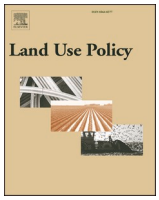
Land Use Policy 134 (2023) 106917

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol



Impact of early access to land record information through digitization: Evidence from Alternate Dispute Resolution Data in Punjab, Pakistan

Inayat Ullah [a,*], Saqib Hussain [b]

[a] Dept. of Govt & Public Policy (GPP), National University of Sciences & Technology (NUST), Pakistan
[b] KDI School of Public Policy and Management, Republic of Korea

ARTICLE INFO

JEL Classification:
G38
Q15
J52
B23

Keywords:
Land Administration
e-Governance
Alternate Dispute Resolution

ABSTRACT

We leverage novel data extracted from weekly updated registers of Alternate Dispute Resolution (ADR) centres to examine the impact of early access to land record information through digitization on dispute resolution outcomes in the Punjab province of Pakistan. Employing a quasi-experimental design, we estimate the causal effect of early access to Punjab Land Record Management Information System (PLRMIS) on the registration and resolution process of land-related disputes. Our results reveal that ADR centres in districts with early treatment experience an average increase of approximately 50 cases compared to those in districts with late treatment. By utilizing generalized multi-level mixed effect and two-stage least square models, we find that early implementation of PLRMIS significantly increases successful mediation outcomes by 126 cases in the treatment region with no effect on mediation failure cases. These findings provide compelling evidence for the pivotal role of PLRMIS in facilitating effective alternate dispute resolution, indicating increased public utilization of the system. Our results underscore the effectiveness of digitization and e-governance systems in improving land administration, reducing information asymmetry, and expediting the dispute resolution process.

1. Introduction

The transformation of land governance systems is increasingly emphasized in developing countries to keep pace with the digital evolution and meet the rising expectations of citizens. Various national and international organizations, as well as governments, have played a crucial role in introducing reforms aimed at transforming conventional land record management systems. For instance, the World Bank has committed billions of dollars in different parts of the developing world to upgrade inefficient, paper-based land records and services (World Bank, 2005; Holstein, 1996; USAID, 2010). These reforms have core objectives that encompass economic growth, political stability, credit supply, environmental preservation, and the achievement of sustainable development goals (SDGs) (Conning and Deb, 2007; De Soto, 2000; North, 1990). Previous research on land-related reforms has predominantly focused on their direct short-run effects. While the extent of these effects is still debated, the existing findings suggest that digitization of land records benefits certain stakeholders by increasing ownership security, enhancing transparency, reducing transaction costs, preventing fraud, and improving record accessibility. Most studies on land-related reforms have overlooked the assessment of their impact on civil disputes, which primarily stem from an ambiguous land record system.

Land in the Punjab province of Pakistan is known for its fertility, agricultural diversity, and its contribution to the rural economy of the country. Prior to the implementation of the land digitization program, issues related to land ownership and administration posed significant constraints for both the government and the general public in realizing its true value. These issues included inefficient registration and transfer systems, tenure insecurity, and disparities in land distribution (Ali, 2013; Marshall, 1975; Thakur et al., 2005). The archaic manual land record system, which had been in place for centuries, also led to increased transaction costs for formal and informal land transactions, as well as a rise in land-related disputes in both rural and urban areas (Cheema et al., 2006). In Pakistan, land-related disputes in civil courts are often delayed due to the inefficiencies and complexity of the land record system. Instances of fraud, incorrect demarcation and multiple parties registering claims to the same piece of land are the primary causes behind the majority of disputes brought before Pakistan's civil courts."

In this research, we hypothesize that providing the public with easy access to land records initially leads to an increase in the frequency of land-related dispute registrations. This increase was observed in the

* Corresponding author.
E-mail address: inayat@s3h.nust.edu.pk (I. Ullah).

https://doi.org/10.1016/j.landusepol.2023.106917
Received 24 March 2022; Received in revised form 12 September 2023; Accepted 14 September 2023

Punjab province as a result of the land-record digitization program that made land-related information publicly accessible. However, we argue that this enhanced access indirectly contributed to a higher likelihood of successful dispute resolution. We assume that in the past, the public had limited access to land records, and obtaining that information incurred high transaction costs, resulting in a lower number of dispute registrations. We specifically attempt to answer the following questions:

- Do districts that had early access to the digitization program exhibit differences in land-related dispute registrations compared to districts where the program was implemented three years later?
- Does the PLRMIS have a direct or indirect causal effect on the dispute resolution process in the Punjab province?

Using novel data extracted from weekly registers maintained by Alternate Dispute Resolution (ADR) centres in Punjab, our analysis reveals a substantial increase in the number of civil disputes, specifically those related to land, in districts that were exposed to the PLRMIS by 2013 compared to districts where the program was implemented three years later in 2016.

The following section offers a brief overview of the historical development of land administration and the importance of transparent property rights in the sub-continent. Section 3 presents a detailed account of the digitization process and the establishment of alternate dispute resolution centres in Punjab. Section 4 outlines the study area, data sources, and the methodology employed in this study. The results are presented and discussed respectively in Section 5 and Section 6. The last section concludes.

2. Land governance and property rights

2.1. The historical context of land administration in Pakistan

The history of land administration and revenue generation in the Indian Sub-continent dates back to the 13th and 14th centuries, when Ala Uddin Khilji, the first Indian Sultan, initiated the registration and administration of land records (Ali, 2013). Subsequent rulers continued this practice and collected land revenue. In the 16th century, Sher Shah Suri introduced fixed crop rates, leading to significant improvements in the measurement of land records (Thakur et al., 2005). In the 17th century, Akbar, the powerful emperor of the Mughal Empire, implemented substantial reforms in land administration, including the classification of lands and revenue estates (Ali, 2013). The British rule, which followed the Mughal Empire, further enhanced the land administration system to increase land revenues across the sub-continent (Marshall, 1975). However, the uniform implementation of laws posed challenges, leading to the introduction and modification of state-specific regulations during British rule (Thakur et al., 2005). An important intervention by the British rule in India was the "Punjab Land Alienation Act 1900," which prohibited land transfer rights from agriculture to non-agriculture class (Cheema et al., 2006). Although minor amendments occurred over the years, major land-related laws introduced by the British government, such as "the transfer of property act of 1882" and "the Punjab tenancy act of 1887," continued to exist after the independence of Pakistan and India in 1947. For example, the "land revenue act of 1887" was amended with "the Punjab land revenue act of 1967." Today, the overall land administration system in Pakistan operates within the framework of the British era's laws and regulations (UN-HABITAT, 2012). Table A1 in the supplementary information provides a detailed timeline and evolution of land-related legislation in Pakistan spanning 140 years.

2.2. Transparency in land ownership and social and economic outcomes

There is wide recognition among policy makers and economists about the importance of an efficiently administered and strongly protected landownership (Falkinger and Grossmann, 2013; Papageorgiou and Turnbull, 2005; Lippit, 2018; Blocher, 2006; Derby and Francis, 2002). Land ownership, as a vital household asset, plays a significant role in improving social and economic outcomes. However, realizing these benefits requires a secure property rights regime. Secure property rights can lead to reduced individual spending on rights protection and lower expropriation risks, thereby enhancing investment incentives. Additionally, land serves as a primary source of collateral for accessing credit from both formal financial institutions (such as banks) and informal credit providers (ADB, 2019; Ali et al., 2014). Numerous studies conducted in developing contexts highlight the significant role of secure property rights regimes in facilitating access to credit (Deininger and Goyal, 2012; Greif, 1993; North, 1981).

