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Abstract

This paper analyzes the effects of the Chilean land reform (1962-1973) on the intensity of the current indigenous self-determination conflict (1990-2016). The Mapuche were actively involved in the land reform process, and at least 150,000 hectares were expropriated in their favor. Nevertheless, the counter-reform process, after the 1973 military coup, almost fully reverted these expropriations. This failed land reform potentially created local grievances that may explain some aspects of the current social and political conflict in the region. To test this hypothesis, a unique geocoded plot-level database for the Araucania Region has been assembled. The results from OLS estimates suggest that plots involved in the land reform are more likely to be invaded and attacked. The effect is larger for plots located around indigenous reservations and those in which there was direct Mapuche participation during the land reform. To deal with potential endogeneity problems, we implement an instrumental variable identification strategy based on historical rainfall in the region. The IV estimates mostly confirm the main results. We show that the development of intensive forestry plantations after the land reform is a potential channel for explaining our results.

JEL codes: Q15, D74, N46, O13.
Keywords: Land reform, conflict, indigenous people, Chile.

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1 Introduction

A bulk of studies have provided evidence on the negative effects of violent conflicts on economic development (Blattman and Miguel, 2010; Ray and Esteban, 2017). However, even less violent and non-violent conflicts can have important effects on social and economic outcomes (Chenoweth et al., 2011; Chenoweth and Cunningham, 2013; Dippel, 2014). This is why understanding the origins of conflicts is important as a way to inform policies supporting the process of peace-building and post-conflict recovery. Following the literature on long-term determinants of economic development (Acemoglu et al., 2001; Nunn, 2009; Spolaore and Wacziarg, 2013), recent studies have focused on the historical determination of current conflicts (Besley and Reynal-Querol, 2014; Michalopoulos and Papaioannou, 2016; Fenske and Kala, 2017).

This paper studies how the the historical process of forced private-property formation in the Mapuche indigenous territories affects the intensity of the current self-determination conflict in Chile. A large Mapuche territory was *de facto* independent until the Chilean invasion that ended in 1883. Afterward, their communal land was divided into plots and distributed among new private owners. The Mapuche were confined to small and dispersed reservations, called *Títulos de Merced* (henceforth TDMs), retaining less than 10% of their original territory. Our focus is on the effects of the Chilean land reform (1962-1973), a more recent policy that attempted to reverse the inequalities and grievances of the original land distribution.

Extant literature is divided in terms of the expected effects of land reforms on conflicts. On the one hand, the government can expropriate large landholders and provide land to landless peasants as a way to avoid expected conflict. In this case, the goal is to reduce land distribution inequality and increase the opportunity cost of a revolt (Huntington, 1968; Grossman, 1994; Acemoglu and Robinson, 2006). On the other hand, land reform may be perceived as a decrease in the probability that large landholders will retain their land when the property is contested, therefore increasing the probability of a conflict (Horowitz, 1993; Albertus, 2015; Kapstein, 2017). Empirical studies provide support for these confronting hypotheses depending on the settings in which reforms are implemented (Albertus and Kaplan, 2013; Albertus et al., 2018; Albertus, 2019; Castaneda and Pfutze, 2019).

A different explanation is that land reforms can fail, either because the reform is perceived as unfair by the targeted beneficiaries or because a new government reverts the process. In both cases, conflict may be even more intense than in the absence of the reform (Hidalgo et al., 2010; Domenech and Herreros, 2017; Lopez-Uribe and Sanchez, 2017). In this paper, we study the case of a failed land reform. At least 150,000 hectares were expropriated in favor of the Mapuche in the last years of the Chilean land reform, but virtually all the land was quickly, and sometimes violently, taken back and returned to the original owners or re-distributed during the counter-reform process implemented after the military coup of 1973.

The failed Chilean land reform likely created new local grievances that may explain the intensity of the current social and political conflict. We study the case of the Araucania region, the poorest of the country.[1] This is the area where most TDMs were granted,

[1]The Araucania is a large region, roughly the size of Belgium.

where the Mapuche were most directly involved in the land reform, and also where the current conflict is more intense. This conflict is characterized by relatively low levels of casualties but high levels of property destruction, disruptions of social order, and other relevant effects, particularly in rural areas (Pairicán, 2014; Cayul et al., forthcoming).[2] We focus on the conflict phase 1990-2016, starting with the return of democracy and becoming increasingly more violent in the latest years (Cayul et al., forthcoming). Recent literature describes this as a self-determination conflict. Despite beign one of the most common kinds of conflicts in the world, evidence exists mostly for the most violent self-determination conflicts (Sambanis et al., 2018; Cunningham et al., 2019).

A unique geocoded plot-level database for the region was assembled. Based on the census on the rural property of Araucania (2013), we identified the plots involved in the land reform before the 1973 coup that still exist (around 70% of the original plots). For those plots, we have a rich set of information from different sources (Cuesta et al., 2017). We then used two criteria to select the sub-set of plots where the Mapuche were involved in the land reform: (i) The plot-level data by Correa et al. (2005) based on historical records and ethnographic work in the region and (ii) geocoded data on whether a 2013 plot overlaps with a TDM. The main outcome variable, a proxy for conflict, was taken from a geocoded version of the recently available MACEDA database (Cayul et al., forthcoming). We identified specific plots involved in conflict events, such as land invasions and attacks, between 1990 and 2016.

The results from OLS regressions suggest that plots involved in the land reform are more likely to be invaded and attacked. This effect is larger for plots located around TDMs and those in which there was direct Mapuche participation during the land reform. Nevertheless, these descriptive results are likely biased. Even though we control for a rich set of plot characteristics, several confounding factors can explain the relationship between the current conflict and land reform. For instance, the land reform could have taken place in areas where the Mapuche-Chilean war of the nineteenth century was more violent. We can only imperfectly control for these kinds of confounding factors. To address this issue, we implement an instrumental variable (IV) strategy. Following previous studies, such as Dell (2012) and Lopez-Uribe and Sanchez (2017), we use historical data to create a plot-level variable measuring deviations of rainfall from historical means. In particular, we combine a weather shock with a political shock for our instrument. The surprising election of president Salvador Allende at the end of the (Southern hemisphere) winter of 1970, with a Socialist reform agenda, unleashing a large increase in land invasions in the subsequent months (Correa et al., 2005; González and Vial, 2019). We show that 1970 rainfall strongly correlates with these plot invasions, likely due to the productivity shock spring rain has on wheat crops. More importantly, we provide evidence that the instrument strongly predicts the participation of a plot in the land reform. However, it is unlikely that this instrument is correlated with current outcomes, except through the participation of a plot in the land reform forty years ago. Placebo results show that spring rainfall (and rainfall in any other season) during the decade before and after 1970 does not predict expropriations. The LATE estimates from the IV regressions mostly confirm the main result. Complier plots, i.e. plots that were expropriated because of the productivity shock, are more involved in current conflict events. One caveat is that the instrument is not strong to estimate the heterogeneous

[2]This conflict is not included in the usual international databases, such as UCDP (Gleditsch et al., 2002), because the number of casualties is below the thresholds used as definition of violent conflict.

effect on plots where the Mapuche were involved during the land reform. These results are robust to different definitions of conflict, samples of plots of different sizes, and other changes in the main specification.

We then explore possible mechanisms that may explain the results. First, we confirm that the land reform failed to provide land to the Mapuche since the plots involved in the reform are not more likely be part of an indigenous community or have a Mapuche owner. We find evidence that the structure of current economic activities in the region is a possible channel to explain the results. One of the main targets of the Mapuche political violence are forestry plantations. Those companies started their operations mostly after the land counter-reform, receiving subsidies and other benefits from the military regime (Carruthers and Rodriguez, 2009; Molina, 2012). Many large-scale logging activities are located within the limits of TDMs and other areas claimed by the Mapuche. We show suggestive evidence that plots expropriated in the 1970s are more likely to currently have forestry activities.

The rest of the paper is organized as follows. The next section presents the background and context. In section 3, we present the data, and in section 4 the main results. A last section provides a brief conclusion.

2 Background and context

The Mapuche are the historical indigenous inhabitants of South-Central Chile. Nowadays, they are a relevant group in Chilean society, representing almost 80% of the indigenous population in Chile and about 10% of the Chilean population (around 1.7 million according to the 2017 Census). Many currently live in urban areas (around one-third of them in the capital city Santiago), but a large rural Mapuche population remains in the southern regions of the country. In the area we study, the Araucania region, there are around 170,000 rural Mapuche (this is two-thirds of the total rural population of the region), most of them organized in nearly 2,000 indigenous communities (2017 National Census). This rural population is among the poorest in Chile (Cerda, 2009; Agostini et al., 2010) and in recent years have been involved in an increasingly violent social and political conflict (Pairicán, 2014; Cayul et al., forthcoming).

The historical Mapuche territory, ca. 5 million hectares, was incorporated under the effective Chilean sovereignty in a series of military occupations and confrontations between 1860 and 1883 (Pinto, 2003; Bengoa, 2000). Before this occupation, the Mapuche had remained mostly independent from the Chilean Spanish colony (1541-1810) and the Chilean state, though interlinked through trade and cultural interactions. Only after 1883 did this territory became a *de facto* part of the Chilean state. After the Conquest of Araucania, the Mapuche communal land was divided into plots and distributed among private owners (including foreign and Chilean settlers as well as members of the army). The Mapuche (around 100,000 people according to the 1907 Census) were confined to almost 3,000 TDMs (similar to American Indians' reservations or the *reducciones* in other parts of Latin America), covering ca. 500,000 hectares (Correa and Seguel, 2010; Bengoa, 2000).

