(0.0550)	(0.0570)	(0.0474)
Log of distance to the provincial town	-0.2727***	-0.1040	-0.6723***	-0.2654***	-0.1120	-0.6730***
	(0.0804)	(0.0781)	(0.0635)	(0.0822)	(0.0807)	(0.0634)
Log of distance to the nearest port	-0.0891*	-0.0505	-0.0408	-0.0877*	-0.0520	-0.0388
	(0.0465)	(0.0393)	(0.0467)	(0.0469)	(0.0399)	(0.0464)
Log of annual rainfall	-0.0123	-0.0146**	0.0017	-0.0118	-0.0151**	0.0021
	(0.0088)	(0.0072)	(0.0068)	(0.0087)	(0.0074)	(0.0067)
Log of mean temperature	0.1327	0.0585	-0.1048	0.1154	0.0772	-0.1079
	(0.1208)	(0.1052)	(0.1074)	(0.1220)	(0.1142)	(0.1059)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	5.3986**	5.0219**	17.212***	5.6114**	4.7915*	17.239***
	(2.7541)	(2.3886)	(2.5896)	(2.7139)	(2.5022)	(2.5560)
Weak identification test (Cragg-Donald Wald F statistic)	54.37	54.37	54.37	53.73	53.73	53.73
Observations	10,776	10,776	10,776	10,776	10,776	10,776

Note: This table presents 2SLS regressions using heteroskedasticity-based instruments. Panel A presents the 2SLS regressions which use the instrument 'distance to the 17th parallel north' plus heteroskedasticity-based instruments, while Panel B reports the 2SLS regressions which use only heteroskedasticity-based instruments.
Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table 6. IV regressions of density of firms of different sizes on UXO

Explanatory variables	Dependent variables		
	Log of density of small firms (1-49 workers)	Log of density of medium firm (50-299 workers)	Log of density of large firms (300+ workers)
	(1)	(2)	(3)
Log of proportion of area with UXO	0.0876	-0.4317*	-0.7279**
	(0.2307)	(0.2453)	(0.2993)
Log of district areas	-1.2253***	-1.1591***	-1.0437***
	(0.0591)	(0.0763)	(0.0936)
Log of mean elevation	0.0124	0.0716	0.0652
	(0.0614)	(0.0629)	(0.0775)
Log of distance to the provincial town	-0.6694***	-0.8211***	-0.6609***
	(0.0618)	(0.0712)	(0.0791)
Log of distance to the nearest port	-0.1054**	-0.1407***	-0.1354***
	(0.0413)	(0.0398)	(0.0477)
Log of annual rainfall	0.0131*	-0.0064	-0.0090
	(0.0072)	(0.0086)	(0.0094)
Log of mean temperature	0.2101*	0.2694**	0.1608
	(0.1077)	(0.1144)	(0.1433)
Province fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Constant	13.5685***	12.9399***	12.8307***
	(2.4982)	(2.6140)	(3.2111)
Observations	10,776	10,776	10,776

Note: This table presents the instrumental variable regressions of firm density on the amount of UXO and other control variables for different samples of firms with different labor scales. The instrumental variable for the amount of UXO is 'the distance from districts to the 17th parallel north.'
Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table 7. IV regressions of nighttime light on UXO

Explanatory variables	Dependent variable is log of nighttime light intensity					
	Panel A. Models without controlling for firm density			Panel B. Models controlling for firm density		
	Sample 1992-2018	Sample 1992-2005	Sample 2006-2018	Sample 1992-2018	Sample 1992-2005	Sample 2006-2018
	(1)	(2)	(3)	(4)	(5)	(6)
Log of proportion of area with UXO	-0.464**	-0.241	-0.695***	-0.286*	-0.015	-0.396*
	(0.188)	(0.147)	(0.266)	(0.170)	(0.143)	(0.204)
Log of district areas	-0.636***	-0.627***	-0.645***	-0.366***	-0.312***	-0.388***
	(0.065)	(0.073)	(0.087)	(0.053)	(0.044)	(0.065)
Log of mean elevation	0.101**	0.144***	0.053	0.035	0.053	0.025
	(0.045)	(0.041)	(0.066)	(0.038)	(0.038)	(0.046)
Log of distance to the provincial town	-0.411***	-0.267***	-0.567***	-0.369***	-0.232***	-0.427***
	(0.056)	(0.049)	(0.077)	(0.050)	(0.042)	(0.060)
Log of distance to the nearest port	-0.086**	-0.029	-0.146***	-0.077**	-0.028	-0.100**
	(0.037)	(0.036)	(0.050)	(0.032)	(0.026)	(0.039)
Log of annual rainfall	-0.013**	0.004	-0.025**	-0.011**	0.005	-0.018**
	(0.006)	(0.005)	(0.011)	(0.005)	(0.004)	(0.008)
Log of mean temperature	0.059	0.002	0.113	0.025	-0.051	0.048
	(0.094)	(0.069)	(0.133)	(0.073)	(0.058)	(0.087)
Log of density of FDI firms				0.233***	0.235***	0.239***
				(0.022)	(0.034)	(0.028)
Log of density of joint-venture FDI firms				0.135***	0.246***	0.071
				(0.050)	(0.038)	(0.067)
Log of density of SOEs				0.074***	0.105***	0.067***
				(0.017)	(0.018)	(0.021)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	9.276***	7.756***	12.790***	8.148***	6.921***	9.779***
	(2.078)	(1.562)	(2.945)	(1.587)	(1.235)	(1.950)
Observations	16,497	8,554	7,943	10,758	3,455	7,303