Nevertheless, land-related disputes are prevalent in developing countries due to the lack of a transparent and efficient land administration system (Qazi, 2006; Wehrmann, 2008; Magsi et al., 2017). Previous studies have identified various factors contributing to land-related disputes in developing countries (Bennett et al., 2021; Sarwar and Jalil, 2017). These factors include, but are not limited to, land ownership rights (Boone et al., 2013), transaction costs (Rusu and Hodosi, 2011), ambiguity in land records, tenure security, land titling, and access to credit through collateral lands (Edeh et al., 2022). Land tenure, or tenure security, refers to people's ability to manage and control land, utilize it, dispose of its produce, and engage in transactions, including transfers (International Fund for Agricultural Development, 2015). According to UN-HABITAT (2012), the lack of governments' ability to provide tenure security as a protective right against forced evictions often leads to disputes among different parties (Boudreaux and Sacks, 2009). The conventional paper-based land administration system is primarily maintained for tax collection, while tenure security depends on legal, administrative, and social factors (Ali et al., 2014). The PLRMIS Project appraisal document highlights the high costs associated with land transactions and the prevalence of land rights disputes in Punjab, attributing both issues to the inefficient and outdated land records system (World Bank, Project Information Document, 2005). A key sentence from the project documents is reproduced as below:

> "Inequalities of land distribution, tenure insecurity and difficulties associated with the land administration and registration system are closely interrelated and continue to impose significant constraints on both rural and urban populations, particularly the poor. Land transactions are relatively expensive, and disputes about accuracy of land rights are caused, among others, by the inefficient and dispersed land records system. As a result, land markets are thin and land prices are more than the discounted value of potential agricultural earnings from land. The low mobility of land contributes to perpetuating the highly unequal distribution of land and, thus, livelihood opportunities" (World Bank, Project Information Document, 2005 pp. 1)

Other studies have highlighted the presence of information asymmetry in the conventional paper-based land record system, leading to inefficiencies in land markets and limited access to formal credit (Ali et al., 2014; World Bank, 2005; Huggins and Frosina, 2017; Mitchell et al., 2008). In Section 3.3, we present a theory of change that elucidates the potential mechanisms through which the PLRMIS may impact various outcome of interest.

3. Digitization and the establishment of alternate dispute resolution centres

3.1. Introduction of the Punjab Land Record Management Information System

Recognizing the significance of efficient land administration and its impact on the broader domains of governance and administration, the Punjab provincial government, in partnership with the World Bank,

introduced the Punjab Land Record Management Information System (PLRMIS) and established the Punjab Land Record Authority. The primary objective of PLRMIS was to enhance public access to land information and promote transparency in land records. The program was initially launched in eighteen districts of the province in 2013, collectively referred to as the Early Treatment Region. Subsequently, in the second phase, the program was expanded to cover the entire province in 2016. According to the project documents, one of the key objectives of the program was to provide public access to land-records at low cost and to provide tenure security which ultimately leads to lesser transaction cost.

Unlike the conventional system, the PLRMIS introduced a user-friendly interface that facilitated easy access to land records and streamlined land transactions. To address any resistance and foster a positive attitude among key stakeholders, such as the Land Record Staff (known as "Patwaris") at the Tehsil level, the program implemented various training and capacity-building initiatives. Initially, there was resistence by the Patwaris, but through extensive negotiations, the program incorporated incentives and capacity-building measures for existing staff in the implementation of the PLRMIS. These included the construction of new field offices equipped with IT facilities, transportation allowances, and the allocation of 2% of land revenues to revenue officers. Considering that rural areas often exhibit slower response to such technological advancements, the program launched public awareness campaigns to encourage active participation and utilization of the digitized record management systems. These campaigns included the organization of 36 workshops between December 2011 and February 2014, involving 5663 internal key stakeholders, such as district collectors, additional district collectors, assistant commissioners, and revenue functionaries like tehsildars, girdawars, and patwaris. Additionally, consultations were conducted with 250 representatives from the Punjab Bar Association and field revenue staff to ensure effective implementation of the program. These measures aimed to address potential challenges arising from social unawareness and promote widespread adoption of the PLRMIS.

3.2. The alternate dispute resolution mechanism

Alternative dispute resolution refers to a process in which a neutral third party—a mediator or arbitrator—helps parties who are embroiled in a dispute come to an agreement (Katie, 2023). There are a number of methods that can be followed in ADR, for instance, negotiation, arbitration, conciliation, mediation, evaluation, and transaction (Menkel--Meadow, 2015). The most common feature of any type of ADR method is to find an admissible solution for any dispute without following formal court procedures. Its ultimate purpose is to understand the factual problem at the ground level and resolve it by negotiation (Nathanson, 1997).

Land-related disputes are prevalent in Pakistani courts, with over a million cases pending nationwide across Punjab, Sindh, Khyber Pakhtunkhwa (KP), and Balochistan (Ali and Nasir, 2010). The main causes of these disputes include inaccurate or fraudulent land records, erroneous boundary descriptions leading to overlapping claims, and multiple registrations by different parties (Dowall and Ellis, 2009; USAID, 2008). To reduce burden on the judiciary, the ADR centres were established by the provincial government of Punjab in collaboration with the World Bank in all 36 districts of Punjab in 2016 (Awais and Munir, 2018; Hamid et al., 2016). The core objective of ADRs was to register and resolve the land-related dispute through ADR methods including but not limited to negotiation, mediation, and evaluation. According to the Punjab Alternate Dispute Resolution Act 2019, when a person from the general public gets aware of information about his/her land ownership but it is not in his possession, he/she can file a dispute reference in court. The court refers the dispute case to the ADR centre within thirty days of the filing of the case by the defendant. Besides a personal petition, if a trial court finds any land-related dispute resolvable at ADR, it can refer that case at any stage and at any time to ADR for resolution. Before referring any dispute to ADR, the court shall take the opinion of parties for any specific ADR centre.[1] The court also schedules a timeframe for the resolution of the case that must not exceed 60 days after reference. However, the resolution time may be extended on the application of both parties and the extension may be granted for a maximum of 6 months (The Punjab Alternate Dispute Resolution Act, 2019). Each Centre is represented by a setting judge who is called Mediator.

3.3. Information asymmetry and the choice of parties to select the resolution process

We posit that the choice of parties to opt for alternate mediation process is strongly affected by the availability and access to land record through PLRMIS. Drawing on Klein et al. (2016) and Duke and Jost's (2003) signaling model, we explore the potential impact of digitization on the outcome of dispute mediation in a strategic game scenario. In the presence of ADR centres, parties who have disputes and have taken their disputes to the courts can now decide whether to opt for their proceedings through ADR or continue the litigation process through courts.

Consider two parties involved in a land dispute: Disputant 1 (D1) and Disputant 2 (D2). The desired outcome is the resolution of land disputes with minimal cost and in shorter timeframe. In the presence of information asymmetry, such as prior to the digitization of land records, both parties faced higher costs in the dispute resolution process through litigation. However, in the post-digitization scenario, where both parties are aware that land ownership information is public and transparent, they have equal access to factual information. This increased transparency raises the probability of reaching a resolution faster than before. Suppose D1 chooses to accept alternate mediation (e.g., cooperates (C)) for the dispute, while D2 defects and resorts to the litigation process through the judicial system. D2's decision will ultimately result in no assignment of the dispute to ADR, and conventional litigation will lead to less favorable outcomes for both parties in terms of time and cost. Therefore, choosing cooperation by opting for ADR becomes the likely decision for both parties as it maximizes their benefits. Thus, introduction of the digitized land record system has a great potential to overcome the information asymmetry that otherwise causes a high transaction cost for parties to initiate or peruse disputes related to land ownership and use.

Fig. 1 illustrates the relationship between PLRMIS, dispute registration, and ADR outcomes, highlighting the role of information asymmetry. Prior to the implementation of PLRMIS, land records were manually maintained and not accessible to the general public, resulting in a low number of land-related disputes. The figure also suggests a potential reverse causality, where the implementation of the PLRMIS may have been driven by a higher number of disputes. For instance, the PLRMIS was first proposed in 2003–04, followed by a pilot project in Rahim Yar Khan and Gujrat in 2005. Subsequently, it expanded to cover 13 districts by 2010 and was fully implemented in 18 districts in 2013, with the remaining 18 districts implemented in 2016. Fig. 2 supports this notion by displaying a higher density of Mouzas, which serves as a proxy variable for a larger volume of land records, in the early treated districts. This observation raises the possibility of selection bias in program implementation, highlighting the need for a more rigorous investigation of the program's effectiveness.

[1] In Section 5, we discuss the possibility of dispute registration and resolution process being driven by the individual Judge-specific characteristics.