Large areas of these TDMs are still currently part of the indigenous communities' territory, though many plots located within TDMs are owned by non-Mapuche. Even though the original intention was that land considered part of a TDM could not be transferred to non-Mapuche, in reality many TDMs further lost part of their land as a consequence of legal loopholes and illegal actions (Aylwin et al., 2003; Correa and Seguel, 2010). Almost 80% of the area of the original TDM is located in the Araucania region (Table 1, column 1). The last TDM was granted in 1929. After that, the Mapuche started a period of mass migrations to the urban areas, while those remaining in their original territories started a long process of legal demands in the Indian Courts (*Juzgados de Indios*), including the sub-division into private Mapuche-owned plots within the TDMs (Cloud and Le Bonniec, 2019; Jordan and Heilmayr, 2020).

Table 1: Surface of Mapuche land in the Araucania region (hectares)

	(1)	(2)	(3)	(4)
Province	***Títulos de merced***	**Land reform (1967-1973)**		**CONADI**
	(1884-1929)	Correa et al. (2005)	TDM in plots	(1994-2016)
Cautin	326,795	61,557	61,336	62,922
Malleco	80,900	90,860	52,359	61,376
Total	**407,695**	**152,416**	**113,695**	**124,298**

Column 1 shows the area of *Títulos de merced* (TDMs), in hectares, according to Aylwin et al. (2003). Column 2 shows expropriations during the land reform with Mapuche participation as described by Correa et al. (2005). Column 3 shows the area of plots expropriated during the land reform that overlap with TDMs from our geocoded data. The last column shows land acquired by the *Corporacion Nacional de Desarrollo Indigena* (CONADI) as part of the Chilean Indigenous Policy (1994-2016).

Invoking historical rights over land, several Mapuche communities and people participated in the land reform process between 1962 and 1973. The land reform laws were not designed to target the Mapuche land claims but rather to favor peasants, mainly those living within plots owned by large landholders. Nevertheless, the Mapuche realized that the land reform could be a legal way to solve their claims and started to put pressure by invading plots (*tomas de fundos*) with the support of the left-wing group *Movimiento Campesino Revolucionario*. The land invasion strategy at the beginning of the land reform process was contested by some of the large land owners of the region, including episodes of violent confrontation. This implied that very few plots were expropriated in the Araucania region until 1970 and only a handful in favor of Mapuche owners (Gall and Sanders, 1972; Correa et al., 2005; Cuesta et al., 2017).

This situation changed when the socialist Salvador Allende was surprisingly elected as president in September 1970. Land invasions restarted rapidly after his election and increased even more after he took power in November 1970.[3] With the beginning of the *Unidad Popular* (UP) period (November 1970 - September 1973), the land reform expropriations became part of a broader socialist program. In the case of Araucania, Allende explicitly recognized that the land reform laws were going to be used to favor Mapuche communities. After installing the new government personnel, the UP administration in the Ministry of Agriculture called to cease the land invasions in order to use the legal mechanisms to continue the land reform. Moreover, the Ministry of Agriculture and

[3]A series of violent events between Allende's election and the start of his presidency made it unclear if he was going to effectively take power.

the *Corporación de la Reforma Agraria* (CORA), the state agency in charge of the land reform, were moved temporarily to Temuco, Araucania's regional capital, to speed up the process in the area. Indeed, most of the expropriations in Araucania took place between 1971 and 1972, many of them with direct Mapuche participation (Gall and Sanders, 1972; Steenland et al., 1977; Correa et al., 2005; Le Bonniec, 2013; González and Vial, 2019).

We use two sources of data to measure Mapuche participation in the land reform. One is the plot-level data by Correa et al. (2005), based on historical records and ethnographic work in the region. The other source is our geocoded data, from where we identify if part of the surface of an expropriated plot overlaps with a TDM.[4] Table 1, columns 2 and 3 show that the area of plots expropriated in favor of the Mapuche was approximately 150,000 hectares for the former and 114,000 for the latter. This is larger than the total surface of the land redistributed to the Mapuche as part of the Indigenous Land Policy from the government in the period 1994-2016 (Table 1, column 4) and even larger than the surface of all TDMs granted in the whole Malleco province.

The military coup of September 1973 put an abrupt and violent end to the land reform process. One of the first measures of the Military Junta was the implementation of a counter-land reform. Reverting the land reform in many areas of the country was difficult because of the risk of insurrection and the fact that many peasants had been smallholders for more than decade. However, the case of Araucania was different (Bellisario, 2007; Redondo, 2016; Vasconcelos, 2020). As most expropriations in Araucania were recent and some were still in the process of becoming legally registered, the military authorities in the region took advantage and re-expropriated most plots. The re-expropriated plots were either returned to the original owners or re-distributed to new owners, including the military and forestry companies. This process was often violent, and the beneficiaries of the land reform lost not only their newly acquired land plots, but also the agricultural assets and other investments they had made in the land (Le Bonniec, 2013; Barrena et al., 2016). At the end of the process in 1978, less than 10% of the area of plots with Mapuche participation was not re-expropriated (Correa et al., 2005). Even after 1978, some Mapuche lost their land during a process of transfers and privatization of indigenous plots (Calbucura, 1996; Bengoa, 2011).

Conflict between the Mapuche and the Chilean state reemerged soon after the return of democracy in 1990. The democratic governments were initially more responsive to indigenous demands, but ultimately the Mapuche's longstanding position of relative social and economic deprivation endured. The initial non-violent demonstrations for self-determination and land property promptly turned towards more violent actions, especially when the Chilean state responded with increasingly aggressive tactics.[5] Several organizations using mostly violent tactics have became part of the Mapuche movement and the number of casualties and affected population has been increasing (Cayul et al., forthcoming). This conflict has been one of the most relevant in Chile in recent years, involving important property destruction and the continuous disruption of economic activities and social order (Pizarro, 2011; Marimán, 2012; Tricot, 2013; Pairicán, 2014).

[4] Many historical records indicate that the Mapuche claimed the original TDMs as part of the land reform. For instance, Bengoa (2016) mentions that "In several occasions the invasion of a plot was leaded by the *lonko* (the Chief of the community) holding the original TDM documents in his hands".

[5] One characteristic of the conflict is the existence of several episodes of excessive use of force and discriminatory prosecution by the police and other state institutions, as reported by international human rights organizations (DOS, 2018; HRW, 2019).

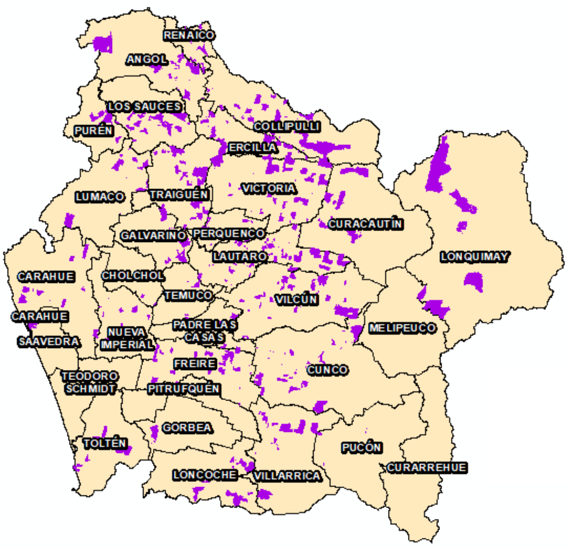
3 The plot-level data for Araucania

We created a new plot-level geocoded database for the Araucania region. These data come from several original sources, many of them never used before for quantitative empirical analysis. The main explanatory variable relates to events of the land reform (1962-1973) and the main outcome variable is the current conflict in the area of study (1990-2016). As part of our empirical strategy, we also include other data from recent and historical records as well as geographical information.

3.1 Plot-level land reform data

We use the digital version of the folders of the CORA by Cuesta et al. (2017). Each folder contains detailed information for plots that were part of the land reform between 1962 and 1973, including dates of expropriation and re-expropriation (for plots involved in the land counter-reform), size, owner, and other characteristics. We consider only plots located in the Araucania region, a total of 679 plots. Nevertheless, some of these plots do not exist anymore, or we were unable to identify them in more recent data. Overall (as explained below) we were able to match almost 70% of the plots involved in the reform with the other relevant data. Hence, our main data consider 455 "CORA plots". Figure 1 displays the distribution of those CORA plots in a map of the region.

Figure 1: Map of the Araucania region and the expropriated plots during the land reform



Note: Produced by the authors based on CORA folders

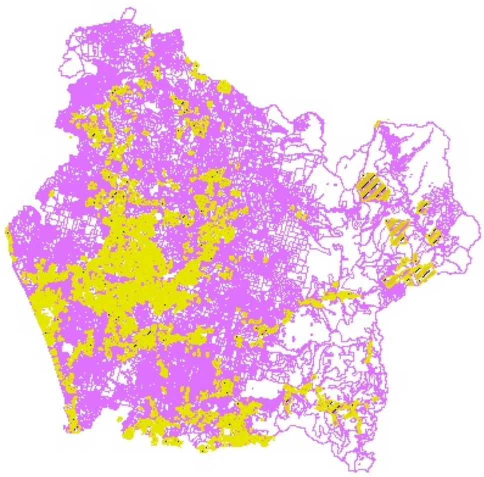
One of the definitions we use to identify expropriated plots with Mapuche participation comes from the work of Correa et al. (2005), a variable we call *CORA_MAPUCHE*. They described 163 of these plots. Their data are part of a large project identifying Mapuche communities and individuals involved in the land reform in Araucania. Most of their sources are primary, such as interviews and focus groups. We have digitalized the data by Correa et al. (2005) and merged that data with the CORA folders by Cuesta et al. (2017). While these should be a one-to-one match, since Correa et al. (2005) also used

CORA as their baseline data, we found some discrepancies. Twenty-five of the plots with Mapuche participation were not found in the data by Cuesta et al. (2017). There are also some discrepancies between both sources in terms of date of expropriation and plot characteristics, but around three-fourths of the matches have the exact same information. As with other CORA plots, we have data attrition when matching with current data. We ended up with 103 Mapuche CORA plots in our main dataset (63% of the plots identified by Correa et al. (2005)).

