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INSTITUTIONAL CHANGE AND AGRICULTURAL LAND USE IN TRANSITION COUNTRIES: UNDERSTANDING INSTITUTIONAL CONSTRAINTS OF FARMERS' DECISION MAKING

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SUMMARY

Depending on multiple factors and regional characteristics, the area of agricultural land fluctuates with varying scale and speed. These fluctuations generally occur as a result of changes in a way individuals use their land. Human activities, such as agricultural expansion, intensification, or land abandonment, play a significant role not only in maintaining economic well-being and food security but also in the transformation of landscapes, environmental conditions, and biodiversity. Environmental and socio-economic factors are claimed to be the dominant determinants of land use change; however, the impact of institutional change cannot be neglected.

Post-Soviet and allied countries introducing market-oriented reforms during the last three decades demonstrated profound fluctuations in the area of cultivated land. Simultaneously, this period was associated with substantial institutional shifts in the agricultural sector of transition economies. Despite the adoption of similar reforms after 1990, these countries have been following discrepant trajectories in agricultural development. The sources of discrepancies were not only unequal initial institutional conditions but also land reforms that were implemented partially or remained written only on the paper without entering into force. In order to investigate how institutional change influences land use in transition economies, this dissertation considers an analysis of land tenure settings at cross-country and individual levels.

Based on the time-series cross-sectional data of 29 transition economies in East Asia, Central and Eastern Europe, and the former Soviet Union for the period of 1991–2014, this dissertation initially identifies the drivers of agricultural land use with a specific focus on land governance factors at the country level. Land tenure indicators such as land ownership and land transferability were evaluated by assessing land legislative documents. The results suggest that improved ownership rights increase land abandonment in transition economies; furthermore, land

ownership is not always associated with land transferability. Yet countries with more transferable land rights demonstrate higher agricultural land use. Favourable conditions of macro-scale socio-economic factors such as population density, the share of rural population, and yield of cereals foster agricultural cultivation.

A micro-level approach is used to explore the influence of land tenure rights perceived by farmers on the intention to intensify land use in two ways. Firstly, a neoclassical model of decision-making is applied to analyse whether mismatches between land rights and their actual practices affect farmers' intentions to increase agricultural production. Farm-level data collected during a survey conducted in 2019 in southern Kazakhstan and eastern Uzbekistan and land legislations are used to find discrepancies between legal land rights and perceived land rights. Comparative analysis of tenure conditions reveals that Kazakh farmers are less restricted in land use than Uzbek farmers are. The results of the empirical analysis indicated that mismatches between land rights on paper and perceived land rights tend to reduce farmers' willingness to gain higher output.

Secondly, using the behavioural approach, the dissertation provides evidence that perceived land rights and their discrepancies with written rules play a considerable role in the formation of farmers' intentions to intensify land use. By extending the theory of planned behaviour, the study shows that perceived land rights and their discrepancies with formal land rights have a substantial importance not only for farmers' intentions but also for the underlying psychological constructs. While the institutional factors influence intentions only indirectly through attitude, subjective norms, and perceived behavioural control in the case of Kazakh farmers, a direct but controversial effect on intention occurs in the case of Uzbek farmers. The findings from two neighbouring Central Asian countries provide valuable insights that can contribute to improving land policy design to enhance land tenure security.

ZUSAMMENFASSUNG

In Abhängigkeit von mehreren Faktoren und regionalen Merkmalen schwankt die landwirtschaftliche Nutzfläche mit unterschiedlichem Umfang und Geschwindigkeit. Diese Schwankungen treten im Allgemeinen aufgrund von Änderungen in der Art und Weise auf, wie Menschen ihr Land nutzen. Menschliche Aktivitäten wie die Expansion, Intensivierung oder Aufgabe von Land in der Landwirtschaft spielen nicht nur eine wichtige Rolle bei der Aufrechterhaltung des wirtschaftlichen Wohlergehens und der Ernährungssicherheit, sondern auch bei der Veränderung von Landschaften, Umweltbedingungen und biologischer Vielfalt. Es wird behauptet, dass Umwelt- und sozioökonomische Faktoren die dominierenden Determinanten der Landnutzungsänderung sind, wobei die Auswirkungen des institutionellen Wandels jedoch nicht vernachlässigt werden können.

Die postsowjetischen und alliierten Länder, die in den letzten drei Jahrzehnten marktorientierte Reformen eingeführt haben, zeigten tiefgreifende Schwankungen in den kultivierten Landflächen. Gleichzeitig war dieser Zeitraum mit erheblichen institutionellen Veränderungen im Agrarsektor der Transformationsökonomien verbunden. Trotz der Verabschiedung ähnlicher Reformen nach 1990 haben diese Länder unterschiedliche Wege in der landwirtschaftlichen Entwicklung eingeschlagen. Die Ursachen für Diskrepanzen waren nicht nur ungleiche institutionelle Anfangsbedingungen, sondern auch Landreformen, die nur teilweise umgesetzt oder lediglich auf dem Papier festgehalten wurden. Um zu untersuchen, wie institutionelle Veränderungen die Landnutzung in Transformationsökonomien beeinflussen, wird in dieser Dissertation eine Analyse von Landbesitzbedingungen auf länderübergreifender und individueller Ebene durchgeführt.

Basierend auf den Zeitreihenquerschnittsdaten von 29 Transformationsländern in Ostasien, Mittel- und Osteuropa und der ehemaligen Sowjetunion für den Zeitraum 1991–2014 werden zunächst die Treiber

der landwirtschaftlichen Landnutzung identifiziert, jedoch mit einem besonderen Schwerpunkt zur Landpolitik auf Länderebene. Landnutzungsindikatoren wie Landbesitz und Landübertragbarkeit wurden durch die Betrachtung von Landgesetzgebungsdokumenten bewertet. Die Ergebnisse deuten darauf hin, dass verbesserte Eigentumsrechte die Bereitschaft zur Aufgabe von Landflächen in Transformationsländern erhöht und Landbesitz nicht immer mit der Übertragbarkeit von Landflächen verbunden ist. Länder mit mehr übertragbarem Land weisen jedoch eine höhere Landnutzung auf. Günstige Bedingungen makroökonomischer sozioökonomischer Faktoren wie Bevölkerungsdichte, Anteil der ländlichen Bevölkerung und Getreideertrag fördern den landwirtschaftlichen Anbau.

Zwei Ansätze auf Mikroebene werden verwendet, um den Einfluss der von den Landwirten wahrgenommenen Landbesitzrechte auf deren Einstellung zur Landnutzungsintensivierung zu untersuchen. Zunächst wird anhand eines neoklassischen Entscheidungsmodells analysiert, ob Unstimmigkeiten zwischen Landrechten und ihren tatsächlichen Praktiken die Absichten der Landwirte zur Steigerung der landwirtschaftlichen Produktion beeinflussen. Daten auf Betriebsebene, die während einer im Jahr 2019 in Südkasachstan und Ost-Usbekistan durchgeführten Umfrage sowie der Landgesetzgebung erhoben wurden, werden verwendet, um Diskrepanzen zwischen gesetzlichen Landrechten und wahrgenommenen Landrechten festzustellen. Eine vergleichende Analyse der Nutzungsbedingungen zeigt, dass kasachische Landwirte in ihrer Landnutzung weniger eingeschränkt sind als usbekische Landwirte. Die Ergebnisse der empirischen Analyse zeigen, dass Divergenzen zwischen Landrechten auf dem Papier und wahrgenommenen Landrechten tendenziell die Bereitschaft der Landwirte zur Erzielung einer höheren Produktion verringern.

Zweitens liefert die Dissertation unter Verwendung des Verhaltensansatzes Belege dafür, dass wahrgenommene Landrechte und ihre Abweichungen von schriftlichen Regeln eine erhebliche Rolle bei der Meinungsbildung der Landwirte bezüglich der Landnutzungsintensivierung spielen. Durch die Erweiterung der Theorie des geplanten

Verhaltens zeigt die Studie, dass wahrgenommene Landrechte und ihre Diskrepanzen mit formalen Landrechten eine wesentliche Bedeutung für die Entscheidungsfindung der Landwirte haben. Während diese Faktoren die Absichten bei kasachischen Landwirten nur indirekt durch Einstellung, subjektive Normen und wahrgenommene Verhaltenskontrolle beeinflussen, tritt bei usbekischen Landwirten eine direkte, aber kontroverse Auswirkung auf die Absichten auf. Die Ergebnisse aus zwei benachbarten zentralasiatischen Ländern liefern wertvolle Erkenntnisse, die zu einer angepassten Gestaltung der Landpolitik zur Verbesserung der Sicherheit des Landbesitzes beitragen können.

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LIST OF ABBREVIATIONS

2SCML	two-step conditional maximum likelihood
AP	actual practice
AR	autocorrelation
CEE	Central and Eastern Europe
CIS	Commonwealth of Independent States
CTA-SEM	Confirmatory Tetrad Analysis in PLS-SEM
EA	East Asia
FAO	Food and Agriculture Organization of the United Nations
FR	full right
FSU	former Soviet Union
GDP	Gross Domestic Product
LLR	limited right
LR	land right
NI	net import
NR	no right
NX	net export
PBC	perceived behavioral control
PCSE	Panel-Corrected Standard Errors
PLS-SEM	Partial Least Squares Structural Equation Modeling
RER	real exchange rate
SN	subjective norms
TOT	terms of trade of agriculture
TPB	Theory of Planned Behaviour
TRA	theory of reasoned action
TSCS	time-series cross-sectional data
USSR	Union of Soviet Socialist Republics
VIF	Variance Inflation Factor
WDI	World Development Indicators
WGI	World Bank's Worldwide Governance Indicators dataset

1 INTRODUCTION

1.1 INSTITUTIONAL DIMENSION OF THE LAND USE CHANGE

Agricultural land use change plays a significant role in maintaining economic well-being and food security and directly contributes to the transformation of landscapes, environmental conditions, and biodiversity (Plieninger et al., 2016). Driven by a variety of factors, fluctuations in the area of agricultural land occur with varying scales and speeds. Generally, these fluctuations are a direct result of changes in land use activities. Figure 1.1 depicts two general manifestations of agricultural land use change (van Vliet et al., 2015). One of them is agricultural intensification that appears as an increase in agricultural area and intensification in farm management. Another one is agricultural disintensification that, principally, can be manifested as agricultural land abandonment and decrease in land management intensity. A land manager is a decision-maker whose behaviour is determined by a wide range of drivers that can be categorized into four comprehensive groups: geophysical drivers, socio-economic drivers, institutional drivers, and individual farmer's characteristics.

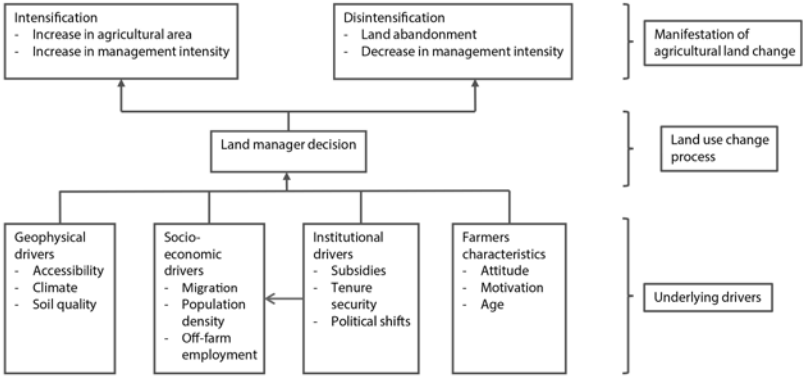


Figure 1.1: Framework of land use change process and driving factors

Note: Adopted from van Vliet et al. (2015)

A set of factors, such as local climate, soil type, water resources, topography, comprises the geophysical environment that determines whether the land is suitable for agricultural activities. Socio-economic factors refer to the external influences on the cost of farming activities and management intensity (e.g. availability of labour, capital, inputs; distance to market; price supports and subsidies). Geophysical and socio-economic factors are claimed to be dominant determinants of land use change in the literature (Briassoulis, 2003; Rey Benayas et al., 2007). However, a number of studies confirm that the impact of institutional factors cannot be neglected (Wegren, 2012). Institutions that comprise formal and informal policies and property rights draw a framework that regulate land use (Plieninger et al., 2016).

Evidence from empirical studies demonstrates that land tenure relationships and property rights have a significant impact on land use. In Europe, for example, the risk of land abandonment has been lower in regions where most of the land was owned in comparison with regions where land was rented (Alix-garcia et al., 2012; Terres et al., 2015). Land users with ownership rights perceive higher tenure security and reduced uncertainty regarding benefits from land investments (Feder, 1987). The lack of secure ownership reduces capital accumulation that, in turn, leads to lower input demands. A number of studies consider property rights as the most powerful category of institutions that facilitate economic development (North, 1990; Rodrik, 2007), shape individual incentives to carry out effective economic activity, and enable access to input markets (Besley and Ghatak, 2010; Demsetz, 1967; Forbord et al., 2014; Gebremedhin and Swinton, 2003; Kabubo-Mariara, 2007; Pearse, 1992; Smith, 1981).

1.2 INSTITUTIONAL CHANGE IN TRANSITION ECONOMIES

Transition economies in East Asia (EA), Central and Eastern Europe (CEE) and the former Soviet Union (FSU) produce more than one third[1] of global agricultural production (see Table A1 in Appendix A for country details). Yet many of these countries still have considerable potential to increase the value of their agricultural commodities by putting agricultural land, which was abandoned during the period of economic transition, back into production (Swinnen et al., 2017). In addition, the potential of these countries is associated with the lack of efficient land allocation to more productive users due to unfavourable institutional environment (Kvartiuk and Petrick, 2021).

Institutional characteristics seldom change rapidly across time within one country. For this reason, an outstanding political phenomenon, such as the dissolution of the Soviet Union, gives an opportunity to evaluate the impact of institutional drivers on land-use change. The period of economic transition from central planning to free markets in transition economies was associated with significant institutional shifts in the agricultural sector. Extensive political and economic reforms, which were intended to establish market-based economies through the land privatization, restructuring of collective and state farms, and the liberalization of prices and trade led to crucial institutional changes in agriculture. These changes did not always result in the formation of well-functioning land markets that would enable land allocation to more efficient users. Together with market failures, differences in the pre- and post-reform tenure settings created the distortion of effective land allocation (Ho and Spoor, 2006; Lerman et al., 2004).

The right to own property and to transfer property provide an essential base for effective resource allocation. However, in transition economies, land rights are most often fragmented or controversial (Wehrmann,

1 Own estimates based on the net production value of agriculture from FAOSTAT.

2008). Producers take decisions related to land use within the framework of land use rights provided by the government. Aggregated individual-level decisions form the patterns of land use on the national level. On the other hand, a cross-country analysis of land use change fails to provide insights on the impact of individual farmer characteristics and effects of non-economic attitudes and perceptions, which cause differences in behavioural patterns and play an important role in investigating drivers of land use change (Lambin et al., 2000). Moreover, an individual-level analysis gives an opportunity to control for unobservable heterogeneity in land use decisions. For instance, the implementation of agricultural reforms on the local level may vary within one country. Such heterogeneity is a source of inaccuracy in the interpretations of the estimates in macroeconomic studies and particularly estimates of the institutional effects (Fischer, 2010).

To reveal whether there are differences in the institutional framework at national and individual levels, it is necessary to understand the mechanism of decision-making process. Land users are decision-makers in agricultural sector that can intuitively or logically choose among actions by taking into account characteristics of physical and socio-economic environment, as well as regulations of agricultural policy and own attitudes and beliefs (Celio et al., 2014). Therefore, the framework of this study will be organised around the analysis of farmers' decision-making process or, in other words, human behaviours that shapes land use systems (Berkes and Folke, 1998).

1.3 SELECTED THEORIES OF DECISION MAKING

Several scholars made use of the assumption that a farmer is a rational individual (Best, 2009; Edwards-Jones, 2006). The neoclassical approach to the decision-making process assumes that people have access to full information and act in complete certainty. Considering all possible options,

the decision-maker can select the most beneficial arrangement. When it comes to agriculture, Schultz (1964) claims that farmers are guided by the principle of profit maximization. Later, he added that farmers "are no less concerned about improving their lot" and try to gain the maximum benefit with limited resources (Schultz, 1980).