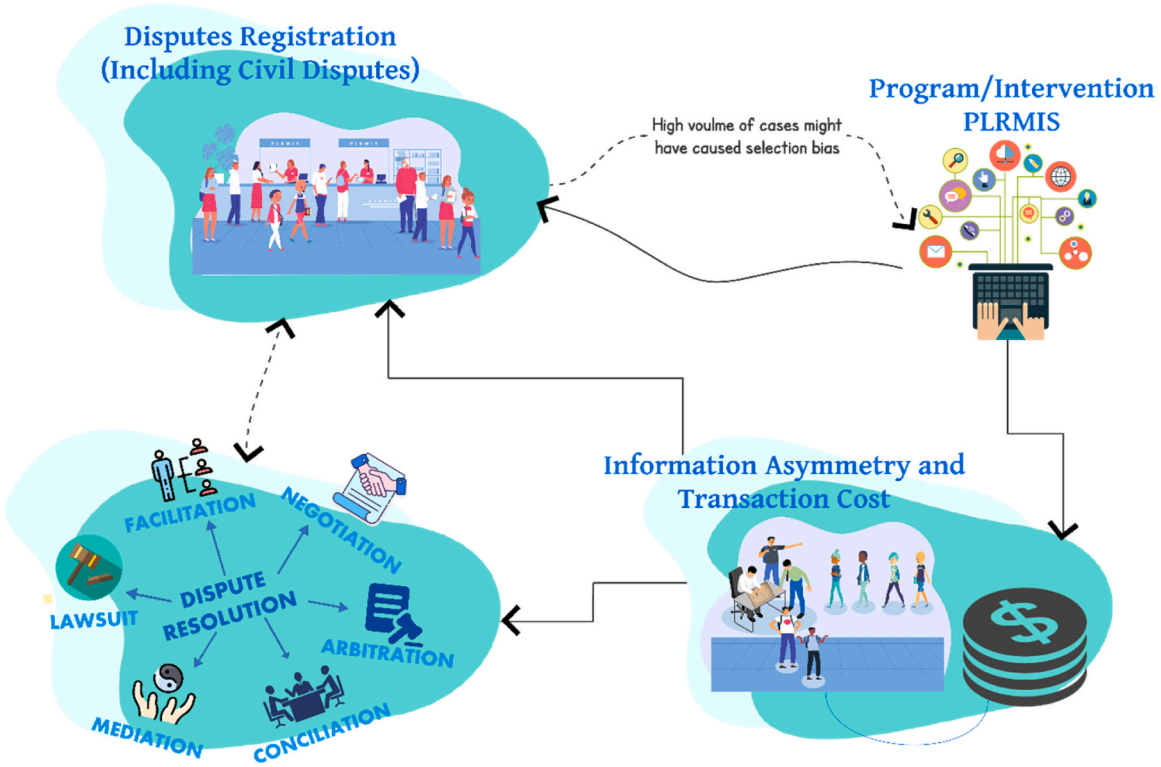


Fig. 1. Styled Model of Program's Expected Effect.

4. Study area, data and methodology

4.1. The study area

The Punjab province occupies a total area of 205,345 km^2 and is the most densely populated province in Pakistan, housing over 80 million inhabitants, which accounts for 55% of the country's total population. Most of the Punjab's population is distributed across the rural areas where agriculture is the dominant sector of the economy. The administrative unit of the province is district while the agricultural land size is measured by the number of mauzas. Due to budget constraints, initially the PLRMIS was implemented only in the 18 districts of Punjab while the remaining[2] districts were included later in 2016. Fig. 2 shows the implementation of the program in two sets of districts in Punjab with a maximum of three years difference. For experimental purposes, those 18 early exposed districts are called the early treatment group while those districts that were exposed to the program later in 2016 are called the late treatment (comparison) group.

4.2. Data

Our analysis relies on data obtained from the weekly maintained registers of Alternative Dispute Resolution centres operating in each district of the Punjab Province. The data covers the period from June 2017 to December 2020, and includes key variables of interest such as the number of disputes registered, successfully mediated references, failed mediation cases, criminal cases, civil cases, rent-related cases, and disputes other than these categories. To facilitate analysis, the data is organized in a multi-level panel format, where each week is represented for each mediating judge in corresponding district. While most data points are reported on a weekly basis (from one specific date to another date), some instances involve reporting for a two to three-week period, resulting in an unbalanced panel. To address this issue, we introduce a variable called "period in days" which calculates the number of days between the "from" date and the "to" date. Additionally, we create a new time variable called "week" and assign a unique value ranging from 1 to 63 based on the reported count of cases over time.

Table 1 presents summary statistics in a panel decomposed form for the key variables derived from the ADR weekly data. Furthermore, we include the standard deviation for each variable, both between districts and within districts. The reason for panel decomposition is to understand the variance of variables of interest between districts and within districts over time. The "within" standard deviations tells us how much each of the variable varies within districts *i*, while ignoring all variation between districts. Similarly, the between standard deviation shows the variation between districts while ignoring the within variation in each district.

In addition to ADR data, we also use data on the other variables including gross literacy rate, population density, number of police stations, number of mauzas- a territorial unit for land administration purpose precisely measured and divided into plots/khasras/survey numbers-, which come from the Punjab Development Statistics.

4.3. Empirical strategy

To evaluate the impact of PLRMIS on disputes registration and resolution outcomes in Punjab, we adopt a quasi-experimental approach. We compare two sets of districts: the early-treated districts where PLRMIS was fully functional by 2013, and the late-treated districts where the implementation was completed in 2016. This comparative analysis allows us to assess the causal effects of PLRMIS on the desired outcomes while considering temporal and spatial variations in the program's implementation.

As an initial step, we compare the means of the outcome variables between the treated districts and controlled districts to identify any

[2] In 2017, Punjab was administratively divided into 36 districts, however in the ADR data we use in this study, some districts were divided into two units, therefore the total number of administrative units are 38.

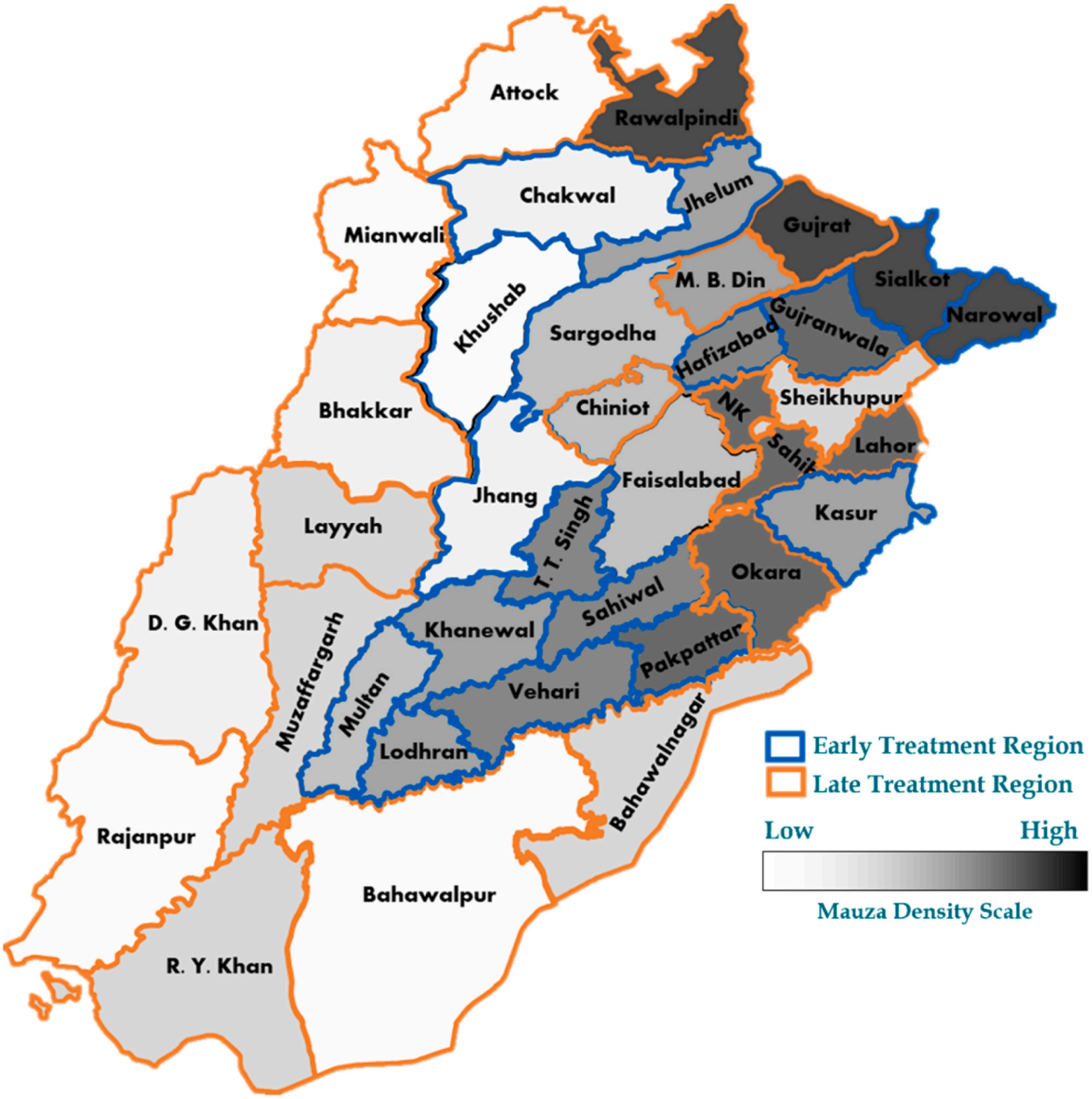


Fig. 2. Implementation of PLRMIS and Mauza Density in Punjab. (Source: Authors analysis using data from Punjab Development Statistics) *Note:* Mauza-density is measured as the ratio of total number of mauzas to the total size of the district is square kilometers.

significant differences. Furthermore, we employ kernel density plots (see Fig A1 in the supplementary information) to visualize the observed difference in outcome variables between treated and control districts. However, relying only on mean differences can be biased, as indicated by the substantial differences among the overall, within, and between standard deviations presented in Table 1. For instance, the reported standard deviations for total disputes registered highlight that the variation across districts (SD = 105) differs from the variation within districts (SD = 171). This suggests that if we randomly select two districts from the data, the difference in the total number of registered disputes is likely to vary compared to the difference within a single district over two randomly selected weeks. Furthermore, simple mean comparisons are susceptible to potential bias caused by confounding factors that may simultaneously influence the variables of interest, independent of the treatment.