3.2 Historical data

The TDMs where the Mapuche were settled after the Conquest of Araucania at the end of nineteenth century is a relevant variable in our data. We use geocoded data on TDMs developed by CONADI. The distribution of these TDMs is shown in Figure 2.

Figure 2: Map of the Araucania region and the distribution of TDMs and current plots



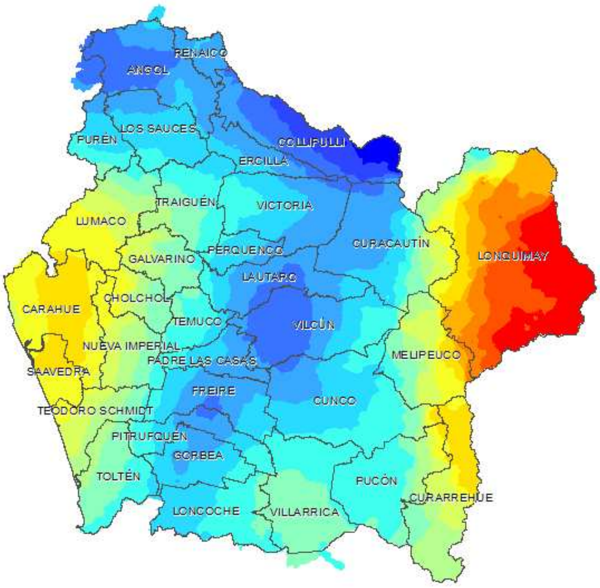
Note: TDMs in yellow; mosaic of the area covered by the plots in the 2013 cadaster in purple. Produced by the authors based on data from CONADI and CIREN.

We use information on TDMs to control for the historical location of Mapuche in the region and to build a second indicator of Mapuche participation in the land reform. We consider that plots adjacent to TDMs or those in which part of the area overlaps with a TDM are a proxy variable for Mapuche involvement in the land reform. While the data of Correa et al. (2005) can be considered as "direct Mapuche participation," the variable built from geocoded data of CORA plots next to or within TDMs is a proxy for "assumed Mapuche participation". We call this variable *CORA_TDM* and identify 137 of this kind of plots. Moreover, 61 of the CORA_MAPUCHE plots are also *CORA_TDM*, confirming that this variable is meaningful. Since more than half of *CORA_TDM* plots are additional to those in the data by Correa et al. (2005), we take the two variables as different ways of identifying Mapuche participation in the land reform. In the empirical analysis we also use a variable combining the two variables.

Another relevant historical variable relates to rainfall in the region. We use WorldClim

2.1, the historical monthly weather data by the Climatic Research Unit, University of East Anglia (Fick and Hijmans, 2017). These data are based on satellite images with spatial resolution of 2.5 minutes (around 21 km^2).[6] In the empirical analysis, we use plot-level rainfall estimates based on the inverse distance weighted interpolation from the centroids of the cells in WorldClim 2.1 data. Our main variable of interest is the deviation of rainfall in the spring of 1970 from its historical mean, our instrumental variable, whose distribution is shown in Figure 3.

Figure 3: Map of the Araucania region and the distribution of rainfall in the spring of 1970



Note: Produced by the authors based on historical satellite data from WorldClim 2.1

3.3 Conflict data

We take conflict data from MACEDA, a recent publicly available event-level database on the self-determination conflict between the Mapuche and the Chilean state. These unique data have more than 2,600 observations for the period 1990-2016, using mainly media reports as sources (Cayul et al., forthcoming). Of those events, 1,680 took place in the Araucania region (the rest in other regions of Chile). We use some of the (non-publicly available) background data of MACEDA to build a new plot-level database of rural conflicts in the Araucania. Our data contain 174 plot invasions and 276 plot attacks for the period 1990-2016. In total, we find 585 plot-level conflict events (Table 2), which is one-third of all the events identified by MACEDA in the region. As some of those events occurred in the same plot (e.g. there is a plot where 61 conflict events took place), we have 213 plots with at least one conflict event in the our data. Appendix figure A2 displays the intensity of plot-level conflict events aggregated at the municipality level. While in 13 municipalities there were no conflict events, the rest of the municipalities had conflicts of different intensities.

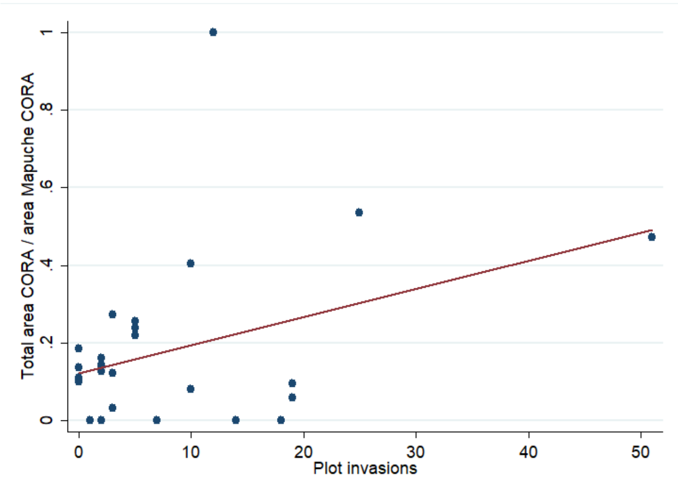
[6] To check the accuracy of the WorldClim 2.1 data, we compared these data with rainfall records from 14 weather stations in the Araucania region available during the period. We found that the satellite data was considerably accurate around those stations.

Table 2: Conflict data: Number of conflict events in the Araucania region

Type of event	MACEDA Cayul et al. (forthcoming)	Plot-level data by the authors
Attacks	622	276
Invasions	315	174
State coercion	365	108
Blockades	120	11
Threats	42	9
Protests	176	7
Total	1680	585

Figure 4 shows the relationship of conflict intensity with the intensity of land reform at municipality level. Mapuche participation in the land reform, considering the share of Mapuche expropriated surface area over the total, varies across municipalities. Figure 4 shows that the intensity of Mapuche land reform is positively correlated with the number of plot invasions in a municipality during the 1990-2016 period. As Mapuche participation is more likely in municipalities where the rural Mapuche population is larger, in appendix figure A3 we show an alternative measure of the "intensity of Mapuche land reform" considering the expropriated surface area with Mapuche participation as a share of the TDMs in the municipality. There is also a positive correlation with current plot invasions in this case.[7]

Figure 4: Hectares expropriated with Mapuche participation (as a share of the total expropriated) and plot invasions by municipality (1990-2016).



Note: Produced by the authors based on MACEDA data

[7]In figures 4 and A3 there is an outlier observation, with many plot invasions and high intensity of the land reform. This observation corresponds to the municipality of Ercilla. In table A3 we show that the main results are robust in a sample where plots located in Ercilla are excluded.

3.4 Recent plot characteristics

Recent data for plots in Araucania were taken from the 2013 cadaster on rural property (CIREN, 2013). These data contain raster data for 144,091 plots in Araucania, most of the in rural areas (some urban areas are included as these areas were still rural when the cadaster was first developed in the 1960s). Some of the rich information contained in this cadaster includes the current owner's name, legally registered area (in addition to the geocoded mosaic area), the economic use (agriculture or logging), among other characteristics. Figure 2 shows the mosaic of the area covered by plots from the 2013 cadaster.

We matched the 2013 cadaster data with the data from CORA, finding 70% of the plots described in the CORA folders.[8] Many plots in the 2013 cadaster are very small: 20% are smaller than 1Ha and 63% smaller than 6Ha (which is the area of the smallest plot in the CORA folders). Those small plots are likely located in current urban areas and are less likely to be involved in conflict events (the smallest plot in MACEDA has an area of 5.5Ha). Therefore, in the main empirical specifications, we use the largest plots in the cadaster. We take the plots with more than 40Ha since 98% of the plots expropriated in the land reform were larger than this size.[9]

For these plots, we also include data about their altitude (from publicly available geocoded data) and the distance to relevant landmarks, such as Temuco (the regional capital and headquarter of the land reform government apparatus during 1971), water bodies, and regional borders.

Other relevant recent data were taken from geocoded data developed by CONADI. We include the location of 1,925 indigenous communities legally registered until 2018. Also from CONADI, we obtained geocoded data of the 124,298Ha of plots acquired by this institution from 1994 to 2016 as part of the official national policy of the Indigenous Law of 1993 (Figure 1, column 4). Additionally, we use the data on Mapuche last names by MDP (2019) to identify plots owned by Mapuche in the 2013 cadaster.