However, the assumptions of neoclassical economic theory have lost their validity in the real world (Herbert, 1981). The environment of every individual is in a continuously changing mode (Cole, 2004) and catching all information is impossible. Incomplete information and cognitive limitations deflect a rational individual from optimal behaviour. Considered as another version of the rational actor model, the Prospect Theory takes into account biases in rational decisions that occur because of individual perception of losses and gains (Kahneman and Tversky, 1979). The theory of bounded rationality reviewed the neoclassic approach and included the concept of limited perceptions by boundedly rational actors who can adjust their behaviours by using heuristic, or by reaching an aspiration level (Gigerenzer and Selten, 2001). Zalega (2014) claims that neoclassical economics is bounded to static and formatted analysis and does not include decision-makers beliefs. The theory fails to capture people's emotions, interests, and imperfections. Behavioural economics has questioned the assumptions of the rational choice theory and attempted to find out how individuals make decisions in a world of uncertainty, limited cognitive resource, and biased decision. Simon (1959) claimed that individuals do not run for profit maximization but, rather, they seek for satisfying behaviour. Edwards-Jones (2006) proposed that profit maximization assumptions make sense only in cases when financial factors are important and, with declining of the dominance of finance, profit maximization models tend to get less applicable. Some studies indicated that farmer's goals change during the life cycle. Young farmers can focus on obtaining a high profit from agricultural activity sacrificing their leisure time (Gasson and Errington, 1993). With increasing age, farmers may wish to allow more time for leisure and their family. The presence of a successor is also one of the influential factors correlating with family farm management decisions and willingness to intensify production (Sottomayor et

al., 2011). Farmers that identified the successor have a strong motivation to improve and to invest in the agricultural activity. Moreover, the probability of saving the land and transferring it to the successor empirically shows to rise with farm size and farm specialization (Glauben et al., 2002).

Modelling human behaviour with the consumat approach[2], Jager and Janssen (2012) claim that decisions can change in accordance with the cognitive efforts of individuals and their abilities such as a capacity to elaborate on future outcomes, uncertainty tolerance, and ambition. Each of these abilities can be a serious constraint for performing effective and rational choices. For instance, farmers' time discounting can lead to consuming all financial opportunities in the present without the consideration of future needs. Thus, when farmers need to obtain inputs (e.g., seeds, fertilizers), they may have a lack of liquid assets.

All the above models nevertheless failed to capture the full complexity of farmers' behaviours, and psychological constructs that constitute farmers' decisions. Considering the gap in the literature, Ajzen (1991) proposed the Theory of Planned Behaviour (TPB) that states that behavioural intentions were designated by three main psychological elements: attitudes, subjective norms, and perceived behavioural control. Attitudes explain the positive or negative assessment of the individual's behaviour. Subjective norms assume an individual's perception of the social pressure upon them to perform or not perform the behaviour. Finally, perceived behavioural control associates with the evaluation of own capability to successfully perform the behaviour (Borges et al., 2016). The application of various theories to assess the sensitivity of the results to different assumptions about land-users' decision-making is important (Schlüter et al., 2017).

2 Consumat is an artificial consumer in the human behaviour simulation model of Jager and Janssen (2003).

1.4 RESEARCH GAPS, OBJECTIVES AND THE STRUCTURE OF THESIS

Much of the literature on the institutional dimension of land use change fails to capture the dynamic effect of institutional change on land use. Due to usually slow and gradual transformation of institutions, understanding their role in land use change is difficult (Alix-Garcia et al., 2012; Prishchepov et al., 2012). In addition, they might have both direct and indirect effect on land use. Institutional factors such as land tenure settings have a direct impact on land management through land policies and reforms (Raymond and Spoehr, 2013). Political shocks and rapid institutional changes may impact indirectly the use of agricultural land by changing the economic behaviour of rural households (Alix-Garcia et al., 2012; Bittner and Sofer, 2013; Hanh et al., 2017).

Additionally, the determination of the institutional role in land use change can be difficult, because some dimensions of the institutional framework, particularly formal ones, might differ at the national level and others, informal ones, at the individual level. The impact of formal and informal institutional arrangements on the performance of farming activity is analyzed separately in the corresponding literature neglecting the effect of their interactions.

Considering the gaps in the literature, the overarching question of this dissertation is: "What is the role of land rights in land use change?" To respond on this question, three following objectives were identified:

1. to analyze the drivers of arable land use change with a special focus on the role of national differences in land use rights and governance effectiveness;
2. to explore whether and how mismatches between land rights and actual practices affect farmers' willingness to intensify land use;
3. to investigate whether perceived land rights influence the formation of farmers' intention to intensify land use.

Transition economies are chosen as a case study region to reach these objectives due to observable changes in land tenure settings and land use patterns during the last three decades.

The first objective is addressed in Chapter 2. To investigate the impact of institutional change with respect to land governance across transition economies on agricultural land use, the study uses time-series cross-sectional data from 29 transition economies in East Asia, Central and Eastern Europe, and the former Soviet Union for the period of 1991–2014 to analyse the drivers of land abandonment in transition economies with a special focus on the role of land use rights, and governance effectiveness. I operationalise land ownership and land transferability by evaluating land legislative documents to create variables for the empirical analysis. The results indicate that countries with fully established private ownership experience higher rate of land abandonment; however, countries with more transferable land demonstrate higher land use.

Chapter 3 considers the second and third objectives. To explore whether and how mismatches between land rights and actual practices affect farmers' willingness to intensify land use, we applied a new approach proposed by Klümper et al. (2018) to reveal paper-practice mismatches in Kazakhstan and Uzbekistan. The multidimensional nature of perceived land rights is covered by operationalizing the bundles of rights approach proposed by Schlager and Ostrom (1992). Firstly, this study presents a comparative descriptive analysis of real tenure conditions of Kazakh and Uzbek farmers. Afterwards, empirical analysis confirms that mismatches between land rights on paper and perceived land rights (such as the violation of law restrictions or incomplete use of land rights) generally reduce farmers' willingness to intensify land use. Chapter 3 uses the farm-level data collected during a survey conducted in 2019 in southern Kazakhstan and eastern Uzbekistan.

The third objective aims at investigating whether perceived land rights influence the formation of farmers' intention to intensify land use by utilizing psychological constructs from the TPB. This theory allows viewing land rights as background factors that modify farmers' beliefs related to land intensification. The findings from this study show that

perceived land rights and their discrepancies with written land rights have a substantial importance in the formation of farmers' intensification intention.

The final chapter draws scientific conclusions and provides policy recommendations that may contribute to improving land policy design to enhance land tenure security in transition economies. In addition, the final chapter discusses limitations and ideas for future research.

2 MACRO-ECONOMIC PERSPECTIVES ON LAND USE CHANGE AND TENURE RIGHTS IN TRANSITION ECONOMIES

2.1 LINKING LAND ABANDONMENT AND INSTITUTIONAL CHANGE IN TRANSITION ECONOMIES

Farm restructuring aimed at individualization and land reallocation to market-oriented organisational forms appeared to be one of the crucial reforms for transition to a market economy. One of the first reformers, China, began its transition in 1978 with an introduction of the household responsibility system that replaced the production team system and enabled households to manage their own agricultural production on contracted land. This reform resulted in a dramatic transformation of rural areas and significant growth in agricultural productivity (Lin, 1988). Almost a decade later, applying similar land reforms in the second half of the 1980s, other Asian countries such as Vietnam, Laos, and Myanmar followed the Chinese path (Rozelle and Swinnen, 2004; Rungsuriyawiboon and Wang, 2012). These countries could achieve outstanding increase in income and reduction in rural poverty. When the CEE and FSU countries started transition to a market economy in the early 1990s, observers and governments expected a similar Asian success. However, the outcomes were disappointing, as these countries experienced a huge drop in agricultural outputs. The reasons for the drop laid in the fact that the FSU and CEE countries had differences not only in initial institutional conditions but also in the implementation of market and institutional reforms.

Land privatization and land reforms strategy had two main fundamental approaches: restitutions and distribution of land rights (Hartvigsen, 2014). Restitution of land rights implies the restoration of land rights of former owners, whereas distribution of land rights is the reallocation of physical land plots and land shares to rural population. In some CEE nations (for example Poland, Romania, Czech Republic), land ownership existed during the Socialist period; therefore, the establishment of institutions took less time. A big share of land previously operated by collective farms was returned to former owners. However, not many made use of this possibility which kept large farms intact in these countries.

Unlike in CEE countries, all land in the FSU countries belonged to the state during the socialist era. After the dissolution of the USSR, many FSU nations simply distributed land certificates that, in reality, were not connected with a specific physical plot. Therefore, land distribution remained only on paper leaving certificate holders with uncertain tenure rights (Kvartiuk and Herzfeld, 2019). Later on, some countries (e.g., Moldova and Ukraine) succeeded in converting land certificates into physical plots. Retaining their position as the main landowner, the governments of Laos, Tajikistan, Uzbekistan, and Vietnam provided only leasehold tenancy to farmers (Rozelle and Swinnen, 2004). Even more, Belarus preserved its institutional conditions of land tenure without restructuring (Giovarelli and Bledsoe, 2001).

Thus, development over the last 30 years resulted in different degrees of land tenure conditions across the transition economies. Although land privatization assumes possessing rights to operate, to sell, and to sublease, land ownership is not always associated with rights to transfer the land in the FSU. Despite allowing land ownership, Turkmenistan completely prohibits transferability removing the most important advantage of private property (Lerman and Brooks, 2005). Land may be non-transferrable even when there are no legal restrictions on land transactions. In 2003, Kazakhstan and Russia legalized land ownership for all agricultural producers, but due to the lack of administrative infrastructure, the share of private agricultural land is still negligible (Kvartiuk and Herzfeld, 2019).

Substantial changes in land policies and the transition to a market economy caused to the dramatical decline in agricultural land use in majority of these countries between 1991 and 2014 (Figure 2.1). For instance, in Russia, Ukraine, and Kazakhstan, approximately 57 million hectares of croplands were inferred from production (Meyfroidt et al., 2016). By 2004, Albania, Azerbaijan, Moldova, Romania, and Uzbekistan abandoned between 9 and 11 per cent of cropland compared to 1990. Armenia, Bulgaria, Croatia, Poland, and Slovakia removed more than 20 per cent of their cropland from use in 1990s.

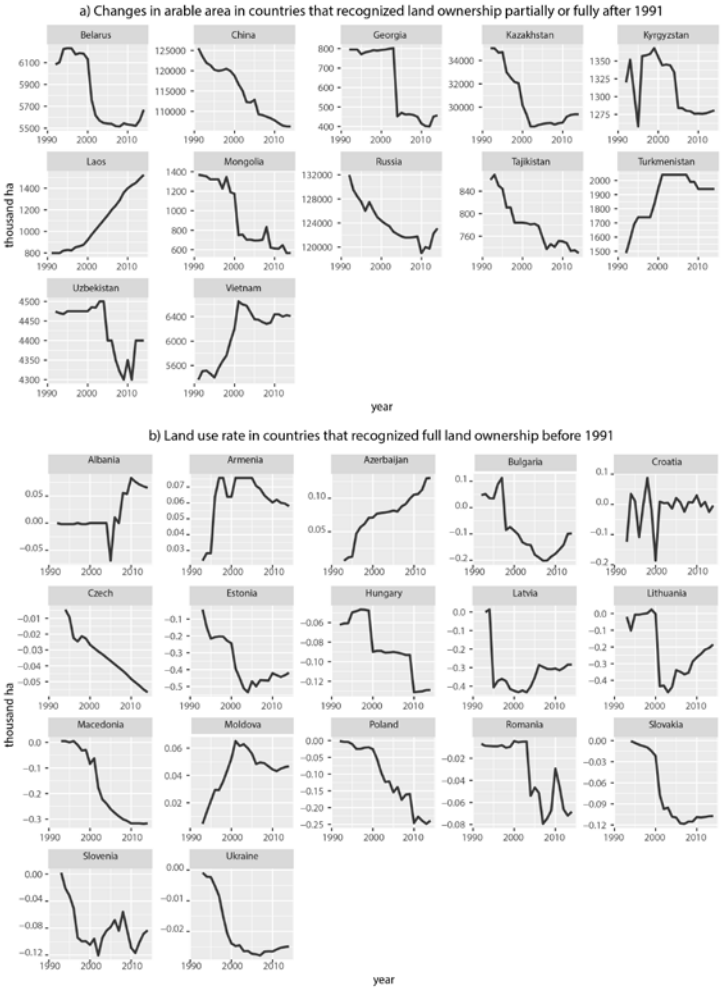


Figure 2.1: Arable land in transition countries during the period of 1991-2014

Note: Base year = 1990

Source: FAOSTAT

Land abandonment in formerly socialist countries was typical for locations with low land productivity, or remote areas with adverse market access and poor job opportunities (Alcantara et al., 2013; Lerman, 2009). Interestingly, regions with similar agroecological conditions, where land market mechanisms were associated with more favourable political and institutional settings, experienced lower land abandonment. Several studies claimed that the reason was efficient land allocation that depends on institutional arrangements that regulate the operation of land (Alix-garcia et al., 2012; Prishchepov et al., 2012).

A part of the abandoned land is still potentially available for crop production and could be recultivated to contribute to global food security (Schierhorn et al., 2014; Swinnen et al., 2017). Being motivated by this potential, we focus on the analysis of land reforms and land use patterns in this dissertation.

2.2 THEORETICAL MODEL OF LAND USE

Using a model of land expansion developed first by Barbier (2001) as a starting point, we develop an economic model of agricultural land use change. Each farmer is assumed to be a rational individual who considers land as one of the production factors that can be allocated among various uses (Barbier, 2001; Chomitz and Gray, 1996). From an economic perspective, land use decisions can be related to expected or realized gains from production, conditional upon natural/environmental and institutional constraints. In market-based economies, the main economic incentive in individual land use choices is to maximize the net present value of return to the land.[3] Thus, the total return to land R_a can be defined as a difference between the revenue from yield and the cost of production (Eq. 2.1):

3 Here, the vector of net returns includes all potential cash returns, which are not only returns from using the land for production, but also from land transfers, such as reallocating, renting out and selling.

$$max\, R_a(\boldsymbol{p}, \boldsymbol{c}, A) = \boldsymbol{pq} - \boldsymbol{wc} \tag{2.1}$$

where R_a is a total return to the land, $\boldsymbol{q}$ is a vector of all outputs produced from this land, $\boldsymbol{c}$ is a vector of inputs, and A is the area of land which is considered a fixed allocatable input. Prices for inputs and outputs are indicated by vectors $\boldsymbol{w}$ and $\boldsymbol{p}$, respectively.