4.4. *Between-within hybrid model*

Panel data offers the advantage of controlling for time-invariant unobserved heterogeneity, making it highly recommended for causal research (Wooldridge, 2010). By employing various forms of difference within and between groups, panel data enables the removal of time-invariant unobserved heterogeneity, although time-varying omitted variables may still be present (Chatelain and Ralf, 2021). Given the longitudinal nature of the ADR data, which spans over 63 weeks and consists of district-level information, and the fact that our parameter of interest is a binary time-invariant variable, the "early--treated district" dummy, standard fixed-effect models or first-difference estimators cannot be utilized to control for unobserved heterogeneity. Figure A2 in the supplementary information displays the district-wise trend in the number of disputes registered in ADR centres for the

Table 1
Summary of ADR Weekly Reports and PDS Data [With panel decomposed SDs].

Variable	Panel	Mean	Std. Dev.	Obs
Alternate Dispute Resolution Variables				
Number of Total Disputes Registered	Overall	318.70	200.70	N = 2394
	Between		105.0	n = 38
	Within		171.85	T = 63
Criminal Cases	Overall	100.87	107.42	N = 2394
	Between		86.10	n = 38
	Within		65.70	T = 63
Land-Related /Civil Cases	Overall	103.7	87.41	N = 2356
	Between		64.54	n = 38
	Within		59.85	T = 63
Family-Cases	Overall	159.30	156.46	N = 2394
	Between		123.04	n = 38
	Within		98.66	T = 63
Guardian Cases	Overall	9.64	12.46	N = 2394
	Between		10.95	n = 38
	Within		6.20	T = 63
Rent-related Cases	Overall	2.15	4.18	N = 2394
	Between		3.78	n = 38
	Within		1.87	T = 63
Other Cases	Overall	19.59	23.67	N = 2394
	Between		19.53	n = 38
	Within		13.72	T = 63
Cases of Mediation Failure	Overall	53.96	43.97	N = 2394
	Between		30.25	n = 38
	Within		32.27	T = 63
Cases of Mediation Success	Overall	116.46	116.46	N = 2394
	Between		70.32	n = 38
	Within		93.52	T = 63
Demographic and Geographic Variables				
Police Stations	Overall	18.711	7.892	2394
Mauzas	Overall	682	344.327	2394
Total Area (km2)	Overall	5551.29	4330.406	2394
Population Density	Overall	491.595	306.152	2394
Adult Literacy (% adult population)	Overall	61.9	18.2	2394

Notes: Summary statistics of the key variables used in this study are reported. Data on alternate dispute resolution variables comes from Lahore High Court publications of ADR data, while data on demographic and geographic variables come from Punjab Development Statistics (PDS). N, n, T represent total number of observations, number of districts and number of time periods in weeks, respectively.

initial 10 weeks, demonstrating that each district exhibits a linear trend in registered disputes, with the overall number varying across districts. A similar trend was observed for the sub-types of disputes registered in ADR offices. Consequently, we adopt a hybrid model as an alternative to standard random effect (RE) or fixed effect (FE) models in the linear case. By demeaning the explanatory and outcome variables (subtracting the mean value from each observation), we address the issue of omitted coefficients of level-two variables. Consider between model as below:

$$\bar{y}_i = \beta\bar{x}_i + \gamma d_i + u_i + \bar{\epsilon}_i \tag{1}$$

where $\bar{y}_i$ is the mean of level-one outcome variable by district, $\bar{x}_i$ is the mean of level-one explanatory variable by district i, d_i is the level-two variable dummy (early treatment, and other controls) that only varies between clusters, u_i is the level-two error term, $\bar{\epsilon}_i$ is the mean of level-one error term. The standard random effect model is given by:

$$y_{it} = \beta x_{it} + \gamma d_i + u_i + \epsilon_{it} \tag{2}$$

where the subscript *i* and t represent the level-two-unit district and level-one-unit time (in weeks) respectively. Subtracting (2) from (1) leads to the "within transformation" that averages out all time-invariant elements including the level-two error term due to the fact that $\bar{d}_i = d_i$ and $\bar{u}_i = u_i$. This within-transformed model is given as:

$$(y_{it} - \bar{y}_i) = \beta_{FE}(x_{it} - \bar{x}_i) + (\epsilon_{it} - \bar{\epsilon}_i) \tag{3}$$

Our interests is not to examine what happens within each district itself, rather we treat them as a random sample from a larger population and following Ruppert et al. (2003) and Diggle et al. (2002), we model the between-districts variation as a random effect at the district level. We thus adopt a hybrid model that separates within- and between-district effects (Neuhaus and McCulloch, 2006; Schunck, 2013; Allison, 2009) and the correlated random-effects model (Cameron and Trivedi, 2005; Wooldridge, 2010) as below:

$$g(\mu_{it}) = \beta_W(x_{it} - \bar{x}_i) + \beta_B\bar{x}_i + \gamma d_i + \alpha_i + u_i \tag{4}$$

This specification includes both the deviation from the district-specific means $(x_{it} - \bar{x}_i)$ and the district specific mean $\bar{x}_i$ among other covariates in the model. γ is the coefficient of time-constant variables that include the early treatment dummy, population density, literacy rate, number of police stations and mauza density. We assume that these time-constant variables included as regressors are not correlated with unobserved district level characteristics (i.e., $\text{cov}(d_i, \alpha_i) = 0$). Also, we hold the strict exogeneity assumption about our regressor (early treatment), which implies that the (unconditional) expected value of the error term (u_i) is zero while the error term does not correlate with any of our explanatory variables including the early treatment dummy. We estimate Eq. (4) using a generalized linear mixed model (GLMM), an extension of generalized linear model (GLM), allowing for estimating a random effect model that also takes care for the fixed effect component in the regression. For the GLMM model, we control for demographic and geographic characteristics including population density, literacy rate, number of police station and mauza density, as well as control for individual mediating judge fixed effect.

We also compare the estimates of the hybrid model with a closely related model called "correlated random-effect or Mundlak (1978)" model. Schunck and Perales (2017) and Wooldridge (2010) suggest including the level-one variable (x_{it}) in its undemeaned (original state of variable without subtracting mean value from observations) form. These decomposed models can approximate fixed-effects estimates for specifications in which a fixed-effects estimator is not available or implemented (Neuhaus and McCulloch, 2006; Schunck, 2013).

4.5. Endogeneity in early treatment and the two stage least square approach

Causally attributing the difference in outcome variables between the two groups solely to the PLRMIS requires careful consideration of potential sources of endogeneity when working with observational data. Several factors, such as self-selection into treatment, unobserved time-varying confounders, unit heterogeneity, measurement error, reverse causality, and autocorrelation, can induce bias in our analysis (Angrist and Krueger, 2001). In our case, one potential source of selection bias is the criterion used to select districts for early implementation of the PLRMIS. During the initial stage of PLRMIS implementation, 18 districts in Punjab were at the Kanungoi (sub-tehsil) level due to logistical constraints and limited resources. However, later implementation at the Tehsil level in the remaining districts was deemed more rational and feasible (World Bank, 2017). While the selection of districts into treatment was primarily driven by budget and feasibility considerations rather than socioeconomic factors, it is still possible to argue that district selection may have been influenced by geographical subdivisions or other unobserved factors. In this case, there could be reverse causality, where districts with a larger volume of land records were prioritized for early treatment.