4 Main results

4.1 OLS results

The main specification is as follows:

$$\text{Conflict}_p = \alpha + \text{CORA}_p\beta_1 + \text{CORA}_p * \text{MAPUCHE}_p\beta_2 + \text{X}'_p\gamma + \mu_p, \quad (1)$$

where $Conflict_p$ is a conflict variable for plot p, CORA_p is a dummy taking value one if the plot p was registered in the CORA folders (i.e. was expropriated during the land reform 1962-1973). MAPUCHE_p is a variable for Mapuche participation in the

[8] As some CORA plots have split, we identify and merge them as a unique plot using the original CORA plot as a reference. In appendix table A3 we show that the main results are robust to include these divided plots as additional units in the sample.

[9] We provide robustness checks using different areas as cut-offs.

expropriation of plot p, which we capture in three ways: (i) using CORA_MAPUCHE (direct participation), (ii) using CORA_TDM (assumed participation), and (iii) a combination of these two variables (CORA_TDM_MAPUCHE). X_p is a vector of plot-level variable including: plot size (in 2013), a dummy for plots that were part of a TDM, the share of the plot's area that is within a TDM, a dummy for plots divided after land reform, the altitude of the plot altitude, the distance to Temuco (the regional capital) and the distance to water bodies (lakes and the Pacific Ocean). We also include province fixed-effects (there are two provinces). The inference is based on two assumptions on the structure of the data: robust standard errors and allowing for spatial correlation using the Conley method.

Table 3 shows the estimates of equation 1. The estimated β_1 in column 1 suggests that expropriated plots (CORA plots) are more likely to participate in current conflict events. The coefficient is statistically significant and the magnitude is large. A CORA plot is hundred times more likely to be part of the current conflict than the other plots in the region. Inference is very similar using either robust standard errors or allowing for spatial correlation, in all the estimates of the table. Columns 2 and 3 show that this effect is around twice as large for plots with Mapuche participation, considering both direct and assumed participation.

As explained above, mostly large plots were part of the land reform, so comparing them to very small plots (many in current urban areas) can be misleading. In columns 4 to 7 we consider only plots with an area above 40 hectares.[10] The results are very similar in terms of magnitude and significance. In this sample of large plots, the likelihood of a conflict event increases (the mean of the dependent variable is 1.4%), and the estimates should be interpreted as CORA plots being roughly seven times more likely to be part of the conflict, and those with Mapuche participation twice more likely than other CORA plots. It is also noteworthy that the results in column 5 of table 3 imply that plots located within a TDM are twice more likely to be involved in a conflict event, an effect that is almost 10 times larger in CORA plots within a TDM. In column 7 we present the results considering CORA_TDM_MAPUCHE, which combine direct and assumed Mapuche participation. In this specification, CORA plots are five times more likely to have a conflict event than other plots, an effect that is about trice the size in plots with Mapuche participation.

Despite controlling for a rich set of plot-level characteristics, there are still possible confounding factors affecting both participation in the land reform and current conflict. A set of these factors may be time-invariant characteristics at administrative levels smaller than a province, such as municipalities (32 in the Araucania region). In Table A1 we show evidence that this is not the case. The results of estimating 1 including municipality fixed-effects are virtually the same as those in Table 3, both in terms of the estimated coefficients and standard errors. This is consistent with historical evidence suggesting that the land reform was either centrally planned or spatially correlated within groups of neighboring invaded plots, but not related to the agency of local (i.e. municipal-level) authorities. This result is relevant for the identification strategy presented in the next section.

Table 4 shows the estimates of equation 1 for different definitions of the dependent

[10] 40Ha were chosen as cut-off given that 98% of the CORA plots are larger than this size. In table A2 we show that the main results do not depend on the cut-off used for plot area.

Table 3: OLS estimations: Land reform and current conflict (MACEDA, 1990-2016)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CORA	0.110***	0.087***	0.094***	0.116***	0.093***	0.096***	0.073***
	(0.016)	(0.017)	(0.018)	(0.020)	(0.020)	(0.021)	(0.020)
	[0.018]	[0.018]	[0.019]	[0.021]	[0.021]	[0.022]	[0.021]
CORA_TDM		0.081**			0.084*		
		(0.036)			(0.043)		
		[0.038]			[0.043]		
CORA_MAPUCHE			0.069			0.107**	
			(0.040)			(0.052)	
			[0.044]			[0.053]	
CORA_TDM_MAPUCHE							0.125***
							(0.039)
							[0.042]
TDM	-0.000	-0.000**	-0.000	0.021***	0.017***	0.019***	0.017***
	(0.000)	(0.000)	(0.000)	(0.003)	(0.003)	(0.003)	(0.003)
	[0.000]	[0.000]	[0.000]	[0.004]	[0.003]	[0.004]	[0.003]
N	143943	143943	143943	11609	11609	11609	11609
Mean Dep. Var.	0.001	0.001	0.001	0.014	0.014	0.014	0.014
specification	ALL	ALL	ALL	> 40 ha	> 40 ha	> 40 ha	>40 ha
CORA plots	455	455	455	367	367	367	367

Note: Robust standard errors in parenthesis and Conley inference, taking 10km as spatial cutoff, in brackets. The dependent variable is a dummy taking value one if a plot participated in a conflict event from MACEDA, zero otherwise. Control variables include plot size (2013), a dummy for plots that were part of a TDM and the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

variable, using the specification of plots larger than 40Ha and CORA_TDM_MAPUCHE to capture Mapuche participation. We take advantage of the information in MACEDA (Cayul et al., forthcoming) to build plot-level dummy conflict indicators. The most common event is attacks, which occur in two-thirds of the plots with conflict events. Indeed, the results in column 1 are very similar to those using the dependent variable for all kind of events (column 6 of Table 3). Half of the conflict events are land invasions. The results in column 2 of Table 4 indicate that land reform correlate with land invasions only in plots where Mapuche where involved. Considering violent events and destruction of property, the results are very similar to those in column 1 (events considered as attacks). In the last column we consider a variable that is the total number of arrested, wounded or dead people during all events occurring in a plot ("victims"). This variable correlate with CORA plots with Mapuche participation.

4.2 IV results

The OLS results presented in the last section must be interpreted with caution. More than causal effects of the land reform on the current conflict in the area of study, the OLS estimates of equation 1 should be taken as partial correlations. Even though in that specification we control for a rich set of plot characteristics, several confounding factors could be causing the increase of conflict in expropriated plots. Relevant confounding factors are historical events that took place before the land reform. For instance, the

Table 4: OLS estimations: Land reform and type of event in the current conflict (MACEDA, 1990-2016)

	(1) Attacks	(2) Land invasion	(3) Violence	(4) Destroyed property	(5) Victims
CORA	0.050***	0.017	0.049***	0.042***	-0.016
	(0.017)	(0.013)	(0.017)	(0.015)	(0.208)
	[0.017]	[0.014]	[0.017]	[0.015]	[0.213]
CORA_TDM_MAPUCHE	0.115***	0.091***	0.114***	0.081**	2.537**
	(0.036)	(0.031)	(0.036)	(0.032)	(1.094)
	[0.037]	[0.032]	[0.037]	[0.033]	[1.082]
N	11609	11609	11609	11609	11609
Mean Dep. Var.	0.009	0.007	0.009	0.007	0.049
CORA plots	367	367	367	367	367

Note: Robust standard errors and Conley inference, taking 10km as spatial cutoff, in brackets. The dependent variable in column 1 is dummy taking value one if a plot was attacked, zero otherwise. The dependent variable in column 2 is a dummy taking value one if a plot was invaded, zero otherwise. The dependent variable in column 3 a dummy taking value one if a plot was part of any violent event, zero otherwise. The dependent variable in column 4 a dummy taking value one if a plot was part of an event involving destruction of private property, zero otherwise. The dependent variable in column 5 is the number of arrested, wounded or dead people during all events occurring in a plot. Control variables include plot size (2013), a dummy for plots that were part of a TDM and the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

land reform may had been more intense in areas where the Mapuche-Chilean war of the nineteenth century was particularly violent. If this is the case, the current conflict may be explained by the events of the Conquest of Araucania and not so much by the land reform. This mechanism cannot be disregarded as some expropriations during the UP-period targeted specifically plots where the Mapuche had historical claims (Correa et al., 2005). Another confounding factor may be the influence of the Indian Courts before the land reform (1930-1960) (Cloud and Le Bonniec, 2019; Jordan and Heilmayr, 2020). As shown empirically by Jordan and Heilmayr (2020), the use of land by indigenous communities is causally affected by the influence of these courts. If pre-reform land allocation by communities differ, expropriations may have been affected.

To deal with some of the endogeneity concerns of the OLS estimates, we implement an IV strategy. The proposed instrument stems from a long tradition of using unexpected climatic shocks (Miguel et al., 2004; Hidalgo et al., 2010; Hendrix and Salehyan, 2012). In particular, we follow recent studies that use historical rainfall data to build instruments for causal inference of the effects of past events on current outcomes (Dell, 2012; Lopez-Uribe and Sanchez, 2017). Taking advantage of the geocoded data described in Section 2, we create a plot-level rainfall-shock instrument:

$$SHOCK_{p,t} = \frac{Rain_{p,t} - \overline{Rain_p}}{\overline{Rain_p}}$$

The instrumental variable $SHOCK_{p,t}$ is an unexpected event in plot p during the period t. $Rain_{p,t}$ is the rainfall-level and $\overline{Rain_p}$ the long-term mean of that variable. Therefore, the instrument is the deviation of rainfall in t from its long-term mean.