Note: This table presents the instrumental variable regressions of nighttime light on the amount of UXO and other control variables. The instrumental variable for the amount of UXO is 'the distance from districts to the 17th parallel north.'
Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table 8. Heterogeneous effects of UXO on the log of density of FDI firms (2SLS regressions)

Explanatory variables	Log of density of FDI firms							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of proportion of area with UXO	-3.4379*	-2.3992*	2.8442*	-2.4412	-5.4922**	-0.5658*	-0.5545**	0.2513
	(2.0877)	(1.4274)	(1.6766)	(1.7955)	(2.3138)	(0.3232)	(0.2747)	(0.5493)
Log of district areas * Log of proportion of area with UXO	0.4052							
	(0.2843)							
Log of mean elevation * Log of proportion of area with UXO		0.2022						
		(0.1448)						
Log of road density * Log of proportion of area with UXO			-0.5433**					
			(0.2623)					
Log of distance to the nearest port * Log of proportion of area with UXO				0.2729				
				(0.2707)				
Log of distance to the provincial town * Log of proportion of area with UXO					0.3611**			
					(0.1644)			
Proportion of urban population * Log of proportion of area with UXO						-0.0215		
						(0.0225)		
Proportion of people with tertiary education * Log of proportion of area with UXO							-0.0801	
							(0.0516)	
Log of population density * Log of proportion of area with UXO								-0.2368*
								(0.1295)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.3138	5.2455	-9.4469*	8.2446	8.5986	-3.7020	-0.6878	-2.4424
	(5.1121)	(6.3487)	(5.3915)	(9.1300)	(6.0389)	(5.8434)	(3.6217)	(4.4430)
Observations	10,776	10,776	10,776	10,776	10,776	10,776	10,776	10,776

Note: This table presents the heterogeneous effects of UXO on the log of density of FDI firms by including interactions between the UXO variable and several district characteristics in 2SLS regressions. The instruments for these interactions are interactions between the distance to the 17th parallel north and the interacted characteristics. Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Appendix

Table A.1. IV regressions of firm density on UXO without control variables

Explanatory variables	Log of density of FDI firms	Log of density of joint-venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.6427**	-0.5113***	-0.3210	0.3472	0.4217
	(0.2730)	(0.1931)	(0.2451)	(0.2660)	(0.2754)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	6.1760***	5.2126***	9.4660***	11.7521***	11.8987***
	(0.5960)	(0.5140)	(0.4448)	(0.4381)	(0.4506)
Observations	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.2. IV regressions of firm density on UXO with additional variables

Explanatory variables	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.7560***	-0.5344***	-0.5063**	0.1202	0.1920
	(0.2850)	(0.1982)	(0.2361)	(0.1717)	(0.1737)
Log of district areas	-0.4498***	-0.4535***	-0.7026***	-0.4036***	-0.3920***
	(0.1146)	(0.0892)	(0.0921)	(0.0836)	(0.0832)
Log of mean elevation	-0.0024	0.0249	0.0099	-0.0046	-0.0043
	(0.0716)	(0.0485)	(0.0570)	(0.0483)	(0.0486)
Log of distance to the provincial town	-0.0732	0.1085	-0.4131***	-0.3293***	-0.3308***
	(0.1050)	(0.0803)	(0.0881)	(0.0631)	(0.0640)
Log of distance to the nearest port	-0.1383**	-0.0691	-0.0403	-0.0449*	-0.0387
	(0.0575)	(0.0447)	(0.0383)	(0.0267)	(0.0268)
Log of annual rainfall	-0.0197**	-0.0167**	-0.0058	0.0050	0.0053
	(0.0100)	(0.0068)	(0.0073)	(0.0057)	(0.0058)
Log of mean temperature	0.2567*	0.0816	0.0332	0.0839	0.1075
	(0.1535)	(0.1009)	(0.1091)	(0.0863)	(0.0890)
Log of road density	0.2675**	0.1041	0.2584**	0.0818	0.0636
	(0.1259)	(0.0852)	(0.1064)	(0.0895)	(0.0920)
Proportion of urban population	-0.0065	-0.0062*	0.0118***	0.0134***	0.0146***
	(0.0047)	(0.0033)	(0.0037)	(0.0024)	(0.0025)
Proportion of people with tertiary education	0.1577***	0.1362***	0.0988***	0.0409***	0.0386***
	(0.0258)	(0.0208)	(0.0262)	(0.0102)	(0.0105)
Log of population density	-0.2023*	-0.0673	-0.0832	0.6526***	0.6594***
	(0.1197)	(0.0785)	(0.0985)	(0.0924)	(0.0925)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	-0.9572	0.1852	7.7935***	2.0959	1.6492
	(3.3251)	(2.2761)	(2.6539)	(1.9589)	(1.9957)
Observations	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.3. IV regressions of firm density on UXO with province-year fixed effects