To address these concerns, we follow the approach suggested by Hausman and Taylor (1981) and utilize an instrumental variable that meets the necessary conditions and induces variation in the early treatment dummy. We estimate the interaction effect of mauza density

and the total number of disputes registered on the early treatment variable and obtain the predicted values of the endogenous early treatment. This instrumental variable approach helps us address the potential endogeneity issues and strengthen the causal interpretation of the effect of the PLRMIS on the outcome variables (Utami et al., 2021).

First Stage:

$$g(ET_{it}) = \beta_0 + \beta_1(MD_i \times R_{it}) + \beta_2 MD_i + \beta_3 R_{it} + \delta X_{it} + \tau_t + U_{it} \quad (5)$$

where $g(ET_{it})$ is a (probit) function of binary dependent "early treatment" dummy, MD represents the mauza density in district i (measured as total number of mauza divided by the size of the total area in km^2), R_{it} represents the number of received cases to ADR centres in district i at time t. Our interest in the first stage is in the statistical strength of β_1(interaction term). We then run second stage regression of ADR outcome on the predicted values of treatment conditional on district, time, and individual judge fixed effects as follows:

Second Stage

$$Y_{ijt} = \theta_0 + \widehat{\theta}_1 ET_{ijt} \quad + \theta_2 X_{ijt} + \delta_i + \gamma_j + \tau_t + \varepsilon_{ijt} \quad (6)$$

where θ_1 is the parameter of interest indicating the causal effect of program on the outcome of a dispute case Y in district i with mediator *j* in week *t*. For the dispute resolution outcome variable, we also use individual judge fixed effect (γ_j)in this model considering the idea that dispute resolution partly also depends on the personal abilities of a mediating judge. This specification rests on the following justification and assumptions.

If we consider that districts selection into the treatment was based on the volume of existing land records, then the best option would have been to use the original land records data across districts. However, we lack direct observations of the actual land records at the time of assignment. Instead, we utilize the total number of registered disputes as a proxy to approximate the volume of land records. Nevertheless, considering the significant variation in district land sizes across Punjab, using the total number of cases alone is inadequate. To address this, we incorporate the interaction between mauza density (indicating land size) and the total number of registered cases, which serves as a reasonable proxy for the presumed land records at the time of treatment assignment. We find a strong correlation between early treatment and this interaction term i.e., COV (ET, MD*R)‡ 0. Further, we also assume that there is no direct effect of interaction term (MD*R) on the dispute resolution outcomes (Y) except through early treatment after controlling for covariates. Further we assume that weekly average of the number of cases registered in ADR offices is not correlated with individual district random effect.

4.6. Interviews with key informants

To gather in-depth insights and perspectives from individuals who possess specialized knowledge and expertise related to the PLRMIS, we conducted interviews during field visits in fifteen tehsils across five major districts, namely Mianwali, Khushab, Sargodha, Chiniot, and the pilot test districts of Attock and Rawalpindi. The informants were selected based on purposive sampling. The interviews were guided by a semi-structured questionnaire while also allowing room for the informants to share their unique insights and experiences. The data collected from these interviews and discussion with stakeholders played a crucial role in enriching our understanding of the procedures, use, interoperability, and issues related to the PLRMIS implementation.

5. Findings

5.1. Mean-differences in ADR disputes references

Table 2 reports the mean-differences results. We observe significant differences between the early treated and late treated districts in terms of total number of received dispute cases, criminal disputes, civil/land-related disputes, and family-related disputes. On average, districts in the early treated region received 47 more dispute cases compared to the late treated region. Furthermore, the early treated districts showed a higher average difference of 58 cases in civil disputes and 36 cases in criminal disputes compared to the late treated region. The t-test confirms the statistical significance of these differences at a 1% significance level. Moreover, the disparity in the outcome of the ADR process, specifically the successful resolution, is also statistically significant and positive. We believe that this ADR outcome variable is partly influenced by the PLRMIS, as many disputes stem from the ambiguity of land-related records. However, as we earlier noted that the simple mean difference approach is susceptible to concerns such as confounding variables that may simultaneously affect both groups, which can potentially offsett the program's true effect.

Table 2
Mean Difference between Treated and Control Districts (t-test).

	Early Treated Group		Late Treated Group		Mean Difference (t-test)		
Variables	N	Mean	N	Mean	Diff	S.E	p-value
Number of Total Disputes Registered	1134	343.4	1260	296.4	47.0	(8.16)	0
Criminal Cases	1134	119.8	1260	83.7	36.1	(4.33)	0
Land-Related /Civil Cases	1116	134.4	1240	76.0	58.4	(3.40)	0
Family-Cases	1134	182.3	1260	138.6	43.7	(6.34)	0
Guardian Cases	1134	9.3	1260	9.9	-0.6	(0.51)	.25
Rent-related Cases	1134	2.7	1260	1.6	1.1	(0.17)	0
Appeals Cases	1134	16.9	1260	9.0	7.9	(0.96)	0
Previous Pendency Cases	1134	0.10	1260	0.11	0.01	(0.06)	.79
Other Cases	1134	20.0	1260	19.2	0.8	(0.96)	.41
Mediation Outcome of ADR Office							
Number of Mediation Failure	1134	60.8	1260	47.7	13.1	(1.78)	0
Number of Mediation Success	1134	215.3	1260	175.1	40.2	(4.69)	0
Previous Pendency Cases							
Number of Police Stations	1134	18.3	1260	19.0	-0.7	(0.32)	.059
Number of Mauzas	1134	703.9	1260	662.2	41.7	(14.07)	.003
Population Density (People/km2)	1071	521.5	1260	466.1	55.4	(12.67)	0
Literacy Rate (% of Total)	1134	46.4	1260	39.1	7.3	(0.49)	0

Table 2 shows the mean differences of key variables used in this study between 18 early treated districts and 20 late treated districts in the Punjab Province, Pakistan. Data on disputes registration and ADR outcomes come from the Alternate Dispute Resolution Centres' records in all 38 districts across the Punjab Province. Data on the demographic and geographic variables including police stations, mauzas, literacy rate, and population density come from Punjab Development Statistics 2017. The last three columns represent the coefficients of mean difference, standard errors, and p-values. Statistical significance at the 1, 5, 10% levels are indicated by *** , ** , and * , respectively.

5.2. Impact of early access to PLRMIS on civil disputes registration

Table 3 presents the estimates of the program effect on civil/land-related disputes using generalized mixed effects, hybrid random effects, and instrumental variable approaches. The coefficient of Early Access to PLRMIS is consistently large across the three specifications, indicating a substantial treatment effect. Controlling for population density, number of police stations, literacy rate, and mauza's density, districts in the early treated region are estimated to have 50 more cases compared to the late treated region. The hybrid model, which incorporates time-varying regressors such as the total number of cases received in ADR centres, shows a positive relationship between the total number of registered cases and civil/land-related cases (within-district effect). The instrumental variable approach, using the 2SLS Hausman-Taylor model, provides a slightly larger and more causal estimate (52.8) compared to the hybrid model (49.8). The instrument used in the HT model is the number of disputes registered at ADR centres other than those categorized in the data. The random-effects group-specific growth curves shown in Fig. 3 demonstrate a significantly higher linear trend in the coefficients of early treated districts over time, both in terms of civil disputes' registration process and dispute resolution outcomes. The RE-GCs estimation is conducted following Bernardi et al. (2017) and Stawarz (2013) after applying the mixed effects GLM model.

Table 3
Early Treatment Effect on Civil Disputes Registered in ADR Centres.

	Mixed Effect GLM	Hybrid (Between-Within) Model	Correlated-RE (Mundlak) Model	Hausman-Taylor RE Model
Early Access to PLRMIS	58.38 ***	49.85 ***	49.85 ***	52.83 ***
	(17.76)	(17.22)	(17.22)	(19.15)
No of Cases Registered (TV)	0.090 ***			
	(0.006)			
β_W (Within-district Effect of Cases Registered)		0.211 ***	0.211 ***	
		(0.00603)	(0.00603)	
β_B (Between-district Effect of Cases Registered)		0.264 ***		
		(0.0810)		
$\tau = \beta_B - \beta_W$			0.0535	
			(0.0813)	
Demographic and Geographic Controls (TI)	Yes	Yes	Yes	Yes
District Effect	Random			
Week Effect	Fixed			
Constant	21.38	37.71	37.71	64.37 **
	(36.57)	(39.40)	(39.40)	(27.6)
Test of RE Assumption (Wald Tests p-values)	n/a	0.510	0.510	
Mean of the Dep. Var	100.8	103.7	103.7	103.7
Observations	2294	2294	2294	2294
Number of districts	37	37	37	37