Unusual rainfall variation is a well documented shifter of agricultural productivity in developing countries. The setting of our study, the Araucania region in the 1960s and 1970s, bears various similarities to those analyzed in previous studies, such as high poverty levels, low development of irrigation systems and low diversification of cultivation. We will use a measure of $Rain_{p,t}$ based on spring's rainfall (October to December). This is the case as agronomic studies have shown that rain levels during spring are relevant determinants of land productivity for the production of wheat, the main crop in Araucania at the time of the land reform.[11] To build $\overline{Rain_p}$, rainfall's long-term mean, we consider the period 1980-2009. We used a long period after the land reform because rainfall data prior to it (i.e., before 1962) is scarce. We do not include years after 2009 given the existence of a "mega-drought" in the region of study starting in 2010 (Garreaud et al., 2020).

There are many options to chose t. In principle, any rainfall shock during the years of the reform could have affected expropriations in the area of study. For instance, in 1968 Chile experienced one of the worse droughts of the twentieth century. Nevertheless, the area of study was much less affected than the rest of the country. Instead, our instrument combines climatic as well as political shocks. The political shock is the surprising election of Salvador Allende as president at the end of the winter of 1970. As described in Section 2, his socialist government program proposed a large expansion of the land reform process, including the use of expropriations as a mean for reparations to the Mapuche. After Allende took power, there was a large increase in land invasions, many of them leading to expropriations (Correa et al., 2005; González and Vial, 2019).

Previous studies have shown that rainfall shocks may affect land invasions (Hidalgo et al., 2010). Using historical data on plot invasions after Allende became president from González and Vial (2019), in Appendix table A4 (column 1) and Appendix table A5 (columns 3 and 5), we show that $SHOCK_{p,1970}$ is a strong predictor of the invasion of a plot. Plots with positive shocks (more rainfall than historical mean) are more likely to be invaded, and expropriated afterward.[12] Indeed, all invaded plots in our sample were expropriated, and invasion during the land reform correlate with current conflict (Appendix table A5). Even if $SHOCK_{p,1970}$ would have not affected invasions, there are other possible relationships with expropriations. A more directed channel may be given by the fact that one of the goals of Allende's government was to develop a large-scale production of grains (mainly wheat) in the Araucania region to stop depending on foreign markets. Therefore, more productive plots were likely more attractive for expropriation.

Our IV model considers the following equations for the first stage:

$$\mathrm{CORA}_p = \alpha + \mathrm{SHOCK}_{p,1970}\lambda_1 + \mathrm{SHOCK}_{p,1970} * \mathrm{Mapuche}_p\lambda_2 + \mathrm{X}'_p\gamma_1 + \eta_p, \tag{2}$$

$$\mathrm{CORA}_p * \mathrm{Mapuche}_p = \alpha + \mathrm{SHOCK}_{p,1970}\lambda_3 + \mathrm{SHOCK}_{p,1970} * \mathrm{Mapuche}_p\lambda_4 + \mathrm{X}'_p\gamma_2 + \varsigma_p, \tag{3}$$

and the following second stage:

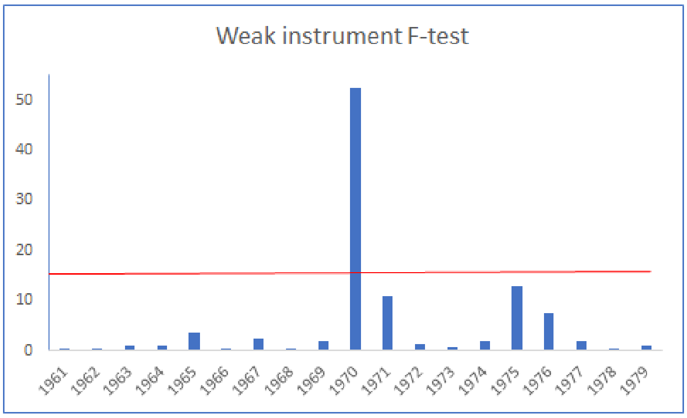
[11] According to the 1965 Agricultural Census, 48% of the cultivated area in the region, corresponding to 200,000 hectares, produced wheat.

[12] Our result suggest that the motivation for plot invasions is different than that driven the results by Hidalgo et al. (2010). In their case, there was a negative relationship between the rainfall shock and invasion, consistent with economic opportunity costs. In our case, the relationship is positive, therefore related to the increase in the returns of land invasions.

$$\text{Conflict}_p = \alpha + \widehat{\text{CORA}}_p\delta_1 + \widehat{\text{CORA*Mapuche}}_p\delta_2 + \text{X}'_p\delta_3 + \nu_p. \tag{4}$$

The results in table 5 show that $SHOCK_{p,1970}$ is an strong instrument to predict that a plot was expropriated during the land reform. Column 1 shows that the first stage weak instrument F-test is 97.8 in the full sample and 52.4 in the sample of plots with more than 40 hectares. The Anderson-Rubin test at the bottom of table 5 confirms the result. Appendix table A4 shows that $SHOCK_{p,1970}$ is a positive and statistically significant at the 1% level predictor of CORA plots in all specifications.[13] Moreover, figure 5 presents placebo estimates for $SHOCK_{p,t}$ using 9 years before 1970 and 9 years after 1970. The results indicate that the only year for which $SHOCK_{p,1970}$ is not a weak instrument is 1970. Given that climate shocks only affect participation in the land reform in the year in which most expropriations (and plot invasions) took place, we consider plausible that $SHOCK_{p,1970}$ affects current conflict only trough its effect on CORA. Therefore, we take this result as indirect evidence for the validity of the exclusion restriction.[14]

Figure 5: Placebo F-test of the excluded instrument: Rainfall in spring of each year



Note: Kleibergen-Paap F-test for different specifications. Red line is critical value at 10% maximal IV size.

While $SHOCK_{p,1970}$ is a valid instrument when considering all CORA plots (equation 2), this seems not to be the case in the sub-sample of CORA plots with Mapuche

[13]In appendix table A6 we show that $SHOCK_{p,1970}$ is also a significant predictor of conflict in the reduced form specification. While we cannot disregard that there is some correlation of the rainfall shocks across years, appendix table A6 shows that, after controlling for $SHOCK_{p,1970}$, the rainfall shocks in the 60s and 70s are not economically significant correlates of conflicts, with few exceptions. If rainfall shocks contemporaneous to the conflict are considered (1990-2009), some are strong correlates of conflict, as predicted by the literature on weather and conflict, but the coefficient for $SHOCK_{p,1970}$ tends to keep its magnitude and significance.

[14]Appendix figure A4 shows that using rainfall during the whole year is a weak instrument to predict expropriation of a plot. This is the case for rainfall in 1970 and in other years as well. This provides evidence supporting the hypothesis that rainfall affects the probability of expropriation trough its effect on the productivity of wheat production. Another test to this hypothesis is the change in predictive power according to agricultural production. Using data from the 1965 Agricultural Census, we can identify the share of wheat production over total agricultural production at municipality level. If the four municipalities with the largest share of wheat production are excluded from the sample, the first stage weak instrument F-test in the sample of plots with more than 40 hectares decrease from 52.4 to 30.5. If instead the four municipalities with the smallest share of wheat production are excluded, the F-test increases to 56.5.

participation (equation 3). The results in appendix table 5 indicate that when the interaction with variables for Mapuche participation are included, the first stage F-test is significantly reduced. Additionally, the results in appendix table A4 imply that $SHOCK_{p,1970}$ is not always a statistically significant predictor of the interaction of CORA and the Mapuche variables and that the estimated coefficients are out of the expected range of prediction. We therefore conclude that $SHOCK_{p,1970}$ is unlikely to be a good instrument for that interaction, and these results must be taken with caution.

Table 5: IV estimations: Land reform and the current conflict (MACEDA, 1990-2016)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CORA	0.304***	0.418***	0.310***	0.305**	0.422**	0.305**	0.345*
	(0.084)	(0.135)	(0.091)	(0.109)	(0.163)	(0.109)	(0.138)
	[0.111]	[0.175]	[0.119]	[0.141]	[0.211]	[0.141]	[0.177]
CORA_TDM		-0.435			-0.490		
		(0.271)			(0.275)		
		[0.310]			[0.320]		
CORA_MAPUCHE			-0.081			-0.067	
			(0.180)			(0.195)	
			[0.199]			[0.198]	
CORA_TDM_MAPUCHE							-0.218
							(0.239)
							[0.256]
TDM	0.000	0.002*	0.000	0.019***	0.038***	0.020***	0.027***
	(0.000)	(0.001)	(0.000)	(0.004)	(0.011)	(0.004)	(0.009)
	[0.000]	[0.001]	[0.000]	[0.004]	[0.013]	[0.004]	[0.009]
N	143112	143112	143112	11609	11609	11609	11609
Mean Dep. Var.	0.001	0.001	0.001	0.014	0.014	0.014	0.014
CORA plots	455	455	455	367	367	367	367
specification	ALL	ALL	ALL	>40 ha	>40 ha	>40 ha	>40 ha
F-test weak instrument	97.805	32.593	59.856	52.447	20.619	31.140	29.243
Anderson-Rubin (p-value)	0.000	0.001	0.000	0.004	0.015	0.011	0.014

Note: Robust standard errors in parenthesis and Conley inference, taking 10km as spatial cutoff, in brackets. The dependent variable is a dummy taking value one if a plot participated in a conflict event from MACEDA, zero otherwise. Control variables include plot size (2013), a dummy for plots that were part of a TDM and the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

The estimates from the IV regressions in columns 1 and 4 of table 5 tend to confirm the OLS estimates for CORA. Taken the results as a LATE, for complier plots (i.e. plots that were expropriated because of the productivity shock), the effect of the land reform is an increase in the intensity of the conflict. The estimated coefficient for the CORA variable is around 3 times larger that the OLS estimates, indicating that these compliers are more likely to participate in conflict events. The last three columns of appendix table A2 displays the IV estimates using different cut-off for the minimum plot size in the sample. The coefficient for the CORA variable is robust in all different sub-samples. Appendix table A3 shows robustness to other changes in the main specification.