Explanatory variables	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.7863**	-0.5593***	-0.5390**	0.0887	0.1603
	(0.3126)	(0.2159)	(0.2669)	(0.2370)	(0.2395)
Log of district areas	-0.5901***	-0.5941***	-1.1276***	-1.2298***	-1.2319***
	(0.0907)	(0.0722)	(0.0693)	(0.0597)	(0.0612)
Log of mean elevation	0.1054	0.0999*	0.1838***	0.0153	0.0221
	(0.0740)	(0.0510)	(0.0597)	(0.0627)	(0.0640)
Log of distance to the provincial town	-0.2690***	-0.0942	-0.7153***	-0.6811***	-0.6952***
	(0.0892)	(0.0701)	(0.0663)	(0.0628)	(0.0632)
Log of distance to the nearest port	-0.1153**	-0.0493	-0.0491	-0.1091***	-0.1038**
	(0.0546)	(0.0415)	(0.0454)	(0.0422)	(0.0432)
Log of annual rainfall	-0.0111	-0.0137	-0.0055	0.0069	0.0099
	(0.0129)	(0.0092)	(0.0098)	(0.0089)	(0.0090)
Log of mean temperature	0.1905	0.0427	-0.0044	0.2272**	0.2512**
	(0.1590)	(0.1041)	(0.1191)	(0.1072)	(0.1103)
Province-year fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	3.7584	4.8385**	16.4320***	12.8773***	12.5887***
	(3.4476)	(2.3060)	(2.7260)	(2.4736)	(2.5358)
Observations	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.4. IV regressions of log of number of firms on UXO

Explanatory variables	Dependent variables				
	Log of the number of FDI firms	Log of the number of joint venture firms	Log of the number of SOEs	Log of the number of private firms	Log of the number of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.5669**	-0.3575**	-0.1160	0.1596	0.1709
	(0.2514)	(0.1477)	(0.1941)	(0.2426)	(0.2400)
Log of district areas	-0.0763	-0.1365***	-0.2923***	-0.2342***	-0.2290***
	(0.0795)	(0.0499)	(0.0493)	(0.0619)	(0.0618)
Log of mean elevation	0.0229	0.0523	0.2299***	0.0116	0.0239
	(0.0651)	(0.0370)	(0.0433)	(0.0644)	(0.0641)
Log of distance to the provincial town	-0.3396***	-0.1565***	-0.8102***	-0.6866***	-0.7001***
	(0.0747)	(0.0467)	(0.0560)	(0.0641)	(0.0636)
Log of distance to the nearest port	-0.1681***	-0.1333***	-0.0583	-0.1056**	-0.1033**
	(0.0441)	(0.0310)	(0.0465)	(0.0433)	(0.0434)
Log of annual rainfall	-0.0136	-0.0022	-0.0019	0.0161**	0.0134*
	(0.0091)	(0.0050)	(0.0063)	(0.0078)	(0.0075)
Log of mean temperature	0.2231	0.0864	0.1145	0.2394**	0.2464**
	(0.1400)	(0.0748)	(0.0837)	(0.1122)	(0.1105)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	2.5431	2.8888*	9.7986***	8.4402***	8.5934***
	(3.0913)	(1.6547)	(1.9543)	(2.5898)	(2.5481)
Observations	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.5. IV regressions of log of the number of firms on UXO (linear model)

Explanatory variables	Dependent variables				
	Number of FDI firms	Number of joint venture firms	Number of SOEs	Number of private firms	Number of all firms
	(1)	(2)	(3)	(4)	(5)
Log of bombs, missiles, rockets per km2	-0.7919**	-0.1003**	-0.1328	-3.4699	-3.7030
	(0.3578)	(0.0512)	(0.1299)	(5.9766)	(6.0938)
Log of district areas	-3.1432	-1.5117***	-4.2492***	-235.6097***	-241.3705***
	(2.2641)	(0.4745)	(1.0370)	(64.7211)	(65.6503)
Log of mean elevation	0.9581	0.9990**	2.4143***	110.8852***	114.2984***
	(2.0169)	(0.4702)	(0.7345)	(39.9395)	(40.3826)
Log of distance to the provincial town	-5.2308*	-1.6860*	-7.9361***	-234.8904***	-244.5126***
	(3.1769)	(0.8706)	(1.0029)	(42.4411)	(43.6614)
Log of distance to the nearest port	-4.0158*	-0.6025*	-0.9740	-40.3563	-41.9328
	(2.4350)	(0.3235)	(0.6693)	(45.3195)	(46.0966)
Log of annual rainfall	-0.2675	0.0025	-0.0096	-1.1484	-1.1555
	(0.2143)	(0.0358)	(0.1197)	(5.4086)	(5.4516)
Log of mean temperature	2.9032	0.0243	-0.7972	-1.7157	-2.4886
	(2.4328)	(0.3435)	(0.7727)	(41.2123)	(42.0067)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	58.0217	34.3285***	152.2623***	4,790.559***	4,977.150***
	(60.048)	(10.868)	(23.6004)	(1,194.58)	(1,214.95)
Observations	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.6. IV regressions of log of the number of firms on UXO (linear model)