Note: Data on outcome variables come from weekly maintained registers published by ADR Centres in Punjab province. Demographic controls include population density gross literacy rate, number of police stations, geographic controls include the number of mauzas. The data for these variables come from Development Statistics Reports. In all regressions, the dependent variables are the number of civil disputes registered. Early Access to PLRMIS is a binary indictor that equals 1 if the set of districts were exposed to the first phase of PLRMIS program in 2013, 0 if the district was not exposed until 2016. For Hausman and Taylor, the *Early Access* to PLRMIS is considered endogenous while *total cases other than the categorized cases* is used as instrument. Robust Standard errors are clustered to district level shown in parentheses *** $p < .01$, ** $p < .05$, * $p < .1$

5.3. Impact on dispute resolution outcomes

Table 4 presents the effects of early access to PLRMIS on the number of successful dispute mediation cases and the number of cases in which the mediation process failed. We report results from both the generalized linear mixed-effects model (GLMM) and the two-stage least squares (2SLS) estimates. The coefficients from the GLMM provide suggestive evidence that PLRMIS contributes to the ADR mediation process. Districts in the early digitized region are estimated to have, on average, 71 more successful cases compared to districts in the late treated group. Similarly, the coefficient for the number of failed cases is negative, indicating a positive impact of PLRMIS on the ADR process. The 2SLS results in Table 4, Panel A, show a larger and statistically significant impact of the program on the ADR success rate. We control all observed characteristics and apply district, time, and individual judge fixed effects. The 2SLS estimate represents the local average treatment effect (LATE), which, given the means of ADR successful cases (e.g., 194), is estimated to be 126 for early treated region. For cases in which mediation failed, the 2SLS estimate is positive but not statistically significant. These results are interpreted conditionally on the variation caused by the interaction of mauza density and total cases registered on the endogenous variables (early access to treatment). Specifically, for districts in the early treated group, the number of dispute resolution success cases is expected to increase by 126. This indirect LATE effect provides information about the subjects who benefit from the treatment. Comparing the results, the 2SLS estimates provide a more causal interpretation and indicate a larger impact of the program. The F-statistic of the first stage shows significant correlation between the instrument and the endogenous variable indicating the validity of the instrument.

5.4. Homogeneity between two groups

While there may be significant variations within and between districts in terms of other socio-economic characteristics, previous research highlights the commonality of civil court cases, land-related disputes, and registration practices across the Punjab province (CPIN, 2020; Gazdar, 2009; LandLinks, 2020; MOCC, 2020; NDMA, 2020; Niazi, 2003; USAID, 2010). We check this key assumption of the parallel trend (homogeneity of two groups before access to the program) using alternate data from Punjab development statistics reports. In Table A 1 appendix, we show results of the difference-in-differences fixed-effect model on reported crimes in two groups over the last 15 years. We check the pre-2013 trend between the early treated districts and late treated districts in terms of reported crimes, total land utilized, cultivated and non-cultivated land size. The coefficient of our interaction term is statistically not significant indicating no difference between the two groups, hence supporting our assumption that before 2013, there was no systematic divergence between the two groups of districts. Additionally, we run a fixed effect regression model and account for district specific time-trend by ploting adjusted predictions of the reported crimes in Punjab for two groups separately. Results of the adjusted predictions shown in Fig. 4 show a common trend between the two groups over the last 15 years.

6. Discussion

The empirical findings presented in our study reveal a significant difference between two groups of districts, reflecting the effect of phased implementation of the PLRMIS program over a span of three years. This observed divergence in the outcome of interest can be attributed to the introduction of PLRMIS, as it was rolled out in two waves, encompassing 18 districts in 2013 and the remaining 18 districts in 2016. Specifically,

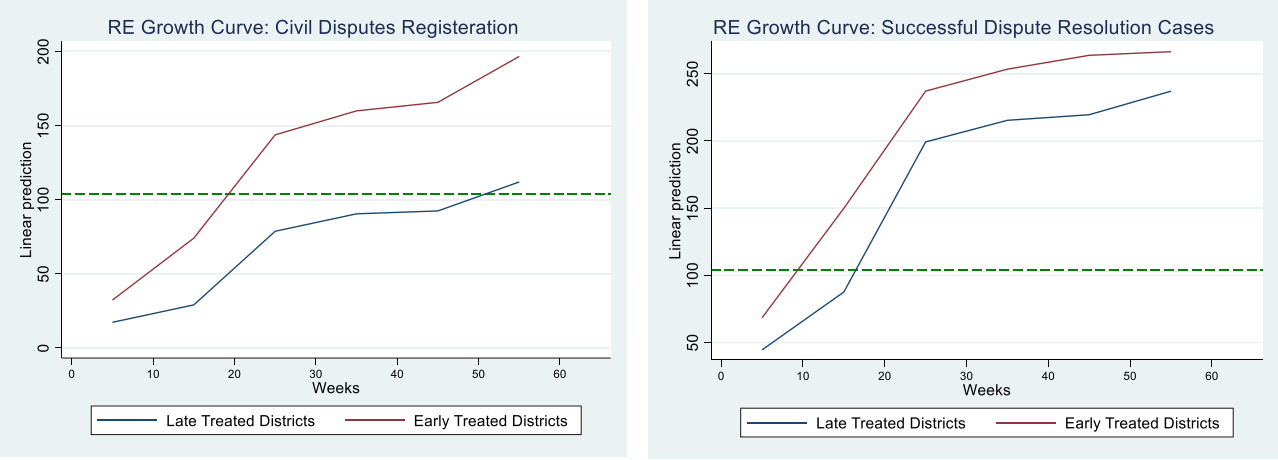


Fig. 3. Random-Effects Growth Curves.

Table 4
Early Treatment Effect on Dispute Mediation Outcomes (GLMM and 2SLS-FE).

	Mediation Success Cases		Mediation Failure Cases	
Panel A	GLMM	2SLS-FE	GLMM	2SLS-FE
Early Access to PLRMIS	71.03 ***	126.2 ***	-18.72 ***	26.87
	(11.61)	(25.58)	(5.844)	(21.62)
β_W (Within-district Effect of Cases Registered)	0.253 ***		0.127 ***	
	(0.0548)		(0.0271)	
β_B (Between-district Effect of Cases Registered)	0.905 ***		0.100 ***	
	(0.0662)		(0.0272)	
Controls	Yes	Yes	Yes	Yes
Mediating Judge FE	Yes	Yes	Yes	Yes
Panel B-First Stage				
Endogenous Variable: Early Access to PLRMIS				
Instruments: Mauzas× Total Number of Registered Cases				
F-Statistics:		56.9		56.9
Mean of the Dep. Var	194.1	194.1	53.9	194.1
No. of Districts	37	37	37	37
Observations	2394	2394	2394	2394

Note: The first and third column show the multi-level mixed-effects generalized linear model (GLMM) while the second and last column show the two-stage least square effects of the early access to PLRMIS on the ADR outcomes. The ADR outcomes include the number of successful mediation cases and the number of unsuccessful (failed) mediation cases as reported in the weekly data by the ADR centres. *Early Access to PLRMIS* is a binary indictor that equals 1 if the districts were exposed to the first phase of PLRMIS program in 2013, 0 if the district was not exposed until 2016. Control variables include *Previous Pendency* representing the number of cases already accumulated in ADR offices at the time of initial observation, demographic *controls* include population density, gross literacy rate, number of police stations in each district. In the first stage (Panel B), the interaction term of the Mauzas and total number of disputes registered in ADR is used as an instrument to predict the treatment assignment. *Mediating Judge* FE controls individual judge-specific characteristics in the dispute resolution process at ADR centres. Robust Standard errors are clustered to district level shown in parentheses *** p < .01, ** p < .05, * p < .1

our analysis focuses on three key aspects: 1) the impact of the program on dispute registration, 2) the success of dispute resolution or mediation, and 3) instances of mediation failure. To ensure robustness and minimize biases, we employed rigorous evaluation techniques and thoroughly examined alternative explanations for any systematic differences between the early-treated and late-treated districts, using secondary data.

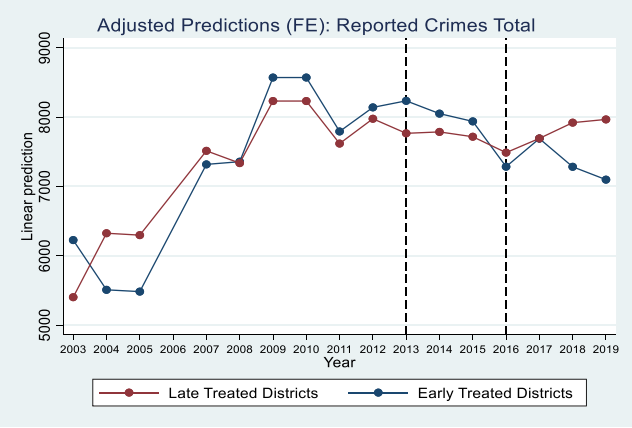


Fig. 4. Fixed Effect Adjusted Prediction - Reported Crimes. Note: Standard errors clustered at district level. The prediction margins are shown at 95% confidence interval.