In the case of the estimated coefficients for the variables CORA_TDM, CORA_MAPUCHE and CORA_TDM_MAPUCHE, all of them are not statistically significant in the results displayed in table 5. While the coefficients are negative and large, standar errors are very large for these interactions, particularly when spatial correlation is considered. As mentioned before, these results must be taken with caution given the possible weak IV problem.

Table 6 show results for the IV estimates of the effects of CORA on different aspects of the current conflict. The previous OLS results are mostly confirmed, namely that expropriated plots are more likely to be attacked but not invaded, and that violent events and destruction of property is more likely to take place in former CORA plots.

Table 6: IV estimations: Land reform and type of event in the current conflict (MACEDA, 1990-2016)

	(1) Attacks	(2) Land invasion	(3) Violence	(4) Destroyed property	(5) Victims
CORA	0.343***	-0.019	0.373***	0.276***	0.544
	(0.088)	(0.079)	(0.091)	(0.079)	(1.443)
	[0.112]	[0.085]	[0.123]	[0.095]	[1.430]
N	11609	11609	11609	11609	11609
Mean Dep. Var.	0.009	0.007	0.009	0.007	0.049
F-test weak instrument	52.447	52.447	52.447	52.447	52.447

Note: Robust standard errors in parenthesis and Conley inference, taking 10km as spatial cutoff, in brackets. The dependent variable in column 1 is dummy taking value one if a plot was attacked, zero otherwise. The dependent variable in column 2 is a dummy taking value one if a plot was invaded, zero otherwise. The dependent variable in column 3 a dummy taking value one if a plot was part of any violent event, zero otherwise. The dependent variable in column 4 a dummy taking value one if a plot was part of an event involving destruction of private property, zero otherwise. The dependent variable in column 5 is the number of arrested, wounded or dead people during all events occurring in a plot. Control variables include plot size (2013), a dummy for plots that were part of a TDM and the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

5 Mechanisms

In this section we explore potential channels that can explain the effects of land reform on the current rural conflict in the area of study. We estimate two models. In the first model we test if the variables CORA and CORA_TDM_MAPUCHE significantly correlate with different dependent variables that proxy for a possible channels. In the second model, we test if the current conflict, now the dependent variable, correlates with that possible channels. In both models, we use OLS estimates with municipality fixed-effects and the same set of control variables described before.[15]

Table 7 presents the results. A first possible grievance of the land reform is to first provide large land holdings to the Mapuche, only to quickly take the land back during the counter-reform. Therefore, CORA plots should not be currently owned by the Mapuche. This is confirmed in the results shown in column 1. The dependent variable is a dummy taking value one if the owner of the plot is a Mapuche according to the data in the 2013 cadaster, zero otherwise. CORA plots do not have a higher probability to be owned by a Mapuche and this also the case for CORA plots with Mapuche participation in the land reform (CORA_TDM_MAPUCHE). The result is confirmed in column 2, which show that plots that participated in the land reform are not more likely to be part of a Mapuche community (as recorded by CONADI). The results in the lower panel of Table 7 suggest that plots owned by a Mapuche (10.5% of the sample) are not involved in conflict events.

Another possible mechanism is that the counter-reform could have been more intense in the CORA plots with Mapuche participation. As discussed before, most of the expropriations of plots in the region were reverted soon after the military coup. This implies that we cannot disentangle the effects of the land reform and counter-reform, unless counter-reform were more intense in the sub-sample of plots with Mapuche participation. 81.5% of the expropriation in our data were reverted until 1979, and 82.7% when only plots with Mapuche participation are considered. This is confirmed in the results in column 3 of table 7. Also, the lower panel of Table 7 suggest that conflict is not more intense in plots that participated in the counter-reform (after controlling for the fact that they were expropriated in the first place). Therefore, the way in which the counter-reform was implemented did not affected Mapuche particularly, and the main result should be taken as the joint effect of the land reform and counter-reform.

Since 1994, CONADI has implemented a large land acquisition program for indigenous. If plots that were involved in the land reform are targeted by CONADI, then conflict could be reduced in those plots. The results in column 4 suggest that CONADI do not generally target CORA plots, though it is more likely to acquire CORA plots that had Mapuche participation. This result may suggest that CONADI's policy may reduce conflict in those plots. Nevertheless, the results at the lower panel of Table 7 seem to imply that actually plots acquired by CONADI have more conflict events. This is probably the case because the agency has targeted plots where Mapuche have disputed the property. Indeed, most CORA plots with Mapuche ownership in 2013 were 34 plots acquired by CONADI, some

[15] We do not use the IV estimates as its assumptions are less plausible in these models. Moreover, municipality-level time invariant variables are relevant to explain some of the after-reform outcomes that we consider possible channels, and the IV estimates are weak when municipality fixed-effects are included in the model.

of them with conflict previous to the acquisition. Therefore, the effect of CONADI land acquisitions is unclear.

Table 7: Possible mechanisms explaining the effects of land reform on the current conflict

	(1) Mapuche owner (2013)	(2) Mapuche community (2013)	(3) Counter-reform (1973-1979)	(4) CONADI land (1994-2016)	(5) Forestry plantation (2013)
			Land reform		
CORA	-0.016	0.010	0.810***	-0.029	0.113***
	(0.015)	(0.008)	(0.041)	(0.021)	(0.024)
CORA_TDM_MAPUCHE	0.025	-0.025	0.019	0.085**	0.054
	(0.048)	(0.024)	(0.044)	(0.039)	(0.042)
Mean Dep. Var.	0.105	0.022	0.027	0.069	0.126
			Conflict		
MACEDA	0.001	0.005	0.062	0.015*	0.009**
(dependent variable)	(0.005)	(0.011)	(0.039)	(0.008)	(0.004)
Mean MACEDA = 0.014					
N = 11609					
CORA plots = 367					

Note: In the upper panel, CORA and CORA_TDM_MAPUCHE are explanatory variables. In the lower panel, MACEDA (a dummy for conflict events) es the dependent variable and the main explanatory variable is in the top of the column.
OLS estimation with fixed-effects at the municipality level in plots larger than 40Ha. Robust standard errors. The dependent variable in column 1 is a dummy taking value one if the owner of the plot is a Mapuche in 2013, zero otherwise. The dependent variable in column 2 is a dummy taking value one if there is an indigenous community in the plot in 2013, zero otherwise. The dependent variable in column 3 is a dummy taking value one if a plot was registered in the land counter-reform between 1974 and 1979, zero otherwise. The dependent variable in column 4 is a dummy taking value one if a plot was part of the land acquisition program for indigenous people from CONADI (1994-2016), zero otherwise. The dependent variable in column 5 is a dummy taking value one if a plot was owned by a forestry firm in 2013, zero otherwise. Control variables include plot size (2013), a dummy for plots that were part of a TDM and the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital) and distance to water bodies. In the estimations of the lower panel, we also control for the land reform variables CORA and CORA_TDM_MAPUCHE

Another possible grievance of the failed land reform is the change in the ownership of the CORA plots after the counter-reform. 21% of the CORA plots in our data were used for forestry plantations in 2013. Those plots are mostly owned by firms that started their operations after the counter-reform, receiving subsidies and other benefits from the military regime. These large-scale forestry plantations have had negative ecological impacts, often affecting Mapuche communities (Heilmayr et al., 2020; Clapp, 1998). The results in column 5 of table 7, where the dependent variable is a dummy taking value one if a plot was a forestry plantation in 2013, zero otherwise, confirms that CORA plots are twice more likely to currently have forestry activities.[16] Previous literature has described that these forestry firms are one of the main targets of the Mapuche political violence (Carruthers and Rodriguez, 2009; Molina, 2012). This fact is confirmed in column 5 of the lower panel of table 7, with a coefficient that suggests that forestry plantations are twice more likely to participate in a conflict event. Therefore, we conclude that the economic structure after the land counter-reform is a possible channel to explain the results. In particular, this mechanism is useful to understand why even CORA plots without Mapuche participation during the land reform are currently involved in conflict events.

[16]Some areas in Araucania had already started forestry plantations before the land counter-reform. Using data from the 1965 Agricultural Census, we checked that the results in column 5 of table 7 are robust to the exclusion of municipalities with the largest share of forest plantations in 1965.

6 Conclusions

Conflicts are one of the main constraints of economic development. The analysis of the determinants of the most violent conflicts, as well as their economic and social effects, is prominent in the literature. Nevertheless, only recently there is a focus on the determinants and effects of less violent conflicts. This paper contributes particularly to the recent literature on the historical determinants of these kind of disputes, with a particular focus on self-determination indigenous conflicts.