Explanatory variables	Asinh of density of FDI firms	Asinh of density of joint venture FDI firms	Asinh of density of SOEs	Asinh of density of private firms	Asinh of density of all firms
	Dependent variables				
	(1)	(2)	(3)	(4)	(5)
Asinh of proportion of area with UXO	-0.5672**	-0.3969**	-0.0443	0.1567	0.1496
	(0.2556)	(0.1761)	(0.2068)	(0.2187)	(0.2141)
Log of district areas	-0.0815	-0.1497**	-0.2884***	-0.2403***	-0.2333***
	(0.0921)	(0.0620)	(0.0570)	(0.0646)	(0.0637)
Log of mean elevation	0.0217	0.0848*	0.2748***	0.0108	0.0244
	(0.0740)	(0.0487)	(0.0516)	(0.0637)	(0.0628)
Log of distance to the provincial town	-0.4393***	-0.2795***	-0.9021***	-0.6880***	-0.7010***
	(0.0830)	(0.0571)	(0.0638)	(0.0638)	(0.0629)
Log of distance to the nearest port	-0.1975***	-0.1876***	-0.0653	-0.1058**	-0.1046**
	(0.0462)	(0.0366)	(0.0497)	(0.0430)	(0.0427)
Log of annual rainfall	-0.0146	0.0024	-0.0030	0.0166**	0.0130*
	(0.0100)	(0.0063)	(0.0071)	(0.0079)	(0.0074)
Log of mean temperature	0.2842*	0.1364	0.1642	0.2434**	0.2407**
	(0.1642)	(0.1017)	(0.1018)	(0.1166)	(0.1119)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	2.2301	3.7234	10.4597***	7.3212**	7.7798***
	(3.9568)	(2.4621)	(2.5516)	(2.9205)	(2.8003)
Observations	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.7. IV regressions of density of workers on UXO

Explanatory variables	Log of density of workers of FDI firms	Log of density of workers of joint venture FDI firms	Log of density of workers of SOEs	Log of density of workers of private firms	Log of density of workers of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.5344***	-0.5799**	-0.2925*	-0.0650	-0.0628
	(0.2062)	(0.2292)	(0.1559)	(0.0503)	(0.0513)
Log of district areas	-0.5637***	-0.5316***	-0.8544***	-0.9833***	-0.9836***
	(0.0680)	(0.0671)	(0.0510)	(0.0120)	(0.0119)
Log of mean elevation	0.0783	0.1404**	0.1384***	-0.0029	-0.0030
	(0.0503)	(0.0561)	(0.0432)	(0.0100)	(0.0102)
Log of distance to the province town	-0.3120***	-0.3182***	-0.3893***	-0.0801***	-0.0874***
	(0.0648)	(0.0731)	(0.0488)	(0.0102)	(0.0102)
Log of distance to the nearest port	-0.0900***	-0.1342***	-0.0209	-0.0089	-0.0128**
	(0.0343)	(0.0438)	(0.0244)	(0.0058)	(0.0065)
Log of annual rainfall	-0.0101	-0.0027	-0.0032	0.0004	0.0005
	(0.0070)	(0.0073)	(0.0045)	(0.0015)	(0.0014)
Log of mean temperature	0.1201	0.1100	0.0592	0.0379	0.0356
	(0.1009)	(0.1047)	(0.0693)	(0.0235)	(0.0236)
Province fixed-effects	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
Constant	6.2933***	6.5818***	9.3129***	7.2576***	7.5093***
	(2.2481)	(2.3565)	(1.5562)	(0.5309)	(0.5330)
Observations	10,776	10,776	10,776	10,776	10,776

Note: Density of workers of a firm type such as FDI firms is computed by the total number of workers of the firm type within a district divided by area of the district.
Robust standard errors in parentheses. The standard errors are clustered as the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.8. IV regressions of density of revenue on UXO