In this study, we assume that the individual has only two options of land-use: maintaining crop cultivation and discontinuation of cultivation. By selecting between these options, a producer replaces profit maximization by loss minimization. If the private net return of land cultivation is zero or negative, the land will be abandoned; otherwise, the cultivation will be continued or expanded. The specification of net returns changes in accordance with the specific land-use context that determines the value of land. The pattern of land use at the country-level is determined by an accumulation of individual decisions. Aggregated responses to R_a over all land users in a given country can be expressed as a change in agricultural area between two periods:

$$\Delta A_t = A_t - A_{t-1} = \begin{cases} 0 \text{ or } \Delta A \text{ (land cultivation)} & \text{if } R_a > 0 \\ -\Delta A \text{ (land abandonment)} & \text{if } R_a \leq 0 \end{cases} \tag{2.2}$$

where A_{t-1} is the area of land used for cultivation in the previous period; A_t is the land used for cultivation in the current period. ΔA stands for the difference between both periods, which is negative if abandonment occurs. The value of a hectare used for cultivation is given by:

$$V_a = V(\boldsymbol{p}, \boldsymbol{w}, \boldsymbol{s}, \boldsymbol{\delta}) \tag{2.3}$$

where $\boldsymbol{p}$ is the value of yield harvested from that hectare, $\boldsymbol{w}$ is the cultivation cost, $\boldsymbol{s}$ is the productivity factor, encompassing agroclimatic and soil characteristics, and $\boldsymbol{\delta}$ is the discount rate of a future asset's returns. Following Deacon and Bohn (2000), we assume that secure ownership decreases the expropriation probability of future profits, and on the contrary, the loss of ownership postpones receipts into the future and, hence,

decreases the expected present value of future returns to land. Thus, the total return to cultivated land can be rewritten as:

$$R_a = \delta \times V(\boldsymbol{p}, \boldsymbol{w}, \boldsymbol{s}, \boldsymbol{\delta}) = R_a(\boldsymbol{p}, \boldsymbol{w}, \boldsymbol{s}, \boldsymbol{\delta}) \quad (2.4)$$

which is increasing in $\boldsymbol{p}$ and $\boldsymbol{s}$, and decreasing in $\boldsymbol{\delta}$ and $\boldsymbol{w}$. Given that optimum use of agricultural land is determined by the first-order conditions for Eq. 2.1 (Alig et al., 1988), the change in aggregated agricultural land between two periods is decreasing in $\boldsymbol{\delta}$ and $\boldsymbol{w}$, and increasing in $\boldsymbol{p}$ and $\boldsymbol{s}$:

$$\Delta A_t = A(\boldsymbol{p}, \boldsymbol{w}, \boldsymbol{s}, \boldsymbol{\delta}) \quad (2.5)$$

Any analysis of land use change at the farm level within one country will not be able to control for variables that are constant across observations. Cross-country analysis provides an opportunity to include factors such as macroeconomic policy and institutional drivers that influence decision parameters through agricultural markets and land tenure conditions. The main differences between country-level and household-level models is that prices at the country-level become endogenous and must be replaced by underlying drivers such as macroeconomic variables and policy instruments. Particularly, considering that output and input prices are functions of aggregate supply and demand, we can use exogenous factors that lead to changes in aggregate supply and demand (for example changes in exchange rates, household wealth, subsidies).

Replacing $\boldsymbol{p}$ and $\boldsymbol{w}$ in Eq. 2.5 by the vector of structural economic and demographic variables, $\boldsymbol{z}$, we may present the rate of aggregated land use change (Δr_{Ait}) as

$$\Delta r_{Ait} = r_{Ait}(\boldsymbol{\delta}_{it}, \boldsymbol{s}_{it}, \boldsymbol{z}_{it}) \quad (2.6)$$

where $\boldsymbol{\delta}_{it}$ is a vector of institutional variables that influences agricultural land use not only through land markets but also affecting future assets'

returns through land tenure security, and $\boldsymbol{s}_{it}$ is a vector of environmental variables that influences land productivity and cultivations costs.

We use two indicators of institutional arrangements that approximate the degree of ownership and transferability rights. Considering the literature presented above, we expect that improved tenure rights (for example implementation of full private ownership) will increase aggregated land use under the assumption of all other markets working perfectly. Similarly, freedom to transfer agricultural land to other users will cause the economic value of land to rise and, thus, provides incentives to exercise land use.

However, macroeconomic models have several limitations, too. Firstly, in aggregated models, all farmers are equal; therefore, they fail to provide insights on the impact of individual farmer characteristics and the effects of non-economic attitudes and perceptions, which cause differences in behavioural patterns and play an important role in investigating drivers of land use change (Lambin et al., 2000). Secondly, macroeconomic models neglect any regional or socio-economic differentiation. The individual country-specific analysis gives an opportunity to take unobservable country heterogeneity into account, which might come from differences in the implementation of agricultural reforms at the local level. Such heterogeneity is a source of inaccuracy and bias in the interpretations of the estimates in macroeconomic studies and particularly estimates of the institutional effects (Fischer, 2010).

2.3 DATA AND METHODOLOGY

2.3.1 Empirical specification

We use Eq. 2.6 to derive the empirical model of land abandonment to test institutional drivers of agricultural land use

$$\Delta r_{Ait} = \alpha + \beta_{Git} G_{it} + \beta_{Xit} X_{it} + \nu_i + \varepsilon_{it} \quad (2.7)$$

where Δr_{Ait} is the rate of land use in country i, α is a constant term, G_{it} is a vector of institutional variables and X_{it} is a vector of additional variables, β_{Git} and β_{Xit} are vectors of coefficients to be estimated, ν_i is unobserved country-specific effects and ε_{it} is the random error term. The theoretical model above suggests to hypothesize that better governance, ceteris paribus, facilitate agricultural land use.

2.3.2 Measuring land use rate

There is no commonly accepted measure for land use change that would provide the most accurate estimation of agricultural area. In this study, we refer to the two most relevant FAO definitions, which are relevant to the area of cultivated land (FAO, 2017). One of them is agricultural land that comprises arable land together with permanent croplands, pastures and hayfields. Another definition is arable land that consists of land under temporary crops, pastures and temporarily fallow land. In both indicators, double-cropped areas are counted only once. It's possible that permanent pastures and hayfields are likely to contain abandoned land, which points to arable land as the more appropriate measure. However, several remote-sensing and environmental studies raise concerns related to miscalculation of arable lands in official statistics. For example, land sown with perennial grasses is often reported as a part of official arable land in Russia (Ioffe et al., 2012). Moreover, after more than five years, un-

utilized fallow land may often be recorded as arable land, while, in fact, it is abandoned. Ioffe et al. (2012) and Schierhorn et al. (2013) claim that sown area recorded in official agricultural inventory statistics demonstrates the closest matches with independent remote-sensing estimates for land abandonment because it is reported annually by farmers to local agricultural administrations. Yet, such discrepancies have only been studied in certain countries, particularly European Russia, Ukraine, and Belarus, and the existence of similar problems in the other selected focus countries is unknown. In addition, the studies on mapping abandoned land might face challenges that result in inaccuracies (Lesiv et al., 2018). Official statistics on sown area in tropical countries, such as Vietnam, Laos, and China, include double-cropped acreage, which creates difficulties for calculating the physical sown area. For these reasons, we employ the data on arable area despite the limitations mentioned above.

Following previous studies, we use land use rate as a dependent variable that simultaneously reflects not only abandonment, but also recultivation or agricultural expansion. Sikor et al. (2009) identify land abandonment in each period as "the percentage change in cropland from the amount of cropland at the start period". Meyfroidt et al. (2016) estimate the ratio of abandoned land to the total cropland area using the annual sown area statistics at the provincial level. A similar measure was introduced by Yu et al. (2017) estimating an index of seasonal farmland abandonment by measuring the difference between total farmland area and crop planting area as a share of total farmland area. Since our focus is on changes in arable land use, we apply the opposite of previous studies to calculate the land abandonment rate and estimate the rate of land use with Eq. 2.8:

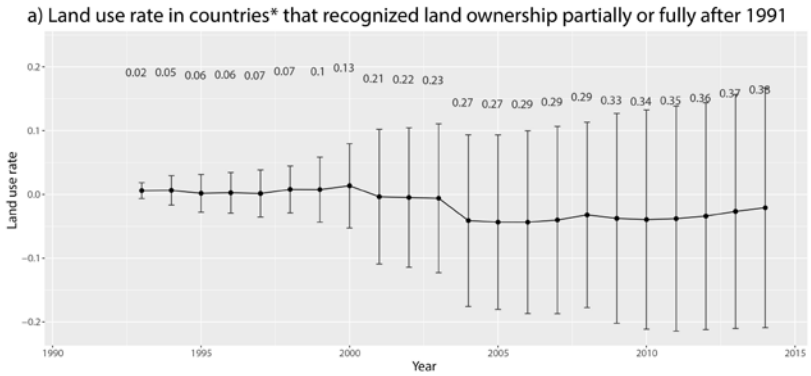
$$\Delta r_{Ait} = \frac{A_t - A_0}{A_0} \tag{2.8}$$

where A_0 is initial arable area in the beginning of 1990s (that is the first year with available data) and A_t is arable area for every following transition period year. Negative values of the rate imply abandonment of arable area; positive values indicate cultivation or recultivation of aban-

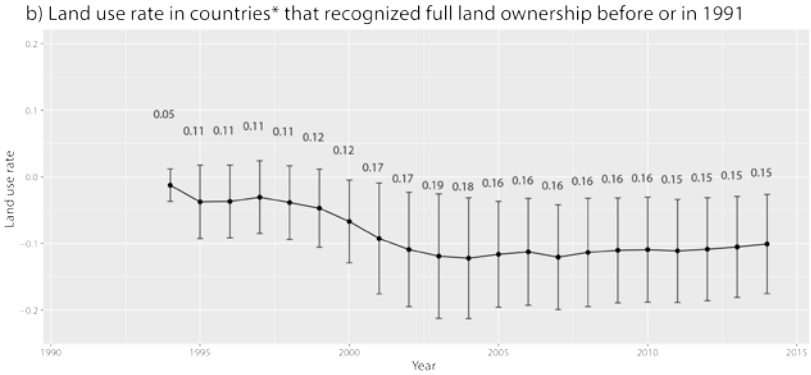
doned land (see Figure A1 in the Appendix A for the trends of land use rates in each country).

Figure 2.2 displays the mean values of land use rates from 1991 to 2014 for two groups of transition economies. First, countries that recognised private ownership of land partially or fully after 1991 belong to group A. Second, group B consists of countries that recognised potentially ownership for all farmland before 1991 or never suppressed private ownership. Standard deviations represent the dispersions of land use rates for each group. Average land use rates in the first group (Figure 2.2a) that comprises not only FSU countries but also East Asian transition economies decrease relatively slightly until 2007 and then partly recover. Although big countries such as China, Kazakhstan, Russia, and Ukraine expose low declines in land use rates, the absolute amount of abandoned area is many times greater than in other countries. The widening standard deviation in group A marks the substantial variability of land use rates among these economies.

The second group (Figure 2.2b) that consists mainly of CEE countries is characterized by a decrease in land use on average until 2004. After that, the rate slightly recovers indicating recultivation of abandoned land. Given that these countries had more improved land tenure rights from the beginning of the transition, the decreasing trend of land use change appears as an unexpected result. The decrease in average land use rates for Group B is absolutely greater than for Group A. However, standard deviations are smaller in Group B indicating less heterogeneity in land use change among countries that recognised land ownership before 1991. The greatest loss of arable land was observed in Mongolia, Estonia, and Georgia, where farmers abandoned more than half of the stock of arable land in the early 1990s (Figure A1 in the Appendix A).



* Group A: Belarus, China, Georgia, Kazakhstan, Kyrgyzstan, Laos, Mongolia, Russia, Tajikistan, Turkmenistan, Uzbekistan, Vietnam



* Group B: Albania, Armenia, Azerbaijan, Bulgaria, Croatia, Czech, Estonia, Hungary, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Slovakia, Slovenia, Ukraine

Figure 2.2: Dynamics of land use rate between two groups of transition economies

Note: Numbers above the line show the standard deviations of land use rates for each year.

2.3.3 Measuring institutional indicators

To evaluate how improved land tenure settings are within each country, we focus on the legally defined land ownership right and the right to transfer agricultural land. Although the implementation and the practical use of land rights may differ from legislation, legally defined tenure rights demonstrate the maximum amount of protection that governments give to landowners and land users (Hartwell, 2018). We adopted an operationalisation method suggested first by Lerman et al. (2004) to measure land ownership and land transferability. For each year within the period of 1991–2014, these two indicators are assessed on the basis of land codes and relevant legislation (see Table A2 in the Appendix A). Table 2.1 presents a three-point scale used to evaluate the level of land ownership and transferability rights for farmers, who produce for commercial purposes, and households, who produce mainly for own needs. For land ownership, we assign a score of 0 if a country does not recognise private ownership for both farms and households in a particular year. A score of 1 is assigned for those countries that partially recognise ownership and granted this right to households, whereas commercial farmers remain deprived from private land ownership. Countries, where households and farmers are allowed to own agricultural land, have a score of 2.

Table 2.1: Operationalisation of land ownership and land transferability

Level	Private land ownership	Land transferability
0	None	No rights to transfer or moratorium
1	Households	Right to lease and inherit
2	Farmers and households	Right to buy, sell and lease

Note: Adopted from Lerman et al. (2004)

Similarly, the indicator of land transferability takes on a score of 2 if a country grants farmers the right to lease, sell, and buy agricultural land without any restrictions (restrictions for foreigners are not considered). A score of 1 is given to countries that allow leasing and inheriting but

prohibit buying and selling of land. Countries that only allow rights to use land without rights to transfer or have a moratorium on land transactions are assigned a value of 0. This indicator relies on the right of land transferability for commercial farmers excluding households that are mainly involved in subsistence farming. We only make an exception for China, Laos, and Vietnam because the laws in these countries do not differentiate between farming households and commercial farmers. Values of both indicators for all years are presented in Table A3 and A4 in the Appendix A.

The Rule of Law indicator from the World Bank's Worldwide Governance Indicators (WGI) dataset was used as a proxy for the governance quality. According to the definitions of WGI, the rule of law reflects the aspects of tenure security enforcement, such as the quality of contract enforcement and property rights. This indicator ranges from -2.5 to 2.5 with higher values, indicating better governance performance. We rescaled this indicator to run from 0 to10 to get rid of negative values.

Although a possible correlation between land ownership, land transferability, and the rule of law might exist, they still measure different aspects of governance. In transition economies, land ownership does not have to entail the right to sublease or sell. Some countries that allow land ownership may put restrictions on land transferability creating impediments to effective land allocation (for example Ukraine and Turkmenistan), and, on the contrary, some countries grant partial or full rights to transfer land without ownership rights (for example Vietnam and Tajikistan). Lerman et al. (2004) assert that land transferability plays a greater role in establishing land markets and effective resource allocation than land ownership. According to the methodology of the rule of law, which is based on perceptions of the level to which governments enforce contracts and maintain the security of property rights, it is obvious that this indicator measures the informal side of legal rights, particularly to what extent these rights can be enjoyed (Kaufmann et al., 2010).

2.3.4 Control variables

Following the existing studies on land use and abandonment, we control for environmental and socio-economic drivers. Firstly, to determine the environmental potential of agricultural land, we use two climatic datasets: annual mean temperature and average precipitation. We retrieved the data from the World Bank database and calculated the annual mean temperature and the average precipitation of the four months, from March to June, that are crucial for crop growth. We converted the temperatures from Celsius to Fahrenheit to eliminate negative values to estimate the natural logarithm of annual average temperatures.

Furthermore, we introduce control variables for demographic and labour market conditions: the share of rural population and population density. A number of studies claim that land abandonment appears in regions with declining and poorer populations (Ioffe et al., 2012; Meyfroidt et al., 2016). On the contrary, the probability of using land for agricultural purposes is shown to be high in regions with increasing population pressure (Wolfersberger et al., 2015). We use data on the share of rural populations and population density provided by World Development Indicators (WDI). The share of rural population is a proxy for migration from rural to urban areas and potential rural labour availability. Higher population density implies increasing demand for food and, hence, increasing pressure on cultivated land. Both, the share of rural population and population density, are assumed to have a negative impact on land abandonment (Meyfroidt et al., 2016). To identify the relative importance of economic development in land use change, we include economic variables into the model such as per capita gross domestic product (GDP per capita), real exchange rate (RER), and the terms of trade of agriculture (TOT). GDP per capita is indirectly associated with farming opportunity costs related to urbanization and industrialization (Li and Li, 2017; Rey Benayas et al., 2007; Yu et al., 2017). Thus, we expect a negative sign for the coefficient related to GDP per capita. Fluctuations of the RER influence the value of agricultural incomes and land through changes in agricultural commodity prices (Hooper and Kohlhagen, 1978). However, the

effect will differ depending on the country's trade status and integration in international markets for agricultural inputs.[4] Therefore, we control for the counterbalancing effects of RER by using the interaction terms of RER and net trade status for agricultural products. We expect that a decline in RER increases land cultivation in net importing economies (NI) but decreases land use in net exporting economies (NX). A decline of agricultural relative to non-agricultural prices, measured by the sectoral TOT, is expected to foster rural-urban migration and a reduction in agricultural land use. Following Butzer et al. (2002), we measure TOT by the ratio of agricultural GDP deflator to non-agricultural GDP deflator.