The conflict between the indigenous Mapuche and the Chilean state is one of the most relevant of the recent years in Chile. We analyze the effects of the land reform (1962-1973) on the intensity of this self-determination conflict (1990-2016). The Mapuche were actively involved in the land reform process, and at least 150,000 hectares were expropriated in their favor. Nevertheless, the counter-reform process, after the 1973 military coup, almost fully reverted these expropriations. This failed land reform potentially created local grievances that may explain some aspects of the current social and political conflict in the region of study, which is the poorest in the country.

A unique geocoded plot-level database for the Araucania Region was assembled. Based on the census on the rural property, we identified the plots involved in the land reform before the 1973 coup that still exist (around 70% of the original plots). We are able to identify plots where the Mapuche were involved in the land reform using historical records and ethnographic work from Correa et al. (2005) and also using geocoded data on whether a 2013 plot overlaps with a TDM. The information on current conflict is taken from a geocoded version of the recently available MACEDA database (Cayul et al., forthcoming). We identified specific plots involved in conflict events, such as land invasions and attacks, between 1990 and 2016.

The results from OLS estimates suggest that plots involved in the land reform are more likely to be invaded and attacked. The effect is larger for plots located around indigenous reservations and those in which there was direct Mapuche participation during the land reform. To deal with potential endogeneity problems, we implement an instrumental variable identification strategy based on historical rainfall in the region. The IV estimates mostly confirm the main results.

We identify two possible grievances as channels that may explain our results. First, we show evidence supporting that the land reform failed to provide land to the Mapuche. Therefore, a large amount of land was granted to indigenous communities and persons during the land reform, but later most of the land was taken back, often violently, during the counter-reform. Our evidence also suggests that another grievance relates to the economic structure after the land counter-reform, with the development of intensive forestry plantations that have had negative ecological impacts, often affecting Mapuche communities.

Our study is not only relevant to understand the origins of conflict in Chile, but also of self-determination indigenous conflicts in the rest of Latin America and other regions. Indeed, this kind of conflicts are one of the most common in the world, but also one of the least studied (Cayul et al., forthcoming). We expect to contribute to inform policies towards indigenous groups and initiatives related to peace processes, which should take historical aspects into consideration.

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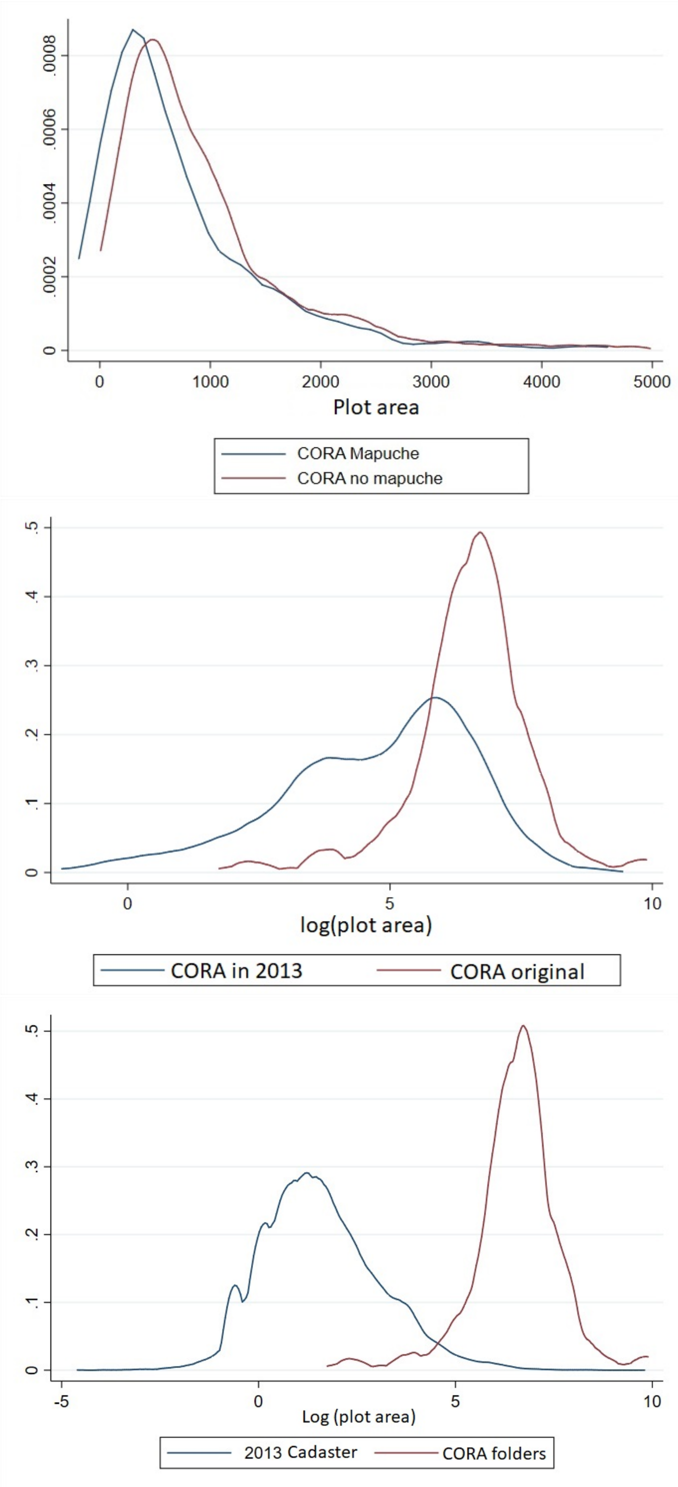
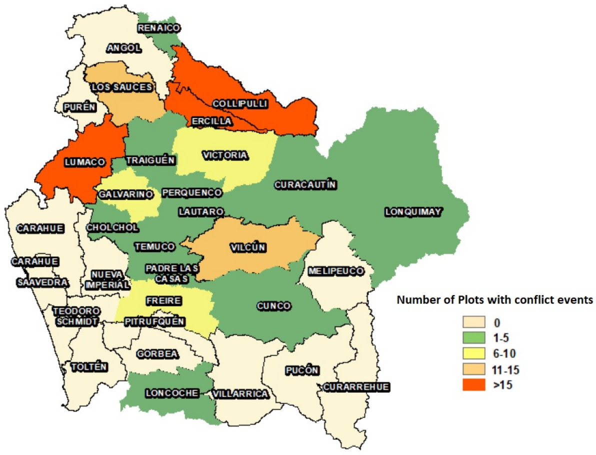
7 Additional figures

Figure A1: Distribution of plot size



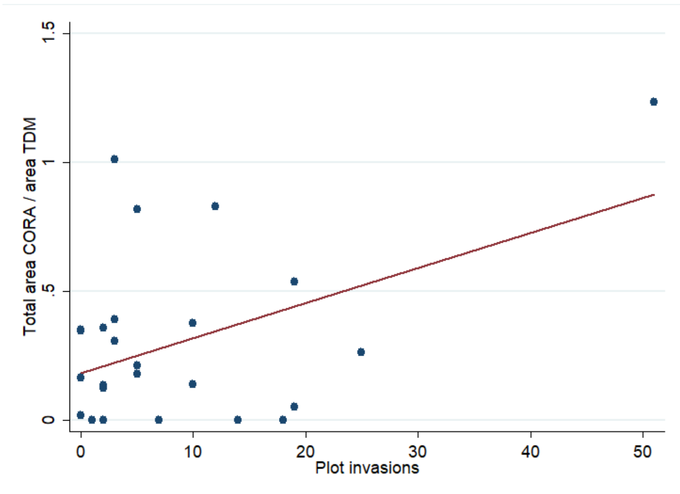
Note: The upper figure is size of the plots from CORA folders for plots with and without Mapuche participation in the land reform. The middle figure is the original size of CORA plots and the size in 2013. The lower figure is the distribution of the CORA plots (N=645) and the plots in the 2013 cadaster (N=144,091)

Figure A2: Map of the Araucania region and the distribution the rural conflict events (at municipality level)



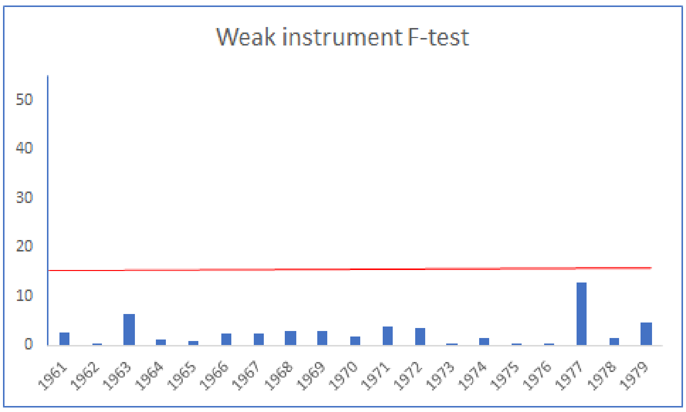
Note: Produced by the authors based on data from MACEDA.

Figure A3: Hectares expropriated during the land reform (as a share of TDMs) and plot invasions by municipality (1990-2016).



Note: Produced by the authors based on MACEDA data

Figure A4: Placebo F-test of the excluded instrument: Rainfall during the whole year



Note: Kleibergen-Paap F-test for different specifications. Red line is critical value at 10% maximal IV size.