Explanatory variables	Log of density of revenue of FDI firms	Log of density of revenue of joint venture FDI firms	Log of density of revenue of SOEs	Log of density of revenue of private firms	Log of density of revenue of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.4293**	-0.4381**	-0.2124	-0.0956	-0.1073
	(0.1695)	(0.1716)	(0.1297)	(0.0805)	(0.0807)
Log of district areas	-0.5028***	-0.4906***	-0.7782***	-0.9020***	-0.9073***
	(0.0566)	(0.0564)	(0.0409)	(0.0199)	(0.0199)
Log of mean elevation	0.0874**	0.1271***	0.1464***	0.0284*	0.0229
	(0.0403)	(0.0411)	(0.0318)	(0.0159)	(0.0163)
Log of distance to the province town	-0.2491***	-0.2178***	-0.3330***	-0.1287***	-0.1347***
	(0.0541)	(0.0585)	(0.0402)	(0.0173)	(0.0175)
Log of distance to the nearest port	-0.0519*	-0.0746**	-0.0029	-0.0115	-0.0134
	(0.0276)	(0.0324)	(0.0205)	(0.0093)	(0.0092)
Log of annual rainfall	-0.0077	-0.0039	-0.0025	-0.0027	-0.0031
	(0.0057)	(0.0056)	(0.0037)	(0.0022)	(0.0022)
Log of mean temperature	0.0724	0.0586	-0.0183	-0.0116	-0.0026
	(0.0817)	(0.0777)	(0.0589)	(0.0419)	(0.0418)
Province fixed-effects	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
Constant	5.5601***	5.4545***	9.3988***	8.0710***	8.1305***
	(1.8095)	(1.7564)	(1.3481)	(0.9438)	(0.9371)
Observations	10,776	10,776	10,776	10,776	10,776

Note: Density of revenue of a firm type such as FDI firms is computed by the total number of revenue of the firm type within a district divided by area of the district.
Robust standard errors in parentheses. The standard errors are clustered as the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.9. IV regressions of firm density on UXO using the 2015-2017 sample

Explanatory variables	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-1.0592**	-0.5561**	-0.7528**	0.1218	0.1276
	(0.4952)	(0.2546)	(0.3478)	(0.2250)	(0.2249)
Log of district areas	-0.7135***	-0.6579***	-1.0084***	-1.1848***	-1.1843***
	(0.1348)	(0.0944)	(0.0950)	(0.0654)	(0.0656)
Log of mean elevation	0.0621	0.1246**	0.1446*	0.0391	0.0415
	(0.1126)	(0.0612)	(0.0766)	(0.0679)	(0.0680)
Log of distance to the provincial town	-0.4153***	-0.1288	-0.6142***	-0.7295***	-0.7321***
	(0.1295)	(0.0805)	(0.0793)	(0.0644)	(0.0644)
Log of distance to the nearest port	-0.1804**	-0.0745	-0.0447	-0.1298***	-0.1298***
	(0.0773)	(0.0459)	(0.0485)	(0.0373)	(0.0373)
Log of annual rainfall	-0.0002	-0.0111	-0.0029	-0.0005	-0.0007
	(0.0689)	(0.0377)	(0.0301)	(0.0254)	(0.0254)
Log of mean temperature	0.3201	0.0194	-0.0818	0.3211***	0.3200***
	(0.2694)	(0.1212)	(0.1847)	(0.1116)	(0.1109)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	6.0823	6.8586**	16.0110***	14.5792***	14.6210***
	(5.7727)	(2.7695)	(4.2197)	(2.6467)	(2.6282)
Observations	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.10. IV regressions of the firm density on UXO using the 2013-2017 sample

Explanatory variables	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.9640**	-0.5928**	-0.6202**	0.1327	0.1391
	(0.4209)	(0.2433)	(0.3021)	(0.2248)	(0.2245)
Log of district areas	-0.7100***	-0.6386***	-1.0571***	-1.1917***	-1.1914***
	(0.1163)	(0.0820)	(0.0788)	(0.0674)	(0.0674)
Log of mean elevation	0.0794	0.1081*	0.1799***	0.0409	0.0438
	(0.0991)	(0.0588)	(0.0659)	(0.0661)	(0.0661)
Log of distance to the provincial town	-0.3667***	-0.1278*	-0.6266***	-0.7160***	-0.7190***
	(0.1170)	(0.0771)	(0.0717)	(0.0665)	(0.0664)
Log of distance to the nearest port	-0.1777***	-0.0670	-0.0537	-0.1260***	-0.1260***
	(0.0653)	(0.0444)	(0.0460)	(0.0385)	(0.0385)
Log of annual rainfall	-0.0064	-0.0105	0.0007	-0.0005	-0.0007
	(0.0595)	(0.0321)	(0.0254)	(0.0219)	(0.0220)
Log of mean temperature	0.2299	-0.0102	-0.1329	0.3002***	0.3008***
	(0.2198)	(0.1154)	(0.1447)	(0.1086)	(0.1079)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	7.2895	7.4330***	17.2748***	14.8291***	14.8320***
	(4.8245)	(2.6127)	(3.3241)	(2.5490)	(2.5302)
Observations	3,672	3,672	3,672	3,672	3,672