Pakistan is known for its high litigation rate, placing a significant burden on the judiciary, which struggles to handle a large number of litigants. In 2017, the lower courts of Punjab alone had approximately 1.3 million pending cases, while the number of appointed judges stood at only 2400. Consequently, each judge had to handle an average of 540 cases simultaneously. This situation is exacerbated by challenges in accessing land-related records, which are crucial for resolving conflicts (Shah et al., 2014). The surge in the number of disputes has overwhelmed the civil courts, prompting the Government of Punjab to establish ADR centres to streamline the resolution process. Initially, land-related disputes were relatively few but strongly correlated with the volume of land records in administrative units such as districts, tehsils, or mouzas. The primary reason behind this association is the availability of information. Data reveals that in the absence of accurate information, the number of land-related dispute cases remains low. However, when correct information becomes accessible, the number of dispute cases increases in districts with a higher volume of land records compared to those with a lower volume.

The implementation of PLRMIS has not only improved access to information, leading to enhanced dispute resolution, but our interviews with key informants in the field also support the notion that reduced information asymmetry has enabled the general public to resolve disputes more effectively over time through ADR mechanisms. The ultimate objective of e-governance interventions is to serve the public efficiently and effectively. This study provides evidence that digitizing

land records has multiple effects, including reducing the time and cost of land transactions, expediting dispute resolution, and decreasing the number of disputes over time. A transparent and efficient land management system can contribute to better resolution of land-related disputes and thereby foster economic development. However, the development of an e-governance system should occur in phases and be accompanied by continuous monitoring and evaluation. The shortage of experienced and skilled personnel in the e-governing system can undermine the program's success. Without a competent workforce, the electronic land management system cannot deliver satisfactory services to the general public.

The establishment of ADR aimed to expedite the judicial process for prolonged cases involving multiple parties in provincial courts. However, while civil and land-related conflicts are predominant, ADR is not directly integrated with PLRMIS data, and its effectiveness depends on the parties' willingness to opt for ADR decisions. Integrating ADR data with PLRMIS, especially for land-related disputes, can be highly beneficial. Despite our efforts to assess the impact of PLRMIS on dispute resolution in Punjab, given the substantial project cost, further research might benefit from conducting a cost-benefit analysis of this program. Additionally, incorporating data from civil courts' cases in future studies could enhance the understanding of the overall dispute resolution landscape. Moreover, exploring how the government can utilize PLRMIS in crucial land use planning and policy-making decisions is highly recommended. Other relevant aspects, such as tax revenue generation and the quality of records in PLRMIS, should also be taken into consideration for comprehensive analysis.

7. Conclusion

In this study, we examined the impact of early access to the Punjab Land Records Management and Information System (PLRMIS) on civil dispute references submitted to ADR centres and dispute resolution outcomes in Punjab province, Pakistan. Our findings provide evidence of the positive effects of the program on the number of disputes registered and the success of dispute resolution. The mean-difference analysis revealed significant differences between early treated and late treated districts in terms of total disputes cases, land-related disputes, criminal disputes, and family-related disputes. Districts in the early treated region experienced, on average, 47 cases more than the comparison group. By utilizing a two-stage least square technique to offer a more causal interpretation, we further demonstrated the significant role of PLRMIS in facilitating successful ADR mediation, indicating increased public utilization of the system. On average, districts in the early digitized region were likely to have 50 more successful cases than districts in the late treated group. Additionally, the coefficient of early access to PLRMIS for the number of failed cases showed a negative correlation, indicating a favorable impact on the ADR process. These findings remain robust even after controlling for covariates, entity-specific variation, and time trends.

Complementing our quantitative evidence, interviews with key informants in the field were conducted in five districts of Punjab province, providing further support to our analysis. The interviews revealed significant variation in the level of usage and understanding of PLRMIS among citizens, as well as the extent to which clients were served by the system. Notably, a majority of individuals involved in land-related transactions and conflicts opted for the PLRMIS online facilities in each tehsil of the districts. Moreover, findings from the field visit to the ADR centres highlighted areas requiring attention from government officials to ensure the sustainable utilization of this flagship program in Punjab. These areas encompassed infrastructure maintenance and development, the litigation process, interoperability of PLRMIS, cost structure, e-literacy among the public, job security for PLRMIS employees, and addressing issues of misuse of authority and other technical matters.

The introduction of PLRMIS in Punjab province exemplifies the transformation of governance mechanisms to enhance productivity and reduce conflicts associated with conventional record administration. Our results offer strong evidence that the PLRMIS program has significantly and positively impacted ADR disputes and dispute resolution outcomes in Punjab province. The implementation of the program led to a higher number of disputes being registered and a greater success rate in mediation cases. These findings underscore the efficacy of digitization and e-governance systems, such as PLRMIS, in improving land administration, reducing information asymmetry, and enhancing dispute resolution processes.

CRediT authorship contribution statement

Inayat Ullah: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Saqib Hussain:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Acknowledgment

The authors gratefully acknowledge financial support from the KDI School of Public Policy and Management throughout this research work. We also thank the Chey Institute for Advanced Studies for supporting the first author (Inayat Ullah) under the International Scholar Exchange Fellowship (ISEF) during his research at Seoul National University (SNU), Republic of Korea. The authors are also grateful to KDIS Prof. Jungho Kim, the project team members and other anonymous reviewers for constructive feedback during the seminar presentation and peer review process. The KDIS alumnus Mr. Rony Rodrigo Maximiliano Rodríguez-Ramírez has extended great support during the analysis of this work and we are grateful for his contributions.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2023.106917.

References

ADB. 2019. Annual Report Retrieved from Asian Development Bank: ⟨https://www.adb.org/documents/adb-annual-report-2019⟩. Retrieved on 25th June 2020.
Ali, Z. (2013). Developing a framework to apply Total Quality Management concepts to land administration: the case of Islamic Republic of Pakistan.
Ali, Z., Nasir, A., 2010. Land administration system in Pakistan–current situation and stakeho. lders' Percept. 11, 16.
Ali, Z., Tuladhar, A., Zevenbergen, J., Bhatti, M.A., 2014. Implementing total quality management concepts to LAND administration system in Pakistan. Am. J. Rural Dev. 2 (4), 74–80.
Allison, P.D., 2009. Fixed effects regression models. SAGE publications,.
Angrist, J.D., Krueger, A., 2001. Instrumental variables and the search for identification: From supply and demand to natural experiments. J. Econ. Perspect. 15 (4), 69–85.
Awais, H., Munir, M.A., 2018. Alternative Dispute Resolution (ADR) in Trial Courts of Pakistan: A Practical Approach Towards New Era of Timely Justice as a Means of 'Justice for All' (May). *Rep. 8th Judic. Conf., Law Justice Comm. Pak.*