8 Additional tables

Table A1: OLS estimation including municipality fixed-effects: Land reform and the current conflict (MACEDA, 1990-2016)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CORA	0.109***	0.086***	0.093***	0.116***	0.092***	0.095***	0.072***
	(0.020)	(0.018)	(0.018)	(0.025)	(0.026)	(0.023)	(0.023)
	[0.018]	[0.018]	[0.019]	[0.021]	[0.021]	[0.021]	[0.021]
CORA_TDM		0.082**			0.085**		
		(0.033)			(0.034)		
		[0.037]			[0.041]		
CORA_MAPUCHE				0.069		0.107*	
				(0.050)		(0.057)	
				[0.040]		[0.052]	
CORA_TDM_MAPUCHE							0.130***
							(0.039)
							[0.042]
TDM	-0.001	-0.001**	-0.001	0.018***	0.015***	0.017***	0.014***
	(0.000)	(0.000)	(0.000)	(0.005)	(0.004)	(0.005)	(0.004)
	[0.000]	[0.000]	[0.000]	[0.004]	[0.004]	[0.004]	[0.004]
N	143943	143943	143943	11609	11609	11609	11609
Mean Dep. Var.	0.001	0.001	0.001	0.014	0.014	0.014	0.014
specification	ALL	ALL	ALL	> 40 ha	> 40 ha	> 40 ha	>40 ha
CORA plots	455	455	455	367	367	367	367

Note: Robust standard errors in parenthesis and Conley inference, taking 10km as spatial cutoff, in brackets. The dependent variable is a dummy taking value one if a plot participated in a conflict event from MACEDA, zero otherwise. Fixed-effects at the municipality-level always included. Control variables include plot size (2013), the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital) and distance to water bodies.

Table A2: Robustness checks on the plot size cut-off: Land reform and current conflict, OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CORA	0.114***	0.121***	0.122***	0.072***	0.073***	0.074***	0.374***	0.317***	0.218*
	(0.017)	(0.021)	(0.023)	(0.018)	(0.021)	(0.023)	(0.079)	(0.117)	(0.124)
CORA_TDM_MAPUCHE				0.111***	0.132***	0.131***			
				(0.034)	(0.041)	(0.044)			
TDM	0.001**	0.024***	0.040***	0.001	0.018***	0.031***	0.002***	0.023***	0.040***
	(0.001)	(0.004)	(0.007)	(0.001)	(0.004)	(0.007)	(0.001)	(0.004)	(0.007)
N	53110	8931	4437	53110	8931	4437	53110	8931	4437
Mean Dep. Var.	0.004	0.017	0.028	0.004	0.017	0.028	0.004	0.017	0.028
CORA plots	436	351	313	436	351	313	436	351	313
specification	>6 ha	>50 ha	>92 ha	>6 ha	>50 ha	>92 ha	>6 ha	>50 ha	>92 ha
	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV
F-test weak instrument							110.117	46.001	39.253

Note: Robust standard errors in parenthesis. The dependent variable is a dummy taking value one if a plot participated in a conflict event from MACEDA, zero otherwise. Control variables include plot size (2013), the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

Table A3: Robustness checks on different specifications: Land reform and current conflict, OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)
CORA	0.116***	0.067***	0.302***	0.105***	0.066***	0.258**
	(0.020)	(0.020)	(0.110)	(0.019)	(0.020)	(0.111)
CORA_TDM_MAPUCHE		0.139***			0.108***	
		(0.036)			(0.038)	
TDM	0.021***	0.016***	0.020***	0.019***	0.016***	0.018***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
N	11670	11670	11670	11344	11344	11344
Mean Dep. Var.	0.014	0.014	0.014	0.013	0.013	0.013
CORA plots	428	428	428	352	352	352
specification	DIVIDED	DIVIDED	DIVIDED	NO ERCILLA	NO ERCILLA	NO ERCILLA
	OLS	OLS	IV	OLS	OLS	IV
F-test weak instrument			52.339			49.208

Note: Robust standard errors in parenthesis. The dependent variable is a dummy taking value one if a plot participated in a conflict event from MACEDA, zero otherwise. Columns 1 to 3 consider a sample with all plots resulting from the division of a CORA plot. Columns 4 to 5 consider a sample without the plots located in the municipality of Ercilla. Control variables include plot size (2013), the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

Table A4: First stages of the IV estimations

	Invaded	CORA	CORA_TDM	CORA_MAPUCHE	CORA	CORA_TDM	CORA_MAPUCHE	CORA_TDM_MAPUCHE
$\text{SHOCK}_{p,1970}$	0.041***	0.029***	0.010***	0.006***	0.193***	0.070***	0.029***	0.069***
	(0.011)	(0.003)	(0.001)	(0.001)	(0.027)	(0.010)	(0.007)	(0.010)
	[0.013]	[0.005]	[0.002]	[0.001]	[0.037]	[0.015]	[0.010]	[0.016]
$\text{SHOCK}_{p,1970}$_TDM		-3.859			-4.895*			
		(1.786)			(1.754)			
		[3.192]			[2.788]			
$\text{SHOCK}_{p,1970}$_MAPUCHE			-4.864***			-5.524***		
			(1.338)			(1.388)		
			[2.446]			[2.118]		
$\text{SHOCK}_{p,1970}$_TDM_MAPUCHE							-4.422**	
							(1.374)	
							[2.118]	
N	143112	143112	143112	11609	11609	11609	11609	11609
mean_depvar	0.004	0.003	0.003	0.003	0.032	0.032	0.032	0.032
specification	>40 ha	ALL	ALL	ALL	>40 ha	>40 ha	>40 ha	>40 ha

Note: Robust standard errors in parenthesis and Conley inference, taking 10km as spatial cutoff, in brackets. Control variables include plot size (2013), the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

Table A5: Plot invasion (during the land reform) and current conflict (MACEDA, 1990-2016)

	(1)	(2)	(3)	(4)	(5)
Invaded	0.218***	1.468***	0.129**	0.215***	1.426**
	(0.053)	(0.472)	(0.062)	(0.060)	(0.592)
	[0.054]	[0.588]	[0.068]	[0.059]	[0.665]
Invaded_TDM_MAPUCHE			0.045		
			(0.107)		
			[0.109]		
N	143943	143112	143943	11609	11609
Mean Dep. Var.	0.001	0.001	0.001	0.014	0.014
invaded plots	62	62	62	50	50
F-test weak instrument		23.203			14.083
specification	ALL, OLS	ALL, IV	ALL, OLS	>40 ha, OLS	>40 ha, IV

Note: Robust standard errors in parenthesis and Conley inference, taking 10km as spatial cutoff, in brackets. Control variables include plot size (2013), the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.

Table A6: Reduced form: Conflict and rainfall shock in different years

	Reduced form: rainfall instrument 1961-1979																			
	70	61	62	63	64	65	66	67	68	69	71	72	73	74	75	76	77	78	79	
$SHOCK_{p,1970}$	0.059**	0.071***	0.075***	0.071***	0.071**	0.072***	0.067**	0.040	0.051*	0.071**	0.057**	0.072***	0.067**	0.067**	0.063**	0.076***	0.070**	0.074***	0.071***	
	(0.027)	(0.028)	(0.028)	(0.027)	(0.028)	(0.028)	(0.027)	(0.035)	(0.028)	(0.032)	(0.026)	(0.028)	(0.027)	(0.027)	(0.026)	(0.028)	(0.027)	(0.028)	(0.028)	
$SHOCK_{p,year}$		0.017*	0.029**	0.009	0.021**	0.026***	0.009	0.036	0.008	-0.014	0.003	0.009**	0.006	0.009	0.088***	0.024***	0.008	0.034**	0.013**	
		(0.009)	(0.012)	(0.006)	(0.009)	(0.010)	(0.008)	(0.036)	(0.009)	(0.012)	(0.021)	(0.004)	(0.006)	(0.007)	(0.030)	(0.008)	(0.006)	(0.014)	(0.006)	
	Reduced form: rainfall instrument 1990-2009																			
	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
$SHOCK_{p,1970}$	0.058***	0.065***	0.076***	0.040	0.061***	0.062***	0.085**	0.057***	0.041*	0.049***	0.057***	0.043**	0.086***	0.102***	0.019	0.046**	0.052**	0.038	0.056***	0.060***
	(0.020)	(0.022)	(0.022)	(0.026)	(0.020)	(0.022)	(0.035)	(0.022)	(0.021)	(0.019)	(0.021)	(0.019)	(0.028)	(0.029)	(0.020)	(0.020)	(0.021)	(0.026)	(0.020)	(0.020)
$SHOCK_{p,year}$	-0.003	0.016	-0.038	-0.027	-0.007	-0.036	0.041	0.004	-0.104***	0.047	-0.038***	-0.038**	-0.021***	-0.048***	-0.064***	-0.040***	0.009	-0.054	-0.060	0.005
	(0.023)	(0.015)	(0.024)	(0.019)	(0.010)	(0.025)	(0.032)	(0.006)	(0.036)	(0.034)	(0.011)	(0.016)	(0.008)	(0.013)	(0.016)	(0.011)	(0.012)	(0.037)	(0.048)	(0.015)
	N=11609 (>40Ha sample)																			

Note: The dependent variable takes value one if there was an event conflict in a plot (1990-2016), zero otherwise. $SHOCK_{p,1970}$ is deviation of rainfall of 1970 from its historical mean and $SHOCK_{p,year}$ deviation of the year in each column from its historical mean. Robust standard errors in parenthesis and Conley inference, taking 10km as spatial cutoff, in brackets. Control variables include plot size (2013), the share of the plot's area that is within a TDM, a dummy for plots divided after land reform as well as plot's altitude, distance to Temuco (the regional capital), distance to water bodies and province fixed-effects.