An increase in agricultural production can be related to a more intensive production on a constant area, and/or to a recultivation of earlier abandoned land. In the process of liberalization, areas with low productivity tend to be abandoned or converted to forest (Sali, 2012). Rudel et al. (2009) found evidence that rising yields were not associated with cropland declines in countries that export grain and do not apply conservation programs. We include the variable cereal yield per hectare to capture the cross-country differences in average productivity.

In addition, we add the variable of armed conflict as a control variable to observe its impact on land use. Causing forced flee from combat zones and destruction settlements, armed conflicts indirectly influence land use and land abandonment (Witmer and O'Loughlin, 2009). Even after the armed conflict ends, the existence of disputed territories may make it difficult to invest in agriculture and to recultivate abandoned lands (Johnson, 2012). The number of deaths in state and non-state conflicts provided by the Uppsala Conflict Data Program Georeferenced Event Dataset (Sundberg and Melander, 2013) allows investigating not only the impact of conflict on land use but also the impact of the severity of a conflict.

Finally, we add the road network density as a proxy variable for infrastructural development. Land abandonment mostly occurs in areas with

4 It is assumed that consumption baskets remain constant; thus, the RER effect is solely caused by a change in the nominal exchange rate.

poor market access and high transportation costs (Van Eetvelde and Antrop, 2004). Yet, developed infrastructure may create a negative impact on land use, since improved road networks may provide an opportunity to access off-farm jobs. Thus, the direction of the effect of improved infrastructure on land use is unknown a priori.

2.3.5 Descriptive statistics and estimation strategy

Due to missing observations, the final panel dataset consists of 26 countries over the period of 19 years (1996-2014). Data sources and descriptive statistics are given in Table A5 (aggregated) and Table A6 (disaggregated by country) in the Appendix A. Following Wooldridge (2008), we transformed such variables as GDP per capita, number of deaths in military conflicts, temperature, precipitation, population density, RER, TOT, yields per hectare, and road density into logarithmic form. To deal with zero observations in number of military conflict deaths, we added 1 to the original variable before transforming to logarithm. The log transformation yields distributions that are closer to normal and makes the non-linear relations as linear as possible by narrowing the range of the data. The analysis of correlation coefficients in Table A7 in the Appendix A demonstrates the absence of collinearity issues. To remove any doubts about multicollinearity among variables, we found the mean of Variance Inflation Factor (VIF) using regression with all independent variables. The overall value of VIF is 4.42 and the highest individual VIF value is 7.93. Both are below the critical threshold of 10, assuming the absence of multicollinearity among explanatory variables.

The strategy for estimating Eq. 2.7 involves two sets of regressions: a set of regressions with a focus on land ownership and transferability rights (Model I) and a set of regressions with the rule of law (Model II). The reason of running two models is a potential collinearity between institutional variables. Tests for joint significance were performed to justify the

relevance of three institutional variables: land ownership, transferability, and rule of law. The null hypothesis that three coefficients are equal to zero was rejected ($\chi^2 = 27.42$). We also estimate two baseline regressions of Model I and Model II only with institutional variables to figure out how the model reacts to the addition of control variables.

The most commonly used panel data models are Pooled Ordinary Least Squares (OLS), Fixed Effects model (FE), and Random Effects model (RE) (Wooldridge, 2008). Pooled OLS neglects the cross-section and time series nature of data and assumes homoscedasticity and no serial correlation. However, pooled OLS is inconsistent when then number of units is small; moreover, the usual standard errors of pooled OLS are incorrect and do not allow making tests on them. FE model assumes that the country-specific effect is a random variable that is allowed to be correlated with the explanatory variables. In RE model, the country-specific effect is randomly disturbed across countries and is uncorrelated with the explanatory variables. To address inefficiency in coefficient and standard error estimation and to select a proper estimator for the land use model, we inspected the nature of the time-series cross-sectional data (TSCS) data and then checked for the presence of heteroscedasticity, autocorrelation, and cross-sectional dependency. In case of appearance of these issues in a model, the signs of parameters become unreliable and estimators that are more robust should be employed.

Results of Wooldridge, Modified Wald, Pesaran, Frees, and Friedman tests are summarized in Table 2.2. The test results indicate the presence of serial correlation, heteroscedasticity, and cross-sectional dependence in both models.

For models with such issues, Beck and Katz (1995) suggest employing the Prais–Winston regression with Panel-Corrected Standard Errors (PCSE), which is very accurate for TSCE data with T>15. The Monte Carlo simulations confirmed that the PCSE estimator with group-wise first-order autocorrelation (AR(1)) produces accurate coefficients for any level of serial correlation (Moundigbaye et al., 2017). This technique helps to modify the entire dataset considering common average autocorrelation across panels. Beck and Katz's (1995, p. 640) claim that in comparative

Table 2.2: Specification tests

Model I	Test	Pooled	Random Effects	Fixed Effects
Serial correlation	Wooldridge	66.006***		
Heteroscedas-ticity	Modified Wald			68310.62***
Cross sectional dependency	Pesaran		1.527	0.929
	Frees		4.944***	6.956***
	Friedman		26.504	15.797
Model II	**Test**	**Pooled**	**Random Effects**	**Fixed Effects**
Serial correlation	Wooldridge	67.400***		
Heteroscedas-ticity	Modified Wald			50363.01***
Cross sectional dependency	Pesaran		2.220**	0.879
	Frees		4.989***	6.069***
	Friedman		29.660	16.334

Note: ***, **, * denote significance level of 1%, 5%, and 10%, respectively.

politics studies, the assumption of common autocorrelation for all panels gives consistent results.

We run our models using pairwise selection, because PCSE requires balanced data (Moundigbaye et al., 2017). Considering that the regression coefficients are subject to sampling uncertainty, we present the regression results with p-values and 95 per cent confidence intervals (CI) to avoid misinterpretation (Hirschauer et al., 2018; Wasserstein et al., 2019). Coefficients are derived from Stata 15 with the function xtpcse and

viewed as coefficients plots with the Stata command *coefplot* written by Jann (2014).[5]

The relation of land ownership and transferability to land use rate could be non-linear due to their categorical nature. As the levels of ownership and transferability denote different land users and different land rights, respectively, their effect on land use rate may change depending on the level. Thus, specification above will not be able to capture the impact properly. In order to test for non-linearities, we create a set of dummy variables for the three levels of land ownership and for the three levels of land transferability. Therefore, we run a similar model with dummy variables to check the robustness of the PCSE results.

2.4 RESULTS AND DISCUSSION

Figure 2.3 presents the results of Model I and II without (baseline) and with (full model) control variables. Despite adding control variables, the effects of the focus variables (land ownership and land transferability) are similar and consistent with baseline models. The negative impact of land ownership in both baseline models suggests that countries with more improved ownership rights experience a reduction of arable land relative to the early 1990s. Countries with more improved transferable land rights show an increase in land use. While the estimated impact of land ownership remains almost unchanged with control variables, the partial impact of land transferability increases. The difference in partial effects of land transferability in both models shows that the influence of control variables in Model II cannot be neglected. The marginal effects of both institutional variables have relatively high magnitudes compared to the magnitudes of control variables. Our findings confirm that land abandonment is mainly driven by aggregated socio-economic and political changes (Müller et al., 2012; Prishchepov et al., 2013).

5 The core Stata commands used to calculate the results for this section are presented in the Appendix C.

Land ownership and land transferability are entered in Model I and II as a linear term. The impact of land ownership seems to be in contradiction with our initial statement that land use is higher in countries with more improved tenure conditions. Moving from the absence of land ownership to allowing ownership to households and further to farmers and households is associated with a reduction by 0.05 in the land use rate in both models (all other variables held constant). However, we should take into account the fact that most of the countries with planned economies, particularly the former Soviet Union members, used arable lands ineffectively, pushing them into unproductive and marginal areas

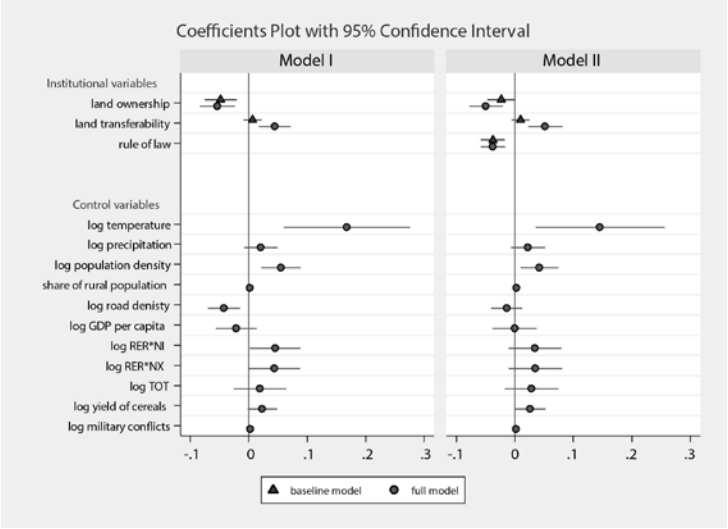


Figure 2.3: Regression coefficients of linear model with a 95% confidence interval

Note: Detailed estimation results are presented in Table A8 and A9 in the Appendix A.

(Nguyen et al., 2018). The introduction of land ownership during the transition period created market conditions under which effective resource allocation occurred and unproductive lands were abandoned at the forefront. Nevertheless, the positive effect of land transferability that plays an important role in the reduction of land tenure insecurity than land

ownership is consistent with our theoretical approach. Moving from the prohibition of transfer to granting the lease and inheritance rights and further to granting the rights to buy, sell, and sublease is associated with an increase by 0.04 and 0.05 in Model I and II, respectively (all other variables held constant).

The negative effect of the rule of law that reflects the effectiveness of property rights and contract enforcement does not seem surprising and demonstrates that countries with more effective governments experience a decline in land use during the transition from a planned to a market economy. Its negative impact on land use rate have a similar magnitude in both specifications: a 10 per cent increase in the rule of law leads to 0.4 per cent fall in the land use rate. Evidence for developing countries has pointed to a negative correlation between the effectiveness of regulatory structure and deforestation rates, which is the same with agricultural land expansion (Barbier and Tesfaw, 2015; Deacon and Bohn, 2000).

The estimated impact of the population density is positive and have coefficients of 0.06 and 0.04 in Models I and II, respectively. In other words, an increase in population density by 10 per cent results in an increase of land use rate by 0.6 per cent (Model I) and 0.4 per cent (Model II). Along with the positive effect of the share of rural population in both models, these coefficients provide strong evidence on the importance of rural population for maintenance and recultivation of arable lands, which is in line with other studies (Baumann et al., 2011; Prishchepov et al., 2013; Verburg and Overmars, 2009). The positive coefficient of cereal yields in Model I and II suggests that agricultural intensification involves an increase in agricultural area; in other words, an increase in cereal yield diminishes land abandonment. Temperature imposes a positive effect on arable land use with the highest effect 0.17 and 0.15 in Model I and II, respectively. However, this effect cannot clearly explain the heterogeneity of land use across transition countries. The reason might be attributed to the high heterogeneity of environmental characteristics within countries. Reliable environmental drivers that may be powerful predictors of land abandonment generally exist on district levels (Baumann et al., 2011). The average values of such indicators miss important information, such

as annual and spatial variation and extreme weather shocks. Therefore, the interpretation of the parameter estimates of environmental variables should be done with caution.

2.5 ROBUSTNESS ASSESSMENT

To assess the robustness of results, we perform two types of analysis. The first analysis is related to the robustness of model specification questioning the linearity of the relationship between land use rate and land rights. The second one addresses the data issues that could occur due to methodological changes in measuring the area of arable land.

We repeated Model II using the same estimator (PCSE) with decomposed land rights to control whether the relation between land rights and land use is not linear. The rationale of this method was to capture the influence of land rights on different levels of limitation. We modified the measurements of land ownership and land transferability, which have three-point estimation, into dummy variables for each point. Thus, we introduced three dummy variables for land ownership (no ownership, partial ownership, full ownership) and three for land transferability (no transferability, partial transferability, and full transferability).

To avoid the so-called "dummy variable trap", we ran two regressions: the first includes two dummies of land ownership and two dummies of land transferability, the second estimates the effect of the remaining dummies. Thus, the interpretation of the dummy variables has to be done in relation to omitted category. It means that the land use rate is equal to the constant term at the reference category (dummy variable that was left out of the model).

Figure 2.4 presents the results that are similar to the results in Figure 2.3. The model with dummy variables for partial and full land rights shows that limited and full land ownership increases land abandonment, whilst partial and full land transferability is associated with increasing agricultural land use. Inversely, the absence of land ownership creates the opposite effect by increasing land use, and the absence of

right to transfer the land causes higher land abandonment. The effects of the control variables are very similar to those presented in Figure 2.3, apart from the fact that the effects of the dummies are more prominent than the three-point measurements of land rights.

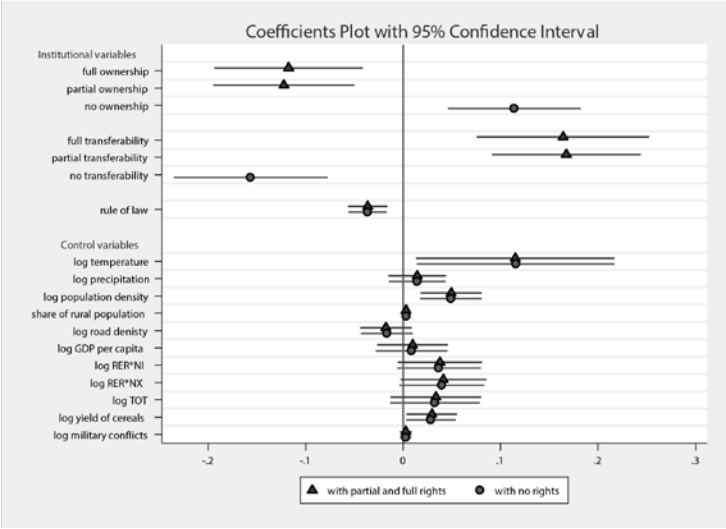


Figure 2.4: Coefficients of regressions with dummy variables for land rights with a 95% confidence interval

Note: Detailed estimation results are presented in Table A10 in the Appendix A.

Recognizing that data on arable land from FAO contains biasedness from methodological changes for some countries in particular years[6], we examine additional specifications for Model I and II. We introduce an additional dummy variable that controls for sharp drops in arable land caused by the changes in statistical methodologies. Table A11 in the Appendix A demonstrates countries and years when methodological changes occurred. These changes refer to the separation of arable land

6 Albania, Bulgaria, Croatia, Georgia, Latvia, Lithuania, Mongolia, and Romania introduced changes in methodologies in agricultural census.

and kitchen gardens, exclusion of unutilized agricultural area from total arable land, or reductions due to changes in geographic boundaries of countries. Thus, statistical revision seems to have downward trend.

Figure 2.5 shows the results of these additional estimations. Changes in the methodology of land use have a significant negative influence on the land use rate due to its downward trend. Yet, the effect of the additional variable on the land use rate is limited. The magnitude of effect of land rights variables, as well as the direction of effect, remain almost the same in both specifications. Moreover, methodological changes have a minor effect on the coefficients of control variables, underlining the robustness of our results.