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.11. IV regressions of firm density on UXO using the 2000-2012 sample

Explanatory variables	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of density of private firms	Log of density of all firms
	(1)	(2)	(3)	(4)	(5)
Log of proportion of area with UXO	-0.6926**	-0.5611**	-0.4872*	0.0836	0.1818
	(0.2855)	(0.2240)	(0.2731)	(0.2530)	(0.2565)
Log of district areas	-0.5451***	-0.5774***	-1.1646***	-1.2433***	-1.2463***
	(0.0857)	(0.0755)	(0.0685)	(0.0594)	(0.0615)
Log of mean elevation	0.1218*	0.0948*	0.1901***	0.0062	0.0148
	(0.0662)	(0.0518)	(0.0606)	(0.0636)	(0.0656)
Log of distance to the provincial town	-0.2279***	-0.0813	-0.7496***	-0.6709***	-0.6898***
	(0.0813)	(0.0715)	(0.0664)	(0.0639)	(0.0648)
Log of distance to the nearest port	-0.0888	-0.0421	-0.0470	-0.1012**	-0.0936**
	(0.0550)	(0.0438)	(0.0475)	(0.0452)	(0.0469)
Log of annual rainfall	-0.0112	-0.0135	-0.0012	0.0123	0.0142
	(0.0104)	(0.0084)	(0.0091)	(0.0084)	(0.0086)
Log of mean temperature	0.1577	0.0601	0.0390	0.1892*	0.2224*
	(0.1424)	(0.1072)	(0.1176)	(0.1134)	(0.1180)
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Constant	4.2295	4.4332*	15.4877***	14.1092***	13.5472***
	(3.0961)	(2.3772)	(2.6987)	(2.6038)	(2.6954)
Observations	7,716	7,716	7,716	7,716	7,716

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.12. Bound estimates of the effect of log of proportion of UXO-contaminated area on log of density of FDI firms

Outcomes/estimators	Lower Bound	Upper Bound
Log of density of FDI firms		
Nevo and Rosen (2012)'s Imperfect IV bounds	-0.7836	-0.1010
Conley et al (2012)'s UCI results		
gmin(-0.0006) gmax(0.0006)	-1.5132	-0.1327
gmin(-0.0012) gmax(0.0012)	-1.6568	-0.0666
gmin(-0.0018) gmax(0.0018)	-1.7780	-0.0081
Log of density of joint venture FDI firms		
Nevo and Rosen (2012)'s Imperfect IV bounds	-0.5650	-0.1337
Conley et al (2012)'s UCI results		
gmin(-0.0004) gmax(0.0004)	-1.0729	-0.1034
gmin(-0.0008) gmax(0.0008)	-1.1658	-0.0559
gmin(-0.0012) gmax(0.0012)	-1.2605	-0.0052
Log of density of SOEs		
Nevo and Rosen (2012)'s Imperfect IV bounds	-0.5426	-0.0761
Conley et al (2012)'s UCI results		
gmin(-0.0008) gmax(0.0008)	-1.2213	0.0639
gmin(-0.0016) gmax(0.0016)	-1.3979	0.1720
gmin(-0.0024) gmax(0.0024)	-1.5797	0.2918
Night-time light		
Nevo and Rosen (2012)'s Imperfect IV bounds	-0.2310	-0.0475
Conley et al (2012)'s UCI results		
gmin(-0.07) gmax(0.07)	-0.4253	-0.0412
gmin(-0.14) gmax(0.14)	-0.4336	-0.0374
gmin(-0.21) gmax(0.21)	-0.4419	-0.0335

Note: This table reports the bounds of IV estimates, adopting the approach outlined by Nevo and Rosen (2012) and Conley et al. (2012).