Bennett, R., Miller, T., Pickering, M., Kara, A.K., 2021. Hybrid approaches for smart contracts in land administration: Lessons from three blockchain proofs-of-concept. Land 10 (2), 220.
Bernardi, L., Bollmann, G., Potarca, G., Rossier, J., 2017. Multidimensionality of well-being and spillover effects across life domains: How do parenthood and personality affect changes in domain-specific satisfaction? Res. Hum. Dev. 14 (1), 26–51.
Blocher, J., 2006. Building on custom: land tenure policy and economic development in Ghana. *Yale Hum. Rts. Dev.* LJ 9, 166.
Boone, W.J., Staver, J.R., Yale, M.S., 2013. Rasch analysis in the human sciences. Springer Science & Business Media,.
Boudreaux, K., Sacks, D., 2009. Land tenure security and agricultural productivity. Mercat. Policy 57.
Cameron, A.C., Trivedi, P.K., 2005. Microeconometrics: methods and applications. Cambridge university press,.
Chatelain, J.B., Ralf, K., 2021. Inference on time-invariant variables using panel data: a pretest estimator. Econ. Model. 97, 157–166.
Cheema, A., Khwaja, A.I., Qadir, A., 2006. Local government reforms in Pakistan: context, content and causes. Decentralization Local Gov. Dev. Ctries.: A Comp. Perspect. 2, 257–284.
Conning, J., Deb, P., 2007. *Impact Eval. Land Prop. Rights Reform.*: World Bank, Poverty Reduct. Econ. Manag., Themat. Group.
CPIN. (2020). Country Policy and Information Note. Retrieved from ⟨https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/897074/Pakistan-Actors_of_protection-CPIN-v1.0_June_2020_.pdf⟩.
De Soto, H., 2000. The mystery of capital: Why capitalism triumphs in the West and fails everywhere else. Civitas Books,.
Deininger, K., Goyal, A., 2012. Going digital: credit effects of land registry computerization in India. J. Dev. Econ. 99 (2), 236–243.
Derby, F.W., Francis, W., 2002. Improv. Facil. Land Title Regist. Process. Tanzan.
Diggle, P., Diggle, P.J., Heagerty, P., Liang, K.Y., Zeger, S., 2002. Analysis of longitudinal data. Oxford university press,.
Dowall, D.E., Ellis, P., 2009. Urban land and housing markets in the Punjab. Pak. *Urban Stud.* 46 (11), 2277–2300.
Duke, J.M., Jost, R.P., 2003. Promoting mediation in property rights conflicts. Land Econ. 79 (1), 29–37.
Edeh, H.O., Mavrotas, G., Balana, B.B., 2022. Land tenure security and preferences to dispute resolution pathways among landholders in Nigeria. Land Use Policy 119, 106179.
Falkinger, J., Grossmann, V., 2013. Oligarchic land ownership, entrepreneurship, and economic development. J. Dev. Econ. 101, 206–215.
Gazdar, H., 2009. The fourth round, and why they fight on: An essay on the history of land and reform in Pakistan. PANOS South Asia, Collect. Soc. Sci. Res.
Greif, A., 1993. Contract enforceability and economic institutions in early trade: The Maghribi traders' coalition. Am. Econ. Rev. 525–548.
Hamid, Q., Chauhdry, M.H., Mahmood, S., Farid, M.S., 2016. Arc GIS and 3D visualization of land records: A case study of urban areas in Punjab. Natl. Acad. Sci. Lett. 39 (4), 277–281.
Hausman, J.A., Taylor, W.E., 1981. Panel data and unobservable individual effects. Économ.: J. Econom. Soc. 1377–1398.
Holstein, L., 1996. Towards best practice from World Bank experience in land titling and registration. Pap. Presente Int. Conf. Land Tenure Adm.
Huggins, C., Frosina, N., 2017. ICT-driven projects for land governance in Kenya: disruption and e-government frameworks. Geo J. 82 (4), 643–663.
International Fund for Agricultural Development. (2015). Land Tenure Security. Agricultural Development Programme in the Highlands (1–8).
Katie, S. 22). What is Alternative Dispute Resolution? *Program on NegotiationHarvard Law School* 2023.https://www.pon.harvard.edu/daily/dispute-resolution/what-is-alternative-dispute-resolution/.
Klein, T.J., Lambertz, C., Stahl, K.O., 2016. Market transparency, adverse selection, and moral hazard. J. Political Econ. 124 (6), 1677–1713.
LandLinks. (2020). Retrieved from ⟨https://www.land-links.org/country-profile/pakistan/1528992503488–6b2250be-7112⟩.
Lippit, V.D., 2018. Land Reform and Economic Development in China: A Study of Institutional Change and Development Finance. Routledge,.
Magsi, H., Torre, A., Liu, Y., Sheikh, M.J., 2017. Land use conflicts in the developing countries: proximate driving forces and preventive measures. Pak. Dev. Rev. 19–30.
Marshall, P.J., 1975. British expansion in India in the eighteenth century: a historical revision. History 60 (198), 28–43.
Menkel-Meadow, C., 2015. Mediation, arbitration, and alternative dispute resolution (ADR). International Encyclopedia of the Social and Behavioral Sciences. Elsevier Ltd.
Mitchell, D., Clarke, M., Baxter, J., 2008. Evaluating land administration projects in developing countries. Land Use Policy 25 (4), 464–473.
MOCC. (2020). Retrieved from ⟨http://www.mocc.gov.pk/moclc/userfiles1/file/MOC/Publications%20on%20Env%20and%20CC/Miscellaneous/land%20use%20and%20care.pdf⟩.
Mundlak, Y., 1978. On the pooling of time series and cross section data. Économ.: J. Econom. Soc. 69–85.
Nathanson, S., 1997. Designing problems to teach legal problem solving. Cal. WL Rev. 34, 325.
NDMA. (2020). Retrieved from ⟨http://www.ndma.gov.pk/Publications/A%20Guide%20on%20Land%20and%20Property%20Rights%20in%20Pakistan%202012.pdf⟩.
Neuhaus, J.M., McCulloch, C.E., 2006. Separating between-and within-cluster covariate effects by using conditional and partitioning methods. J. R. Stat. Soc.: Ser. B (Stat. Methodol.) 68 (5), 859–872.
Niazi, T., 2003. Land tenure, land use, and land degradation: a case for sustainable development in Pakistan. J. Environ. Dev. 12 (3), 275–294.
North, D.C. (1981). Structure and change in economic history: Norton.
North, D.C., 1990. A transaction cost theory of politics. J. Theor. Polit. 2 (4), 355–367.
Papageorgiou, C., Turnbull, G.K., 2005. Economic development and property rights: time limits on land ownership. Econ. Dev. Q. 19 (3), 271–283.
Qazi, M.U., 2006. Background Paper. Computerization of Land Records in Pakistan. The World Bank Pakistan Country Office, Islamabad, Pakistan.
Ruppert, D., Wand, M.P., Carroll, R.J., 2003. Semiparametric Regression (No. 12). Cambridge University Press.
Rusu, L., Hodosi, G., 2011. Assessing the risk exposure in IT outsourcing for large companies. Int. J. Inf. Technol. Manag. 10 (1), 24–44.
Sarwar, T.B., Jalil, M.A., 2017. Critical analysis on the challenges of land administration and management in Bangladesh: are the land rights guaranteed? Int. J. Entrep. Dev. Stud. 5 (1), 67–77.
Schunck, R., 2013. Within and between estimates in random-effects models: advantages and drawbacks of correlated random effects and hybrid models. Stata J. 13 (1), 65–76.
Schunck, R., Perales, F., 2017. Within-and between-cluster effects in generalized linear mixed models: a discussion of approaches and the xthybrid command. Stata J. 17 (1), 89–115.
Shah, R.U., Khan, S.U., Farid, S., 2014. Causes for delay in civil justice in lower courts of Pakistan: a review. Pak. J. Criminol. 6 (1), 47.
Stawarz, N., 2013. Inter-und intragenerationale soziale Mobilität. Eine simultane Analyse unter Verwendung von Wachstumskurven. Z. für Soziol. 42 (5), 385–404.
Thakur, V., Dutta, D., Khadanga, G., Venkatesh, D., 2005. Social Impact of Computerisation of Land Records. Adopting e-governance. Computer Society of India Publications, *New Delhi, India*.
The Punjab Alternate Dispute Resolution Act 2019. (2022). Retrieved 3 December 2022, from ⟨http://punjablaws.gov.pk/laws/2739.html⟩.
UN-HABITAT. (2012). A Guide on Land and Property Rights in Pakistan. UN Habitat - United Nations Human Settlements Programme, 2nd, 85.
USAID. (2008). Pakistan's Agenda for Action: Interim Report. Business Climate Legal & Institutional Reform.
USAID. (2010). PROPERTY RIGHTS AND RESOURCE GOVERNANCE. Retrieved from America:
Utami, B.H.S., Irawan, A., Gumanti, M., Primajati, G., 2021. Hausman and taylor estimator analysis on the linear data panel model. J. Varia 5 (1), 81–88.
Wehrmann, B., 2008. Land Conflicts: A Practical Guide to Dealing with Land Disputes. GTZ Eschborn.
Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel Data. MIT Press.
World Bank. (2017). Implementation Completion and Results Report: Punjab Land Records Management and Information Systems. Social, Urban, Rural and Resilience Global Practice, Pakistan Country Unit, South Asia Region. Retrieved from ⟨https://documents.worldbank.org/curated/en/632241498842804246/pdf/ICR00003719.pdf⟩⟨⟩.
World Bank, W. (2005). World Development Report 2005: A Better Investment Climate for Everyone. Retrieved from ⟨https://openknowledge.worldbank.org/handle/10986/5987⟩.
World Bank – Project Information Document (2005) Pakistan - Land Records Management and Information Systems Program - Province of Punjab Project: Pakistan - Land Records Management and Information Systems Program - Province of Punjab Project (English). Washington, D.C.: World Bank Group. ⟨http://documents.worldbank.org/curated/en/139231468068328413/Pakistan-Land-Records-Management-and-Information-Systems-Program-Province-of-Punjab-Project⟩.