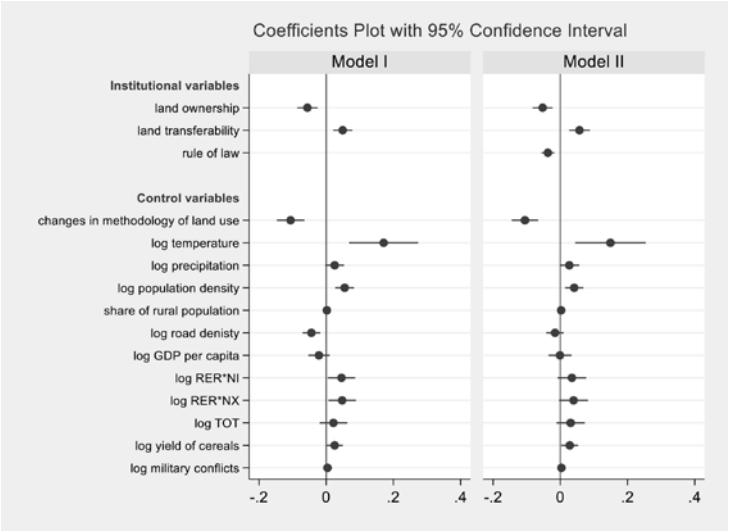


Figure 2.5: Coefficients of regressions with a 95% confidence interval and dummy variable that indicates methodological changes in agricultural land use

Note: Detailed estimation results are presented in Table A12 in the Appendix A.

3 MICRO-LEVEL APPROACH TO ANALYZING THE IMPACT OF LAND RIGHTS ON LAND INTENSIFICATION: EVIDENCES FROM KAZAKHSTAN AND UZBEKISTAN

After demonstrating empirical results, which (partially) contradict theoretical expectations at the country level, the next chapter elaborates on the role of land rights at the level of land users. In the following, the empirical case study is based on two countries out of the group of countries studied in Chapter 2, Kazakhstan and Uzbekistan.

3.1 AGRICULTURAL DEVELOPMENT AND LAND TENURE IN KAZAKHSTAN AND UZBEKISTAN

In countries where a large share of agricultural land belongs to the government, the main problem is that land rights are either not clearly defined or land users lack a consistent understanding of them. Governments might easily acquire the land from land users to extract rents for state budget or for private benefit (De Schutter, 2015). This uncertainty impedes the formation of land markets and distorts production incentives, investments in land-improving measures, and effective allocation of land resources (Feder and Feeny, 1991; World Bank, 2007). That is what has happened to Kazakhstan and Uzbekistan, two transition economies that individualized agriculture after the dissolution of the Soviet Union but failed to provide secure land rights due to ambiguous formulations of land law and ineffective law enforcement (Hanson, 2017; Melnikovová and Havrland, 2016).

To eliminate inefficiencies of collective land management, Kazakhstan and Uzbekistan have undergone salient structural changes in the agricultural sector. Recuperating from the initial slump caused by the disintegration of the centrally planned system, the two countries implemented a set of reforms to build their own national agricultural sectors. Both of them followed a so-called "conventional" approach to land reforms that implied not only the redistribution of land used by state and collective enterprises to households and commercial farms but also land privatization (Lerman and Sedik, 2018). Uzbekistan, however, refrained

from transferring land ownership to farmers leaving it exclusively to the state (Melnikovová and Havrland, 2016). Dehkans[7] and farmers received only land use rights with long-term lease contracts. Moreover, the Uzbek government preserved the Soviet system of state procurement quotas and subsidies for cotton and wheat production denying farmers the opportunity to adjust land use to the new market environment. Kazakhstan went a bit further undertaking the necessary measures to decentralize production and marketing processes and reducing the government influence to a minimum. Land ownership rights were granted to households in 1991 and commercial farmers in 2003. Kazakh farmers have been exposed to fewer state interventions and faced more market-driven incentives. These changes nevertheless resulted in a substantial decline in land use and agricultural production. According to the numbers reported by the Food and Agriculture Organization of the United Nations, about 20 million hectares of cropland in Kazakhstan were abandoned from 1991 to 1999 and only 6 million hectares were recultivated by 2018. Uzbekistan, in contrast, succeeded to avert a dramatic collapse in agricultural production and removed only 800 thousand hectares of sown area in the first decade of independence, of which 300 thousand were recultivated again in the next two decades.

Land reallocation resulted in an increase in the share of individual farms in agricultural production (Lerman and Sedik, 2018). Between 1991 and 2010, the contribution of individual farms to gross agricultural output raised from 32 to 71 per cent in Kazakhstan and from 33 to 98 per cent in Uzbekistan. Although the cropland productivity of newly established individual farms was not significantly different from the cropland productivity of agricultural enterprises at the beginning of the 1990s (Figure 3.1); yet, after 2005, individual producers outperformed corporate farms and continued to enlarge the disparity.

7 Dehkan farm is a small-scale household farm in Uzbekistan.

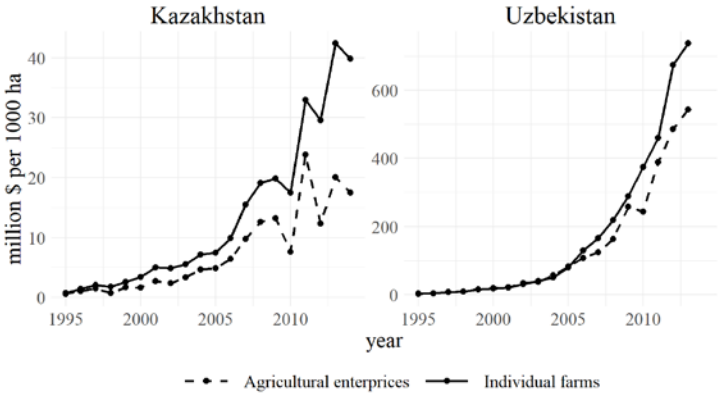


Figure 3.1: Productivity of individual farms and agricultural enterprises (1995-2014)

Source: Compiled by authors using data from statistical yearbooks and Penn World Table (9.0).

Given the considerable contribution of individual farms to the agricultural sector, both countries have introduced policies aiming to increase agricultural productivity. In February 2013, Kazakhstan adopted a new programme "Agribusiness 2020", the main objectives of which were boosting agricultural production and enhancing the competitiveness of local producers through specific measures, such as improving the effectiveness of state regulation, the financial rehabilitation of agricultural sectors, and the removal of bureaucratic barriers (Agribusiness-2020, 2012). However, international and local experts have expressed their concerns about the effectiveness of government support and highlighted the need to give more attention to the institutional and regulatory framework that would enable market mechanisms to allocate resources effectively (Oshakbayev et al., 2018; Petrick and Pomfret, 2016).

Uzbekistan has undertaken several agricultural reforms since getting independence: farm reorganisation in 1992, farm fragmentation in 1998, and several waves of farm consolidation after 2008 (Zorya et al., 2019). Cotton and wheat production that occupies more than 80 per cent of the sown area and remains under the state order system is subject to another consolidation reform since 2018. All of these reforms seek to enhance

productivity, but such frequent farm reorganisations have undermined farmers' management and investment incentives and increased land tenure insecurity among farmers (Mukhamedova and Pomfret, 2019).

Despite relative progress and reforms in land tenure settings, Kazakhstan and Uzbekistan impose different levels of law enforcement on land users. According to Hosking (2005), laws in post-Soviet countries are often not enforced unless they are in the personal interest of administration with powerful authority. Given that agriculture is the most centralized sector in Uzbekistan, the government strictly controls the majority of agricultural activities including input and output allocation and enforces all relevant state decisions. More particularly, cotton and wheat producers risk being a subject to administrative and criminal liability and lose their land if they fail to fulfil mandatory targets (Muradov and Ilkhamov, 2014). In Kazakhstan, where agriculture has the lowest share in the gross domestic product compared to other domestic sectors, the overall economic system is closer to a market economy than in Uzbekistan, but the ability of state structures to enforce effective economic policies remains weak (Satpayev, 2014; World Bank, 2018). The lack of law enforcement is a result of perpetual inter-institutional competition for the redistribution of administrative power and ineffective mechanism for inspection and criminal prosecution. Such low quality of institutions and incomplete land markets push farmers to respond with risk-reducing activities. Therefore, we assume that law enforcement is strongly associated with the perception of land rights by farmers.

3.2 CONCEPTUAL FRAMEWORK

3.2.1 Bundles of land rights

The growing body of literature assigns various combinations of rights to land users. Schlager and Ostrom (1992) propose to split property rights into two groups: operational-level rights, which enable individuals to ac-

cess land and withdraw the land's products, and collective-choice level rights, which grant authority to elaborate operational-level rights. Sjaastad and Bromley (2000) argue that land tenure rights give the privilege to use a plot to one user and assign duty on others to stay off this plot. Scott (2008) identifies "three powers" attached to land tenure: the power to use and manage land, the power to transfer and alienate it, and the power to take income or rent from land use. Pooling together these classifications, Klümper et al. (2018) used three bundles of land rights – land use rights, control and decision-making rights, and alienation rights – to analyse households' tenure conditions in Tajikistan. Different combinations of bundles have various impacts on the investment and land transfer incentives of resource users. Ideally, full private property rights encompass all "three powers" to the right holder. An incomplete set of bundles may undermine the economic performance of the right holder.

However, some scholars claim that the right to tenure security and government protection is attached to land title and granted by the authority issuing official land titles (Ma et al., 2017; Place, 2009). Others see the security as a separate full-fledged right in the joint bundle of tenure rights. In the seminal work of Honore (1960), the right to security has a place in the list of the eleven "incidents of ownership". Ma et al. (2015) distinguish three types of tenure security: legal, actual, and perceived security. Legal security represents the existence of land title or land registration. Actual tenure security measures the actual control of land rights and the actual level of law enforcement. Finally, perceived tenure security, which is defined as the perception of the risk of land eviction, is accepted as a better proxy of tenure security than legal and actual security. The reason for this is that farmers' assessment of their tenure conditions serves as a ground for land use decisions. Sjaastad and Bromley (2000) consider security as an expectation of changes in rights, which refers to "the stability in rights structure." It is obvious that those scholars who refer to tenure security as additional land right actually imply the right to protection from evictions which is only a part of the bundle of rights from the Ostrom perspective.

We add the bundle of government protection that consists of the protection of tenure rights by courts and the legal validity of land certificates following several studies that attempt to revisit and improve the Schlager-Ostrom framework (Galik and Jagger, 2015; Klümper et al., 2018; Sikor et al., 2017). Thus, Table 3.1 presents the four bundles of rights used in this study. Government protection by courts is the right of land user to protect tenure rights in courts in farmers' disputes with other farmers, foreign investors, or local authorities. The second, power of land certificates, is an indicator of land rights that help the land user to prove his/her rights. Land certificates should give security to the holder by default, but the farmer's perception of certificate validity can differ completely from that which is originally conceived. This may be a consequence of the insufficient implementation of land regulations at the local or regional level.

Table 3.1: Bundles of land rights and descriptions

Bundles	Rights	Description
Land Use	Access	Right to enter a defined physical plot
	Withdrawal	Right to obtain the benefits from land
	Land use change	Right to change the type of agricultural activity
Control and decision-making	Management	Right to control internal use patterns and transform the land by making improvements
	Investment	Right to invest in land melioration and irrigation systems
	Exclusion	Right to define who has access to the land
	Income generating	Right to earn income from the land
Alienation	Reallocation	Right to sell or lease the right of management and/or the right of exclusion
	Sell	Right to sell the land
	Leasing	Right to rent out the land
	Inheritance	Right to inherit the land
Government protection	Protection by courts	Right to government protection by courts
	Power of land certificates	Right to have legally valid land certificates

Note: Definitions were compiled from Schlager and Ostrom (1992), Meinzen-Dick (2014), Klümper et al. (2018).

Several studies found that land use pattern is determined not only by legal rights (LR) but also by "customary" law and informal rules that include commonly accepted practices and unwritten norms in use (Meinzen-Dick, 2014; Mwangi and Meinzen-Dick, 2009). We think, however, that the term 'customary law' does not fit properly into the context of our study. Customary tenure, according to FAO (2002), arises from the community's traditions over a long period or the use of land by ancestral societies. Yet, the source of these informal farming practices might

be not only customs but also the need to adapt to new social, political, economic, and technical arrangements. For this reason, instead of terms 'customary claims' or 'de facto rights' we use the term 'actual practices' (AP) that involves not only customary tenure but also newly emerged private land ownership.

Legal rights and actual practices may support (LR=AP) or contradict each other (LR≠AP) (Klümper et al., 2018; Meinzen-Dick, 2014). Farming practice supported by the relevant property right bears fewer risks for farmers and creates a secure environment for land use. Contradicting LR-AP combinations could be two-folded. The first contradiction appears in situations when legal rights are more pronounced than actual practices (LR>AP) and might be a result of unawareness of farmers about land rights or low exploitation of these rights by farmers. The second contradiction appears in situations when actual practices are more pronounced than the relevant rights (AP>LR), and farmers violate law restrictions and disregard the authority of local administration. That might be the case when legislation is not based on effective governance mechanisms, and actual land tenure practices are likely to fill the gaps of the legal system. This type of mismatches also indicates weak institutions with insufficient law enforcement and a lack of trust in government (Broegaard, 2005). Although both types of discrepancies are claimed to be a source of tenure insecurity by Klümper et al. (2018), some studies prove that land users may perceive high tenure security with prominent informal tenure conditions (Rao et al., 2017; UNHR, 2015).

3.2.2 From rational choice to the theory of planned behaviour

Agricultural intensification that is generally defined as an increase in crop yield production per unit of land area (Brookfield, 2001; Kopittke et al., 2019) is an essential aggregated response of farmers to a growing demand for food. A large body of the empirical literature on land use

change considers land intensification in the context of rational choice theory (Bürgi et al., 2017; Hersperger and Bürgi, 2009; Jakovac et al., 2017; Josephson et al., 2014; Sluis et al., 2016; van Vliet et al., 2015). Usually in these studies, land intensification includes adoption or investment behaviours that are determined by the set of geographical, socio-economic, technological and institutional drivers. However, the theory of rational choice has been criticized for several decades. Simon (1956) and Ilbery (1978) argue that the idea of rational decision contains the unrealistic assumption of full information about all decision alternatives. Farmers choose satisfying behaviour rather than a maximizing alternative due to the limited information-processing capabilities. A number of scholars suggest that profit maximization does not drive farmers' decisions alone, rather the combination of socio-economic and psychological factors together may explain the full complexity of farmers' behaviours (Austin et al., 1998; Borges et al., 2019; Martinovska Stojcheska et al., 2016). Indeed, psychological models have proven to explain economic behaviour, however the psychological mechanism that lies at the heart of farmers' actions is still under-investigated (Hansson et al., 2012; Senger et al., 2017). Understanding the psychological constructs of farmers' decisions would contribute to the more precise formulation of policy measures.

One of the most relevant models analysing the formation of human behaviour is the socio-psychological theory of reasoned action (TRA) and its extension, the theory of planned behaviour (TPB) (Ajzen, 1991; Ajzen and Fishbein, 1980; Fishbein and Ajzen, 2010). Although the rational choice and the TRA and TPB models are based on the expectancy-value framework (Lynne, 1995), the TRA/TPB has important advantages as to the understanding of farmers behaviour. The TRA/TPB assumes that individuals' intention to perform a particular behaviour is the main determinant of that behaviour. Intention has three main direct antecedents: attitude towards the behaviour, subjective norms (SN), and perceived behavioural control (PBC) (Figure 3.2). Attitude to a particular behaviour consists of the individual's beliefs about outcomes of this behaviour and the importance of outcomes. Subjective norms are representing the perceived social pressure to perform the given behaviour and demonstrate

individuals' beliefs about approval or disapproval of the behaviour by other individuals or groups. PBC corresponds to the beliefs about control factors, namely opportunities and resources required to perform behaviour, and perceived power over these control factors.

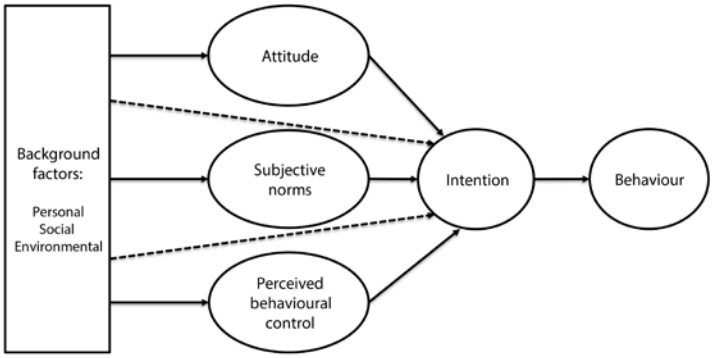


Figure 3.2: The theory of planned behaviour

Note: Adopted from Fishbein and Ajzen, 2010

In order to better understand farmers' land use behaviours, we will use two theories that treat discrepancies between legal and perceived land rights as focus variables. The main difference between rational choice and the TPB is that the TPB does not assume that people are rational but merely their actions derives reasonably from their beliefs.