Table A.13. 2SLS regressions using heteroskedasticity-based instruments

Explanatory variables	Panel A. Small models				Panel B. Large models			
	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of night-time light intensity	Log of density of FDI firms	Log of density of joint venture FDI firms	Log of density of SOEs	Log of night-time light intensity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of proportion of area with UXO	-0.4242**	-0.6949***	-0.0924	-0.4214***	-0.3082**	-0.5893***	-0.0433	-0.1804***
	(0.2003)	(0.2249)	(0.1236)	(0.0451)	(0.1492)	(0.1896)	(0.1088)	(0.0234)
Log of district areas	-0.6231***	-0.5822***	-1.1700***	-0.6398***	-0.3859***	-0.4613***	-0.6366***	-0.3038***
	(0.0731)	(0.0764)	(0.0520)	(0.0141)	(0.0896)	(0.0960)	(0.0709)	(0.0171)
Log of mean elevation	0.1484**	0.0846	0.2374***	0.1060***	0.0415	0.0196	0.0553	0.0402***
	(0.0594)	(0.0622)	(0.0453)	(0.0115)	(0.0567)	(0.0532)	(0.0391)	(0.0098)
Log of distance to the provincial town	-0.2598***	-0.1008	-0.6989***	-0.4097***	0.0051	0.0989	-0.3323***	-0.1580***
	(0.0751)	(0.0743)	(0.0590)	(0.0137)	(0.0767)	(0.0827)	(0.0667)	(0.0137)
Log of distance to the nearest port	-0.0930*	-0.0575	-0.0220	-0.0836***	-0.1027**	-0.0735*	-0.0035	-0.0632***
	(0.0475)	(0.0428)	(0.0461)	(0.0093)	(0.0452)	(0.0433)	(0.0320)	(0.0081)
Log of annual rainfall	-0.0127	-0.0158*	0.0046	-0.0121***	-0.0152*	-0.0173**	-0.0011	-0.0140***
	(0.0092)	(0.0081)	(0.0064)	(0.0024)	(0.0081)	(0.0069)	(0.0056)	(0.0020)
Log of mean temperature	0.1163	0.0676	-0.0950	0.0498**	0.1481	0.0949	-0.0791	0.0043
	(0.1102)	(0.1076)	(0.0966)	(0.0194)	(0.1034)	(0.0961)	(0.0892)	(0.0165)
Log of road density					0.1795**	0.1148	0.1674**	0.1739***
					(0.0854)	(0.0853)	(0.0834)	(0.0171)
Proportion of urban population					-0.0022	-0.0067*	0.0162***	0.0034***
					(0.0034)	(0.0036)	(0.0026)	(0.0006)
Proportion of people with tertiary education					0.1484***	0.1373***	0.0891***	0.0975***
					(0.0194)	(0.0215)	(0.0209)	(0.0032)
Log of population density					-0.0909	-0.0810	0.0319	0.0637***
					(0.0851)	(0.0882)	(0.0699)	(0.0145)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	5.7584*	6.3947**	18.4540***	9.3822***	-0.9928	0.1896	7.7567***	2.9296***
	(3.0572)	(2.8878)	(2.6415)	(0.4557)	(2.5719)	(2.4070)	(2.1943)	(0.4354)
Weak identification test (Cragg-Donald Wald F statistic)	76.52	76.52	76.52	108.95	79.50	79.50	79.50	184.07
Observations	10,776	10,776	10,776	16,497	10,776	10,776	10,776	16,497

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.14. IV regressions of several outcomes on UXO

Explanatory variables	Panel A. Small models				Panel B. Large models			
	Log of road density	Proportion of urban population	Proportion of people with tertiary education	Log of population density	Log of road density	Proportion of urban population	Proportion of people with tertiary education	Log of population density
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of proportion of area with UXO	0.0631	-2.0593	-0.4440	0.0019				
	(0.1797)	(4.4800)	(0.6565)	(0.1482)				
Log of bombs, missiles, rockets per km2					0.0287	-0.9371	-0.2020	0.0009
					(0.0802)	(2.0251)	(0.2815)	(0.0674)
Log of district areas	-0.4071***	-16.8651***	-1.8393***	-0.7336***	-0.4024***	-17.0186***	-1.8724***	-0.7335***
	(0.0615)	(1.6356)	(0.6731)	(0.0723)	(0.0579)	(1.6709)	(0.6813)	(0.0684)
Log of mean elevation	-0.0325	7.3766***	0.8371***	-0.1707***	-0.0356	7.4767***	0.8587***	-0.1708***
	(0.0443)	(1.1623)	(0.2584)	(0.0530)	(0.0395)	(1.1369)	(0.2692)	(0.0509)
Log of distance to the provincial town	0.1684**	-11.7061***	-2.2930***	-0.1895***	0.1756***	-11.9413***	-2.3437***	-0.1893***
	(0.0679)	(1.1881)	(0.1965)	(0.0465)	(0.0663)	(1.2916)	(0.2389)	(0.0530)
Log of distance to the nearest port	-0.0555*	-0.9849	0.0989	-0.0789**	-0.0597***	-0.8474	0.1285	-0.0791***
	(0.0290)	(1.1124)	(0.1144)	(0.0355)	(0.0221)	(1.0794)	(0.1155)	(0.0301)
Log of annual rainfall	-0.1714	5.6050	0.4950	-0.2165*	-0.1785*	5.8356	0.5447	-0.2167*
	(0.1077)	(4.1994)	(0.3382)	(0.1258)	(0.1081)	(4.0888)	(0.3678)	(0.1258)
Log of mean temperature	0.0396	-0.3195	-0.1801	0.2468**	0.0343	-0.1437	-0.1422	0.2467**
	(0.1286)	(2.1292)	(0.3427)	(0.0995)	(0.1393)	(2.3005)	(0.3453)	(0.1054)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	8.3316**	164.1535***	41.1401***	11.0570***	8.5003**	158.6430**	39.9520***	11.0621***
	(3.3846)	(60.8042)	(8.5254)	(2.9160)	(3.6241)	(61.9440)	(8.3881)	(3.0018)
Observations	612	612	612	612	612	612	612	612