3.2.3 Land tenure settings in the TPB model

In their book, Fishbein and Ajzen (2010) underline the particular importance of background factors that can influence behaviour indirectly and contribute to the understanding of behavioural determinants. There are three bases on which people can establish their behavioural, normative, and control beliefs: direct observation, accepting outside information,

or various inference processes. It is assumed that the effect of background factors on beliefs is indirect. Regardless of what is the foundation of beliefs, they can modify beliefs, which, in turn, lead to differences in intentions and actions. Fishbein and Ajzen do not limit the number of background factors that could be investigated; but there should be reason to believe that people may form different behavior-relevant beliefs under the factor to be considered. Structural background factors such as geographical characteristics, societal culture, and political conditions can explain general patterns in behaviour. Institutional factors, as well as cultural and political environment, might have a relevance for farmers' beliefs in regards to land use. Farmers with different tenure conditions are likely to have different experiences and, hence, form different beliefs about land use and investment. In this study, we introduce land tenure settings as a background factor influencing the intention to intensify land use through farmers' beliefs about intensification (Figure 3.2). The reason is that farmers driven by their perception of the external environment such as land rights might attach varying importance to certain beliefs (Meijer et al., 2015; Traikova et al., 2018).

Ajzen and Fischbein (2010) left the TPB model open for incorporating background factors, pointing out at the fact that their relationships with behavioural, normative, or control beliefs are "an empirical question." In order to study land intensification intentions, institutional aspects of land use are expected to be key background factors. As outlined by the literature cited above, the institutional framework has been reduced to tenure security. Empirical evidence so far did not manage to establish a consensus whether higher and more transparent tenure security results in higher intensification. Therefore, a broader operationalisation of the institutional aspects as background factors will be outlined in the following subsection.

3.3 STUDY AREA AND SAMPLE SELECTION

The second and third objectives of this thesis are based on the data collected from farmers that produce crops in Turkistan province of southern Kazakhstan and Samarkand province of eastern Uzbekistan.[8] The two neighbouring regions are characterized by irrigated agriculture that is dominated by cotton and wheat cultivation. Three districts in Uzbekistan (Pastdargom, Payarik, and Jomboy) and three districts in Kazakhstan (Maktaaral, Shardara, and Sariagash) were selected for the survey.

The field survey was conducted in March and April 2019; therefore, farmers were asked to provide information related to the farming activities of 2018. Due to administrative constraints, two different sample selection procedures had to be applied to the list of eligible farms. Eligible farms in this study are legally registered farms that produce mainly crop production, have at least 80 per cent of irrigated land, and were active in farming in 2019. Respondents were chosen from the list at regular intervals. Using a direct random selection approach, 460 farmers were chosen from the lists in three districts in Uzbekistan; they constituted 30 per cent of the eligible farmers.

In Kazakhstan, a random sampling has been applied at two levels. Firstly, a random selection of three sub-districts within each district was performed.[9] Further, around 50 farms in each of nine sub-districts were randomly selected and interviewed. The final sample in Kazakhstan constituted of 495 farmers, which corresponds to only 2 per cent of the officially registered farms. The questionnaire originally prepared in English was translated to Kazakh and Uzbek languages. The pre-survey training and guideline for interviewers were provided in both countries.

Figure 3.3 demonstrates aggregated land area under farms grouped by tenure conditions in two study regions. Uzbek farmers included in the

8 The Agrichange II survey has been financed by Volkswagen Foundation, BMBF, and IAMO.

9 Maktaaral, Shardara, and Sariagash have 9, 10, and 12 sub-districts, respectively.

sample rent state land that constitutes 17914 ha or 4 per cent of the total sown area in Samarkand province. The area under surveyed farmlands in Kazakhstan is 6485 ha which constitutes 0.8 per cent of the total sown area in Turkistan province. Out of 6485 ha, 55 per cent is under private ownership, 30 per cent is rented state land, and 15 per cent is rented land from other farmers.

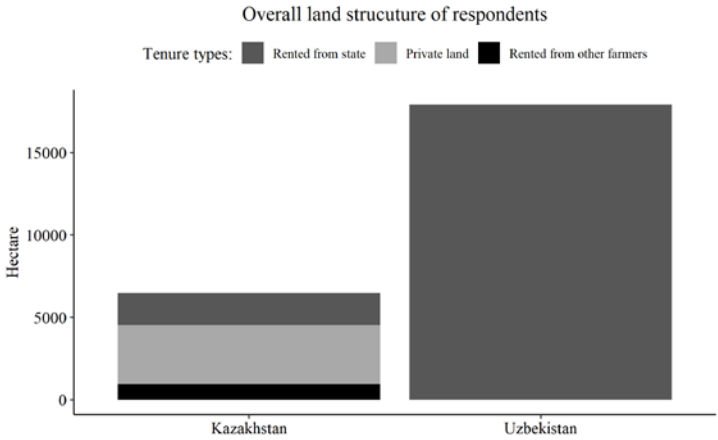


Figure 3.3: The land structures of the respondents

Note: The large share of private land among Kazakh farmers does not reflect the actual land structure on the country level. Only 1.4 per cent of agricultural land in Kazakhstan has been so far privatized.

3.4 OPERATIONALISATION OF LAND RIGHTS, ACTUAL PRACTICES AND THEIR DISCREPANCIES

To compare LR and AP and to find discrepancies between them, one should turn both abstract concepts into measurable observations. Klümper et al. (2018) developed a methodological approach to opera-

tionalise land rights and actual practices in Tajikistan. We adopted this approach in this thesis for case-studies in Kazakhstan and Uzbekistan. Table 3.2 presents a 5-point ascending scale used to assign a particular value to land rights. As land codes offer less degrees of differentiation in land use restrictions, a three-level scale has been used (1, 3, 5). Thus, we used the same 5-point scale but points 2 and 4 were intentionally omitted. To analyse actual practices, we use survey data that encompasses farmers' self-assessment of their land rights. A 5-point ascending scale (see Table 3.2, column 4) was offered after each question formulated as: "To what extent are you free to use the right to access, withdraw from land, etc.?" Land rights were assessed on the basis of the national land codes.

Table 3.2 includes one more land right (the right to lease land from farmers who lease state land) in the alienation bundle. Although subleasing of state agricultural land is prohibited in Kazakhstan and Uzbekistan, anecdotal evidence suggest that this practice is commonly used by farmers. The results of preliminary interviews revealed that active farmers do not intend to rent their land out due to land scarcity, but instead, many would like to lease more land. Therefore, we split the lease right into two, the right to rent out and the right to rent from farmers who lease state land (land tenants), to mirror the actions of the latter ones and to identify if they violate legal restrictions.

Table 3.2: The operationalisation of land rights and land-use practices

Bundles	Right/Practice	Legal rights	Actual practices
Land use	Access	1-no right; 3-limited right; 5-full right.	1-Never hold the practice; 2-rarely hold; 3-occasionally; 4-very frequently; 5-always.
	Withdrawal		
	Land use change		
Control and decisions	Management		
	Investment		
	Exclusion		
	Income generating		
Alienation	Reallocation		
	Sell		
	Rent out		
	Leasing from land tenants		
	Inheritance		
Government protection	Land protection by government		
	Power of land certificates		

Note: Adopted from Klümper et al. (2018)

After the assessment of LR's and AP's, we calculate their discrepancies using the following equation:

$$Discrepancy = Land\ Right - Actual\ Practice \tag{3.1}$$

Further, we interpret these discrepancies as it is shown in Table 3.3 adopted from Klümper et al. (2018). The scale of discrete discrepancy values ranges from -4 to 4, where negative values certify a potential law violation, and positive values show the underuse of rights. The absence of discrepancy, 0, means that land rights perfectly overlap with actual practices.

Table 3.3: Descriptions of the discrepancy level between LR and AP

Discrepancy	Explanation
-4; -3	High mismatch in favour of AP: actual practice is not sanctioned by LR.
-2; -1	Medium mismatch in favour of AP: actual practice is not or partially sanctioned by LR.
0	Match: actual practice is sanctioned by land right.
1; 2	Medium mismatch in favour of LR: limited land right does not hold in practice or legal right is backed partially by actual practice.
3; 4	High mismatch in favour of LR: legal right is not enforced.

3.5 COMPARISON OF DISCREPANCIES BETWEEN LAND RIGHTS AND ACTUAL TENURE PRACTICES

We identified three categories of farmers who participated in the survey and have different legal privileges and limitations in land use: (1) Uzbek land tenants, (2) Kazakh landowners, and (3) Kazakh land tenants. The assessment of their land rights and the respective articles in the national land codes are presented in Table B1 in the Appendix B. Using Eq. 3.1, we identified whether discrepancies between land rights and actual practices exist, and quantified their extent for each of the land rights. To analyse real land tenure conditions of interviewed farmers, we calculated the shares of null, positive, and negative discrepancies for land users with different sets of land rights and presented them in Figure 3.4. Abbreviations in the figure stand for full legal right (FR), limited legal right (LLR), and no legal right (NR) for each component of the bundle of rights. Table B2 in the Appendix B presents the descriptive statistics of actual practices and their discrepancies with legal rights for the three farmer categories.

The results of the land codes' analyses show that Kazakh farmers with private farmland (left bar chart) have the highest number – particularly, 12 out of 14 – of fully transferred land rights among three groups. The

exceptions are the limited right to land use change and the right to lease from farmers with rented state land. Changing the designed purpose of agricultural land is possible only in case if the land becomes a part of urban zone or the quality of soil is not appropriate for particular agricultural activity. As mentioned above, subleasing of state land is completely prohibited. Kazakh farmers who rent state land (middle bar chart) have more limitations than those who own land. Particularly, all rights in the alienation bundle, except for the inheritance right, are completely restricted. Land tenants are allowed to leave land lease rights as an inheritance unless stipulated otherwise in the lease contract.

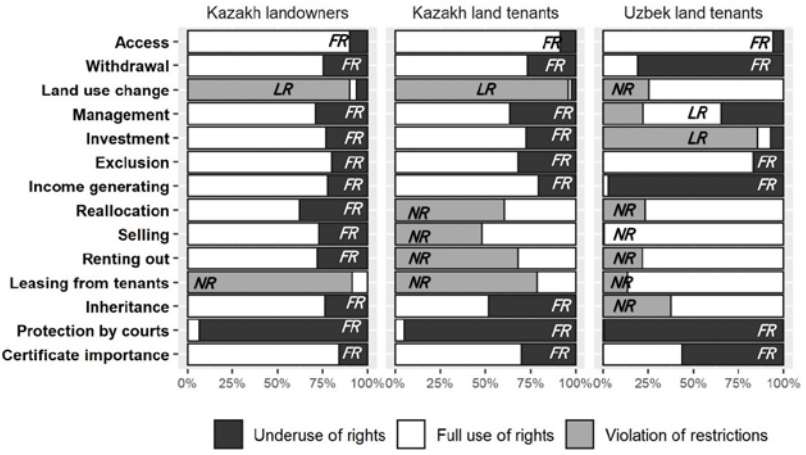


Figure 3.4: Shares of discrepancies (positive or negative) and perfect matches between legal rights and actual practices

Note: The sample size of Kazakh farmers with private land is 331; of Kazakh farmers with rented land is 164, of Uzbek farmers is 460. Abbreviations stand for FR=full right, LLR=limited right, and NR=no right for each of land rights. In case of completely or partly restricted rights, the full use of rights means that farmers are fully aware of restrictions.

Uzbek farmers (right bar chart), the most deprived group in terms of legal land rights, do not have any right in the bundle of alienation rights and the right to land use change. Besides, their management right and the right to invest in land improvements are limited. Before undertaking

any change in land management or investing in land improvements, Uzbek farmers are obliged to obtain permission from the local authorities. Later on, these changes have to be carried out under the control of respective institutions. The presence of written land law and official land titles implies that the legitimacy of these documents is fully backed by authorities issued them. Therefore, two rights in the government protection bundle (the right to government protection in courts and the certificate importance) are assigned the score 5 (FR) for all three groups.

Among three farmer categories, Kazakh landowners represent the group with the highest share of matches. Kazakh land tenants produce the least congruent results among the three groups, although Uzbek farmers have more restricted land rights. The right to land use change and the right to lease land from other farmers who rent state land are of special interest. For both categories of Kazakh farmers, the extremely high share of negative discrepancies, about 90 per cent of the both subsamples, indicates that farmers can practice these activities despite of legal restrictions. The land code prohibits changing the designation and the use provision of a certain agricultural plot. This situation indicates a weak enforcement of land law and the efforts of Kazakh farmers to maximize land value by transferring land to more effective users, even at the cost of tenure security.

Uzbek farmers, who have limited right to make any investment in land improvement independently, show that this limitation is being often violated. However, most of them uphold prohibitions in land alienation and leasing from other farmers. The interesting point is that Uzbek farmers heavily underuse the right to withdrawal and income generating. The reason for this is that most of the Uzbek respondents are cotton and wheat producers who follow state orders in production and mandatory sales plan. This indicates that different land legislative documents contradict each other leading to undermining of farmers' land rights provided by land code in Uzbekistan.

All three categories have a similar pattern for discrepancies in the government protection bundle. Most of the farmers perceive less government protection of their rights in courts than postulated by law. To assess

the actual practice of government protection, we estimate the average of three questions. Farmers were asked about the magnitude of trust in local courts to assist them in disputes on a tenancy with other farmers, investors outside of the region, and local administration. The lowest level of trust in courts was found to be in disputes with local administration for most farmers in both regions. The importance of land certificates was valued on the basis of their validity. Kazakh landowners perceive more security of land titles than do land tenants in Kazakhstan and Uzbekistan.

3.6 DO DISCREPANCIES BETWEEN LAND RIGHTS AND ACTUAL PRACTICES MATTER FOR LAND INTENSIFICATION IN CENTRAL ASIA?

Given that mismatching of land rights and actual practices is common among farmers in both countries, we may assume that these discrepancies have an influence on farmers' decisions regarding land use. Subsequently, the question in how far these discrepancies matter for famer's decision making will be answered.

3.6.1 Operationalisation of intensification intention

The value of agricultural intensification is not observed directly in this study. Therefore, we use a proxy variable based on the farmers' responses to the question: "How likely is it that you will increase crop yield in at least part of your farm in the next year?" The variable is ordinal and measured on a 5-point Likert scale anchored with 1= Extremely Unlikely and 5= Extremely Likely. Figure B1 in the Appendix B demonstrates that the patterns of responses are similar in both regions. The distribution of respons-

es is skewed to the left, indicating that most of the farmers have positive attitudes towards land intensification. The willingness to intensify can be characterized as a socially acceptable option; therefore, one might doubt the validity of responses due to social desirability bias (Nederhof, 1985). To reduce the bias as much as possible, interviewers notified farmers that there was no right or wrong answer and that the data collected would be treated confidentially and in aggregated form. The Likert scale questions were placed at the beginning of the questionnaire to reduce bias from participant fatigue. All respondents and interviewers were men that excluded the risk of gender-related bias.

3.6.2 Additional control variables

Control variables included in the empirical analysis comprise the farm and farmer characteristics. Farmer-specific variables incorporate educational level, age, special agricultural education, use of consultancy services, and the desired period of land use in the future. These factors are expected to affect the probability of land intensification; however, the signs of their impacts are ambiguous across microeconomic studies on land use (Ma et al., 2015b; Qu et al., 2018). Farm-specific variables that may affect productivity or cost of cultivating include farm size, distance to the nearest market, soil fertility, salinity, and irrigation conditions. Economies of scale would predict declining costs per hectare; however, supervision and other costs could increase with increasing farm size. Distance to the nearest market is expected to have a negative effect on land intensification because an increasing remoteness might result in lower farm gate prices, land investment, and input use. The latter three agroecological attributes of farmland provide approximate evaluations by farmers and do not constitute actual physical measures. Land fertility and irrigation conditions are expected to impact positively on the land intensification probability, while soil salinity is expected to impact negatively. Finally, we introduced a dummy variable for Uzbekistan to control for unobserved country differences. In view of such determinants as irrigation infrastructure, water

availability, access to production inputs and local organisations, village dummy variables may give more adequate results to capture village-level variation. Yet our data lacks information about the respondents' villages. The list of additional explanatory variables with descriptions and descriptive statistics is presented in Table 3.4.

Table 3.4: Definitions of additional explanatory variables

Variable	Description	Mean	SD
Farmer characteristics			
Educational level	Level of last completed education degree: from 1=no education to 8=university	5.6	1.7
Age	Age of farmer in years	44.5	11.9
Special agricultural education	Dummy variable for special education: 1=have; 0=otherwise	0.3	
Consultancy services	Dummy variable for using consulting services: 1=have; 0=otherwise	0.1	
Desired period	Number of years a farmer desires to use his land:1=up to 3 years, 2=up to 5 years, 3=up to 10 years, 4=more than 10 years	3.7	0.7
Farmland characteristics			
Farm size	Total land area (ha)	25.4	28.2
Distance to market	Average distance between farm and the nearest market	15.1	10.9
Soil fertility	Weighted average of soil fertility evaluation: 1=not good for cultivation, 2=good for 1 crop per year, 3=good for 2 crops per year, 4=good for >2 crops per year	2.6	0.6
Salinity	Weighted average of soil salinity evaluation: 1=non-saline, 2=low saline, 3=medium saline, 4=high saline.	2.1	1.1
Irrigation conditions	Conditions of irrigation and drainage network: 1=bad, 2=satisfying, 3=good	2.1	0.7
Regional characteristics			
Uzbekistan	Dummy variable for Uzbekistan:1=-farmer resides in Uzbekistan; 0= otherwise		

3.6.3 Model specification and estimation strategy

To test the relationship between farmers' intention to intensify land use and LR-AP discrepancies, we follow the approach of previous studies (Brasselle et al., 2002; Twerefou et al., 2011). Intention to intensify can be expressed as a function of a vector of explanatory variables, $\boldsymbol{X_i}$, among which institutional indicators are of our interest:

$$I_i^* = \boldsymbol{\beta'} \boldsymbol{X_i} + u_i \qquad u_i \sim N(0,1) \tag{3.2}$$

where $\boldsymbol{\beta'}$ is a vector of unknown parameters. The dependent variable, I_i^* is latent and consists of the different likelihood levels of intention, as revealed by the responses, identified by the i^{th} farmer. An observable variable I_i^* that is a collapsed version of I_i^* is ordinal and depends on various threshold points of I_i^*

Several studies have indicated that land rights are endogenous due to simultaneity or reverse causality from land improvements to tenure security (Besley, 1995; Brasselle et al., 2002; Twerefou et al., 2011). For this reason, it would be crucial to control for omitted variables, which drive discrepancies and willingness to intensify at the same time. To capture the potential distortion from endogeneity in our estimates, we use the two-step conditional maximum likelihood (2SCML) approach proposed by Rivers and Vuong (1988). The reason for using 2SCML is that the dependent variable and our focus endogenous variables are discrete. The conventional two-stage least squares model would yield biased estimators under these conditions (Brasselle et al., 2002). Initially, the 2SCML procedure was developed for binary probit regression; however, it has proven to deal with ordered probit as well (Dow, 2008). The first stage of 2SCML includes the estimation of a linear probability regression for the discrete endogenous variable by using instrumental variables to generate the estimated vector of residuals. The second stage involves the estimation of ordinal probit maximum likelihood by adding the vector of

residuals from the first stage. Coefficients of the first stage residuals can be used to test the endogeneity of corresponding variables (Rivers and Vuong, 1988).

Finding appropriate instrumental variables for the LR-AP discrepancies is a complicated issue. To overcome this problem, we used a heteroscedasticity-based instrumental method proposed by Lewbel (2012) that allows constructing instruments in the absence of traditional identification. The traditional way to obtain identification is to find instruments satisfying the exclusion restriction that implies no direct effect of the instruments on the dependent variable in the second-stage regression. However, there are cases when no instrument is excluded, or when validation studies are not available. The principle of Lewbel's[10] is that constructing valid instruments for endogenous variables can be achieved by exploiting heteroscedasticity in the first stage model of the Lewbel's. This approach normally has four stages; each stage includes calculations with the ordinary least squares estimator. Since our dependent variable and potentially endogenous variables are ordinal, we use the first three stages from the Lewbel's to generate constructed instruments; afterwards, we proceed with the second stage of 2SCML. Similar procedures were applied by Rao et al. (2017) with binary probit maximum likelihood in the second stage of 2SCML. Let us clarify our approach with the following steps:

Step (1): In line with the Lewbel's procedures, we run the linear probability regression for each of 21 discrepancy variables ($Discrepacy_j$) on a vector of exogenous variables ($\boldsymbol{X}$) that are control variables in our study:

$$Discrepacy_j = \beta_{0,j} + \sum \boldsymbol{\beta_j X_j} + res1_{disc,j} \qquad \text{for j = 1...21} \qquad (3.3)$$

Step (2): To generate instruments, exogenous variables were standardized ($\boldsymbol{X^Z}$) and multiplied with residuals from Eq. 3.3

10 Following Rao et al. (2017), we use the term "the Lewbel's" for a heteroscedasticity-based estimator.

($\boldsymbol{X}_j^z \cdot res1_{disc,j}$). Thus, we obtained 21 sets of constructed instruments for each of the discrepancies.

Step (3): We performed the first stage of 2SCML for each of the discrepancies by plugging generated instrumental variables into linear probability regression and computed the respective residuals, $res2_{disc,j}$:

$$Discrepacy_j = \beta_{0,j} + \sum \boldsymbol{\beta}_{1,j}\boldsymbol{X}^{\boldsymbol{Z}} \cdot res_{disc,j} + \sum \boldsymbol{\beta}_{2,j}\boldsymbol{X} + res2_{disc,j}, \quad \text{for j = 1...21} \tag{3.4}$$

Step (4): Residuals from Eq. 3.4 were added to the second stage of 2SCML, Eq. 3.5. Finally, we used the ordered probit model to regress farmers' intention (I_k) to the vector of original endogenous (*Discrepacy*) and exogenous ($\boldsymbol{X}$) variables and the vector of residuals ($res2_{disc}$) corresponding to each of endogenous variables.

$$I_k = \beta_0 + \sum \boldsymbol{\beta}_{1,k} \cdot \boldsymbol{Discrepacy} + \sum \boldsymbol{\beta}_{2,k}\boldsymbol{X} + \sum \boldsymbol{\beta}_{3,k} \cdot res2_{disc} + \varepsilon_k \tag{3.5}$$

In Eq. 3.5, k varies from 1 to 4, because we run four regressions for each of the bundles of the LR-AP discrepancies. Due to the presence of heteroscedasticity, we used robust standard errors to adjust the estimate of the variance-covariance matrix of residuals in the final step.[11]

3.6.4 Results and discussion

3.6.4.1 Controlling for the endogeneity of LR-AP discrepancies

The econometric results of four ordered probit regressions (for each bundle of rights) based on the Lewbel's and 2SCML are presented in Table 3.5

11 The core Stata commands used to calculate the results for this section are presented in the Appendix C.

(columns 1-4). The fifth column displays estimates of residuals generated from the first stage of 2SCML. The estimated coefficients in ordered probit models provide the average change in the standard normal value of the dependent variable for a unit change in the corresponding independent variable. The signs of estimated coefficients show the direction of their impacts on the willingness to intensify measured by the latent dependent variable.

The Lewbel's and 2SCML presume to hold several diagnostic tests for the first and second stages. The instruments in the first stage should be correlated with the corresponding endogenous variable. F-test is widely used for testing joint significance, and the common rule is that F statistic should be greater than 10 (Dow, 2008; Xue et al., 2016). Table B4 in the Appendix B presents the test results for the first stage regressions and indicates that instruments are jointly significant in all first-stage regressions. Second, heteroscedasticity-based identification in the Lewbel's requires the heteroscedasticity in the first stage to produce constant conditional correlation (Lewbel, 2012). The results of the Breusch-Pagan test displayed in Table B4 indicate that residuals in almost all first-stage regressions are heteroscedastic. We assume that four regressions, for which heteroscedasticity is not an issue will have no significant effect on the results of the second stage regressions, since the residuals might capture even low insignificant level of heteroscedasticity.

To deal with heteroscedasticity in the second stage regressions, we report robust standard errors in all 2SCML regressions. The significance test of the regression estimates for residuals (Table 3.5, column 5) can be used for a test of endogeneity of the corresponding endogenous variables (Rivers and Vuong, 1988). Our findings confirm the endogeneity of six discrepancy variables as their corresponding residuals are statistically significantly different from zero. Although it was not possible to reject null hypothesis for the remaining residuals, they might still control even for the low level of endogeneity of the corresponding variables (Dow, 2008). Moreover, the Wald tests on the joint significance of generated residuals in each of the four regressions confirm the endogeneity of discrepancies.

The 2SCML results show (Table 3.5, columns 1-4) that nine of twenty-one LR-AP discrepancies significantly determine the intensification willingness, ceteris paribus. In the land use bundle (column 1), we have the following results: Positive discrepancy between the right to withdrawal and its actual practice has a negative impact on the intensification willingness implying that farmers' intention to gain more output would decrease with growing difficulties to withdraw benefits from land. The violation of restrictions in the right to land use change also decreases the probability of land intensification indicating that the more farmers violate law restrictions the less is their willingness to increase production. The negative impact indicates that both types of discrepancies may generate tenure insecurity for farmers.

In the decision-making bundle (Table 3.5, column 2), the violation of restrictions in the management right, the positive discrepancy of the investment LR-AP, and the positive discrepancy of the land exclusion yield a negative impact on land intensification. It is worth mentioning that only Uzbek farmers have restrictions in land management and investment and, hence, can violate these restrictions and produce respective positive discrepancies (Figure 3.4). Nevertheless, the violation of investment restrictions has a positive impact.

In the alienation bundle (Table 3.5, column 3), only one out of nine discrepancies has a statistically significant impact on the farmers' willingness. The positive discrepancy of the land selling decreases farmers' desire to intensify indicating that underuse of the right to sell–the case only for Kazakh landowners–produces land tenure insecurity.

In the tenure security bundle (Table 3.5, column 4), farmers that perceive less tenure protection by government are found to have a lower willingness for land intensification. This finding proves that low trust in authorities undermines perceived tenure security (Rao et al., 2017). The discrepancy of the certificates' importance in favour of the legal right has a positive impact on land intensification. The low importance of land certificates for farmers is not a source of tenure insecurity for farmers in this study.

Table 3.5: Regression results of the Lewbel's and 2SCML estimators

Dependent variable: Willingness to intensify **Discrepancies**	Model with the land use bundle (1)	Model with the control and decision-making bundle (2)
access positive	0.067	
withdrawal positive	-0.093 *	
use change positive	-0.110	
use change violation	-0.509 ***	
management positive		-0.310
management violation		-0.437 **
investment positive		-0.326 **
investment violation		0.219 *
exclusion positive		-0.190 *
income generating positive		0.172
reallocation positive		
reallocation violation		
sell positive		
sell violation		
rent out positive		
rent out violation		
lease from tenants, violation		
inheritance positive		
inheritance violation		
protection positive		
certificate importance pos.		

Model with the alienation bundle	Model with the Government protection bundle	1st stage residuals
(3)	(4)	(5)
		-0.487 **
		-0.127
		1.259
		0.413 ***
		0.252
		-0.882
		0.126
		-0.208
		0.214 *
		-0.187
0.025		0.469
-0.079		-0.064
-0.182 *		1.756
0.083		0.089
0.026		-2.735 **
0.120		-0.225 *
0.036		-0.087
-0.069		0.390
0.107		-0.120
	-0.436 ***	0.378 **
	0.412 **	-0.233

to be continued

Table 3.5: Regression results of the Lewbel's and 2SCML estimators (continued)

Control variables	Model with the land use bundle (1)	Model with the control and decision-making bundle (2)
age	-0.003	-0.007 *
education	-0.014	-0.016
land size, log	0.046	0.021
distance, log	-0.232 ***	-0.234 ***
special education (1-0)	0.284 ***	0.300 **
desired period	0.245 ***	0.150 **
consultancy services (1-0)	-0.061	-0.016
irrigation	-0.023	0.001
salinity	-0.238 ***	-0.173 **
fertility	-0.019	-0.066
Uzbekistan (1-0)	-0.949 ***	-1.223 ***
Θ_1	-4.179 ***	-4.008 ***
Θ_2	-3.446 ***	-3.298 ***
Θ_3	-2.648 ***	-2.492***
Θ_4	-0.988 *	-0.815
Log-likelihood	-956.81	-954.21
Model specification, χ2	132.99 ***	143.59 ***
LR test overidentification, χ2	28.80 ***	12.42 *
Pseudo-R2	0.0603	0.0629
N	955	955

Note: * p<0.05, ** p<0.01, *** p<0.001. Sample size is 955.

Model with the alienation bundle (3)	Model with the Government protection bundle (4)	1st stage residuals (5)
-0.006	-0.002	
-0.022	-0.029	
0.0976 *	0.074	
-0.163 *	-0.099	
0.087	0.001	
0.210 ***	0.263 ***	
0.012	0.038	
-0.043	-0.084	
-0.262 ***	-0.193 ***	
-0.002	0.037	
-0.659 **	-0.447 **	
-3.317 ***	-3.155 ***	
-2.605 ***	-2.454 ***	
-1.826 ***	-1.705 ***	
-0.175	-0.0926	
-962.34	-975.30	
119.76 ***	86.62 ***	
24.65 ***	12.68 ***	
0.0549	0.0421	
955	955	

As for the control variables, we find that soil salinity and the distance to market exert a negative impact on land intensification that is compatible with earlier findings in the relevant literature related to the different geographical context (Feder and Savastano, 2017; Headey et al., 2014; Ma et al., 2017). The coefficient of the variable desired period is positive and significant, indicating that farmers who wish to use land for a longer period tend to intensify land use. A possible explanation for these findings is that land value is lower when farmland is distant from the market and has saline unproductive soil. On the other hand, when farmer plans to use land for a longer period, the value of land rises owing to higher future returns to land. The estimation result for the country dummy shows that Uzbek farmers have less willingness to intensify in comparison with Kazakh farmers. This finding can be explained by the fact that most Uzbek respondents are cotton producers who have intense government intervention. To protect themselves from the potential increase in quotas, farmers might intentionally misreport information (Mukhamedova, 2019). As regards Kazakh farmers, their higher willingness to intensify might be associated with lower law enforcement that pushes farmers to receive short-term benefits. Special agricultural education has a positive effect in all four models but is statistically significant only in two models (columns 1 and 2), confirming that more qualified farmers are likely to intensify more.

3.6.4.2 Disaggregated analysis

To investigate whether the LR-AP discrepancies produce tenure insecurity in different institutional settings, we perform a disaggregated analysis. The 2SCML estimator was not applicable for separate datasets of Kazakh and Uzbek farmers because the Lewbel's instruments proved to be weak. We use the standard ordered probit method, despite it might be biased due to potentially endogenous variables. Table 3.6 demonstrates the results of the standard ordered probit regressions for Kazakhstan (columns 1-4) and Uzbekistan (column 5-8). The number of repressors in country-specific regressions differs from the number of repressors in the

aggregated analysis due to the differences in normative settings of land use in two countries. As Kazakh farmers have fewer limitations in land rights, no negative discrepancies for management, investment, and inheritance rights were revealed. Uzbek farmers did not generate positive discrepancies for the land use change, reallocation, selling, renting out, and inheritance rights; and negative discrepancies for the right to sell.