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A.15. IV regressions of nighttime light on UXO using large model

Explanatory variables	Dependent variable is log of nighttime light intensity		
	Sample 1992-2018	Sample 1992-2005	Sample 2006-2018
	(1)	(2)	(3)
Log of proportion of area with UXO	-0.433***	-0.201	-0.673***
	(0.168)	(0.125)	(0.253)
Log of district areas	-0.341***	-0.278***	-0.412***
	(0.076)	(0.069)	(0.113)
Log of mean elevation	0.017	0.078*	-0.049
	(0.043)	(0.040)	(0.067)
Log of distance to the provincial town	-0.204***	0.005	-0.429***
	(0.067)	(0.054)	(0.099)
Log of distance to the nearest port	-0.083**	-0.025	-0.145***
	(0.036)	(0.033)	(0.053)
Log of annual rainfall	-0.016***	-0.000	-0.026**
	(0.005)	(0.004)	(0.010)
Log of mean temperature	0.069	-0.014	0.153
	(0.087)	(0.064)	(0.129)
Log of road density	0.221***	0.086	0.362***
	(0.076)	(0.060)	(0.117)
Proportion of urban population	0.001	-0.000	0.002
	(0.003)	(0.003)	(0.005)
Proportion of people with tertiary education	0.102***	0.113***	0.090***
	(0.017)	(0.014)	(0.024)
Log of population density	0.002	0.145**	-0.152
	(0.072)	(0.068)	(0.104)
Province fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Constant	2.873	0.645	7.222**
	(2.000)	(1.451)	(3.018)
Observations	16,497	8,554	7,943

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.16. Heterogeneous effects of UXO on the log of density of joint-venture FDI firms

Explanatory variables	Log of density of joint-venture FDI firms							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of proportion of area with UXO	-2.9918*	-2.0988*	2.7307*	-2.4384	-4.6830***	-0.3421	-0.3214	0.5231
	(1.6152)	(1.1184)	(1.4147)	(1.7646)	(1.8038)	(0.2675)	(0.2066)	(0.4778)
Log of district areas * Log of proportion of area with UXO	0.3713*							
	(0.2236)							
Log of mean elevation * Log of proportion of area with UXO		0.1925*						
		(0.1128)						
Log of road density * Log of proportion of area with UXO			-0.4927**					
			(0.2177)					
Log of distance to the nearest port * Log of proportion of area with UXO				0.3084				
				(0.2713)				
Log of distance to the provincial town * Log of proportion of area with UXO					0.3163**			
					(0.1303)			
Proportion of urban population * Log of proportion of area with UXO						-0.0217		
						(0.0198)		
Proportion of people with tertiary education * Log of proportion of area with UXO							-0.0847*	
							(0.0445)	
Log of population density * Log of proportion of area with UXO								-0.2485**
								(0.1100)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.0987	6.0904	-7.5142*	10.5818	8.5556*	-2.5893	0.4700	-1.3740
	(3.9063)	(5.0440)	(4.4780)	(8.9588)	(4.6658)	(4.8638)	(2.7214)	(3.4502)
Observations	10,776	10,776	10,776	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.17. Heterogeneous effects of UXO on the log of density of SOEs

Explanatory variables	Log of density of SOEs							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of proportion of area with UXO	-0.2923	-1.0511	-0.7090	-1.3117	-0.3058	-0.4605**	-0.5698***	-0.5424
	(1.2405)	(0.9600)	(1.4363)	(1.5374)	(1.5153)	(0.2330)	(0.2115)	(0.3514)
Log of district areas * Log of proportion of area with UXO	-0.0323							
	(0.1696)							
Log of mean elevation * Log of proportion of area with UXO		0.0670						
		(0.0994)						
Log of road density * Log of proportion of area with UXO			0.0306					
			(0.2195)					
Log of distance to the nearest port * Log of proportion of area with UXO				0.1305				
				(0.2348)				
Log of distance to the provincial town * Log of proportion of area with UXO					-0.0153			
					(0.1078)			
Proportion of urban population * Log of proportion of area with UXO						-0.0052		
						(0.0150)		
Proportion of people with tertiary education * Log of proportion of area with UXO							0.0252	
							(0.0274)	
Log of population density * Log of proportion of area with UXO								0.0085
								(0.0782)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	7.4528**	9.8502**	8.2717*	12.1917	7.3891*	7.1326**	7.7086***	7.8468***
	(3.2425)	(4.3298)	(4.2528)	(8.2100)	(3.9566)	(3.5985)	(2.6165)	(2.6547)
Observations	10,776	10,776	10,776	10,776	10,776	10,776	10,776	10,776

Robust standard errors in parentheses. The standard errors are clustered at the district and year-province levels.
*** p<0.01, ** p<0.05, * p<0.1.