Although results in Table 3.6 have similarities with the results in Table 3.5, they provide more details on institutional regressors. The underuse of the right to access land induces a reduction in land intensification in Uzbekistan. The violation of land use change right has a positive impact on the willingness of Kazakh farmers and a negative impact in the case of Uzbek farmers. A positive discrepancy in management has controversial but significant impacts in the disaggregated analysis. While it affects negatively Kazakh farmers, Uzbek farmers tend to intensify more. This positive impact among Uzbek farmers can be explained by the fact that despite the strong restrictions in cultivation methods, crop selection, and the application of fertilizers and pesticides, the government subsidizes inputs and seeds to cotton and wheat producers.

The statistically significant impact of positive discrepancies in the investment right and negative discrepancies for the land reallocation, selling, renting out, and inheritance is observed only in the Uzbekistan case. The underuse of the right to exclusion does not affect the probability of land intensification in the aggregated analysis but has a controversial impact in disaggregated regressions. The less Uzbek farmers use the right to exclude the less is their willingness to intensify land use. The positive discrepancy of land rights protection has a significant effect only for Kazakh farmers.

Except for the desired period, other control variables demonstrate inconsistency between the two countries. Distance and special education have no significant effect on the Uzbek farmers' willingness for land intensification anymore, whereas consultancy services reduce the willingness. Contradictory results emerge for irrigation conditions and soil fertility. While these variables increase the willingness to intensify in the Uzbekistan case, Kazakh farmers prove to reduce intensification with better irrigation and fertility conditions.

Table 3.6: Estimates of the ordered probit disaggregate models

Dependent variable: Willingness to intensify	**Kazakhstan**			
Discrepancies	**Land use bundle** (1)	**Control and decision-making bundle** (2)	**Alienation bundle** (3)	**Government protection bundle** (4)
access positive	-0.122			
withdrawal positive	-0.419 ***			
use change positive	0.206			
use change violation	0.270 **			
management positive		-0.456 ***		
management violation				
investment positive		-0.136		
investment violation				
exclusion positive		0.109 **		
income generating positive		0.055		
reallocation positive			0.024	
reallocation violation			-0.039	
sell positive			-0.136 *	
sell violation			0.043	
rent out positive			-0.006	
rent out violation			0.051	
lease from tenants, violation			0.033	
inheritance positive			-0.072	
inheritance violation				
protection positive				-0.242 ***
certificate importance pos.				0.187 ***

Uzbekistan			
Land use bundle	**Control and decision-making bundle**	**Alienation bundle**	**Government protection bundle**
(5)	**(6)**	**(7)**	**(8)**
-0.256 **			
-0.148 ***			
-0.429 ***			
	0.411 ***		
	-0.352 **		
	-0.274 **		
	0.375 ***		
	-0.120 **		
	0.043		
		-0.262 ***	
		-1.427 *	
		-0.374 ***	
		-0.060	
		0.107 *	
			0.108
			0.223 ***

to be continued

Table 3.6: Estimates of the ordered probit disaggregate models (continued)

Dependent variable: Willingness to intensify	**Kazakhstan**			
Discrepancies	**Land use bundle** (1)	**Control and decision-making bundle** (2)	**Alienation bundle** (3)	**Government protection bundle** (4)
age	-0.004	-0.006	-0.007 *	-0.004
education	0.024	-0.026	-0.024	-0.030
land size, log	0.067	0.082	0.100	0.079
distance, log	-0.219 ***	-0.221 ***	-0.226 ***	-0.221 ***
special education (1-0)	0.263 **	0.232	0.237 *	0.274 **
desired period	0.143 **	0.165 **	0.182 ***	0.213 ***
consultancy services (1-0)	0.214	0.159	0.205	0.176
irrigation	-0.182 ***	-0.153 **	-0.138 **	-0.178 ***
salinity	-0.204 ***	-0.228 ***	-0.288 ***	-0.231 ***
fertility	-0.112	-0.158 **	-0.159 **	0.123
Θ_1	-3.875 ***	-4.389 ***	-4.357 ***	-4.225
Θ_2	-2.991 ***	-3.544 ***	-3.498 ***	-3.399 ***
Θ_3	-2.273 ***	-2.834 ***	-2.79 ***	-2.701 ***
Θ_4	-0.651	-1.216 *	-1.198 *	-1.108 *
Log-likelihood	-494.32	-496.04	-501.19	-501.13
Model χ^2	83.59 ***	80.16 ***	69.85 ***	69.97**
Pseudo-R2	0.078	0.075	0.065	0.065
N	495	495	495	495

Note: * p<0.05, ** p<0.01, *** p<0.001

Uzbekistan			
Land use bundle	**Control and decision-making bundle**	**Alienation bundle**	**Government protection bundle**
(5)	**(6)**	**(7)**	**(8)**
0.001	-0.001	-0.003	-0.001
-0.017	0.013	-0.012	-0.004
-0.017	0.036	0.021	0.100
-0.139	-0.146	-0.136	-0.055
0.159	0.089	0.105	-0.058
0.295 ***	0.296 ***	0.249	0.342 ***
-0.528 ***	-0.341 *	-0.372 **	-0.242
0.232 ***	0.276 ***	0.201 **	0.177 **
-0.267 **	-0.086	0.002	0.051
0.206	0.202 *	0.310 ***	0.365 ***
-2.070 **	-0.355	-1.218	0.573
-1.502 *	0.23	-0.641	1.126
-0.547	1.223	0.302	1.966 * *
1.297	9.089 ***	2.104 ***	3.689 ***
-433.98	-431.21	-441..26	-454.46
92.28 ***	97.82 ***	77.72 ***	51.31 ***
0.096	0.102	0.081	0.053
460	460	460	460

3.7 UNDERSTANDING THE ROLE OF PERCEIVED LAND RIGHTS IN THE FORMATION OF FARMERS' INTENSIFICATION INTENTIONS

3.7.1 Modelling farmers' intention to land intensification and estimation strategy

Whether a farmer bases her/his decision on the perceived rights has not been analysed so far. Therefore, two different operationalisation of land rights as background factors will be estimated and compared against each other. Given the flexible nature of the TPB, we develop first a structural model presented in Figure 3.5 to examine the relationship between perceived land rights and TPB constructs. The latent constructs of intention, attitude, subjective norms, and perceived behavioural control have a reflective structure because the items used to measure the constructs are interchangeable and dependent on the variation of the latent construct. The construct for perceived land rights (Perceived LR) is formative because the indicators are assumed to cause the latent construct. We hypothesize, in line with the literature above, that Perceived LR are positively associated with attitude, subjective norms, and PBC. In addition, we examine the direct effect of Perceived LR to farmers' intention.

To investigate whether discrepancies between legal and perceived land rights have an impact on farmers' intention through the behavioural, normative, and control beliefs, we built another structural model (Figure 3.6) that includes two additional latent formative constructs, Rights Underuse and Restrictions Violation. Details on how we build the formative constructs relating to land rights are given below.

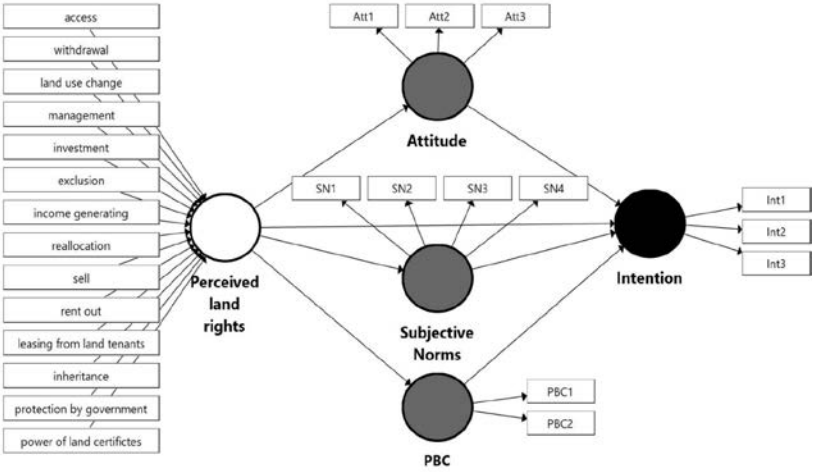


Figure 3.5: Structural equation model of farmers' intention towards land intensification extended with perceived land rights

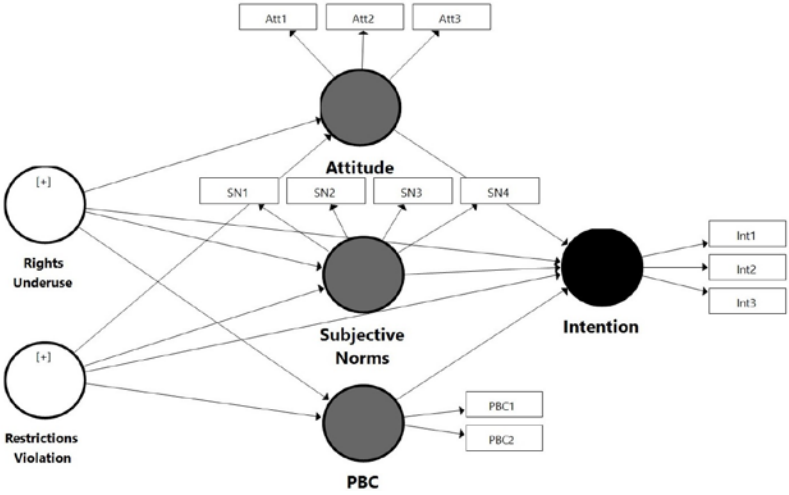


Figure 3.6: Structural equation model of farmers' intention towards land intensification extended with discrepancies between legal and perceived land rights

Considering the complicated combination of latent constructs in the TPB model, we apply Partial Least Squares Structural Equation Modelling (PLS-SEM) to analyse farmers' intention to intensify land use. PLS-SEM estimates partial model structures with principal component analysis and ordinary least squares regressions (Hair et al., 2017). This approach has attracted increasing attention in social sciences over the last decade as it has no distributional restrictions on variables and allows handling formative and reflective constructs simultaneously. In addition, PLS-SEM is well suited for identifying the driving constructs and have high statistical power for predictive models. The estimation of PLS-SEM and related calculations were conducted with SmartPLS 3 software (Ringle et al., 2015). As PLS-SEM is a nonparametric approach, we applied the bootstrapping procedure to test whether coefficients are different from zero based on a t-test. We applied 5000 bootstrap samples estimating path coefficients of the structural model, following the recommendations of Hair et al. (2017).

3.7.2 Measurement of the TPB components

To define the TPB-related questions and statements, we followed the procedures for constructing the TPB questionnaire recommended by Fishbein and Ajzen (2010) and Francis et al. (2004). Table 3.7 presents a list of questions and statements used in the survey. Three questions are used as direct measures of the reflective construct intention, which plays a role of the dependent latent variable in this study since the actual behaviour is not observed. Farmers' behavioural determinants are three latent variables (attitude, subjective norms, and PBC) that we operationalise using several relevant items. All reflective constructs are scored on a five-point Likert scale.

Table 3.7: Statements and scales of the reflective constructs

	Variable	Questions and statements	Scale of 1 to 5
Intention	Int1	How strong is your intention to increase crop yield in at least part of your farm in the next year?	Weak–strong
	Int2	Do you plan to increase crop yield in at least part of your farm in the next year?	Unlikely–likely
	Int3	How likely is it that you will increase crop yield in at least part of your farm in the next year?	Strongly disagree–strongly agree
Attitude	Att1	How important is the increase in crop yield in at least part of your farm in the next year?	Not important at all–Extremely important
	Att2	How profitable is the increase in crop yield in at least part of your farm in the next year?	Exceptionally detrimental– Exceptionally profitable
	Att3	How necessary is the increase in crop yield in at least part of your farm in the next year?	Absolutely unnecessary– Absolutely necessary
Subjective norms	SN1	Most people who are important to you think that you should increase crop yield in at least part of the farm in the next year.	Strongly disagree–strongly agree
	SN2	Most people who are important to you approve that you increase crop yield in at least part of your farm in the next year.	Unlikely–likely
	SN3	Your extended cultural community thinks that you should increase crop yield in at least part of your farm in the next year.	Unlikely–likely
	SN4	Most farmers that are similar to you will increase crop yield in at least part of their farms in the next year.	Strongly disagree–strongly agree
Perceived behavioural control	PBC1	You have enough knowledge to increase crop yield in at least part of your farm in the next year.	Strongly disagree-strongly agree
	PBC2	For you, the increase of crop yield in at least part of your farm in the next year is a feasible task.	Strongly disagree-strongly agree

3.7.3 Measurement of perceived LR, rights underuse and restrictions violation

The first formative construct that we integrated into the TPB model is Perceived LR that incorporate farmers' perceptions about four bundles of land rights. Additional TPB model includes two formative constructs that imply two types of discrepancies between legal and perceived land rights (Rights Underuse and Restrictions Violation). The Klümper et al. (2018) method used to operationalise the bundle of rights approach allows us to make a comparison between legal and perceived land rights, measuring them on the same ordinal scale (for details, see Section 3.4). Actual land use practices are actually land rights that farmers perceive.
The Perceived LR construct is a composite of farmers' perceptions. Each of perceptions in Perceived LR represents independent farming activity that cannot be replaced by others; adding and dropping one of the perceptions may change the conceptual domain of formative construct. These characteristics confirm a formative specification of the Perceived LR construct, nevertheless, we provide additional construct selection procedures below to validate constructs' formative nature (Coltman et al., 2008; Diamantopoulos and Siguaw, 2006; Jarvis et al., 2003).

To build formative latent constructs representing discrepancies between legal and perceived land rights, we separate discrepancies for every land right, if present, into negative and positive items. We combine positive items into one formative construct Rights Underuse and negative items into another formative construct Restrictions Violation. The rationale behind this is that every positive discrepancy is evidence of the farmer's underuse of corresponding land right, and together they compose one index. Similarly, every negative discrepancy indicates the farmer's potential violations of legal restrictions in the corresponding land right and contributes to the common index of Restrictions Violation.

3.7.4 Results

PLS-SEM contains two types of models: measurement model and structural model. The former one represents the relationship between a latent construct and specified observed variables. The structural model shows the path relationship among the latent constructs. In this subsection, firstly, the validation of measurement models and structural model is presented. Afterwards, we provide the robustness check on the findings with control for endogeneity. The discussion of the structural model results is given in the next subsection 3.7.5.

3.7.4.1 Validation of measurement models

To assess the reliability and validity of the reflective construct measures, we use rules of thumb proposed by Hair et al. (2017) that identify the criteria for internal consistency, convergent validity, and discriminant validity. Table B5 in the Appendix B presents corresponding indicators required for the evaluation of reflective models (TPB constructs). All standardized factor loadings have an allowable level that should be greater than 0.70. However, loadings between 0.40 and 0.70 may be admitted if the composite reliability of the construct remains above the threshold value. Based on this rule, we removed two factors (SN3 and SN4 in above table) in the model for Uzbek farmers that correspond to extended cultural community and farming neighbours, respectively, because their loadings were below 0.40. Such low loadings may appear due to poor wording, inappropriate item, or incorrect transfer of the meaning across contexts (Hulland, 2016). Composite reliability values are above the threshold of 0.70 in both country-specific models. The average variance extracted (AVE), a criterion of convergent validity, estimates the amount of variance that a latent variable captures from the corresponding variables. Fornell and Larcker (1981) postulate a threshold value of 0.5 for AVE (that is fulfilled by our reflective models). Heterotrait-monotrait ratio (HTMT) is a measure of discriminant validity that shows how distinct is one con-

struct form others. The HTMT statistics are below 0.90 and the confidence intervals of HTMT are below 1.00 for all reflective constructs; that confirms their discriminant validity.

To assess the stability of formative constructs (Perceived LR, Rights Underuse and Restrictions Violation), we performed Confirmatory Tetrad Analysis in PLS-SEM (CTA-SEM; Gudergan et al., 2008) that initially assumes a reflective measurement specification. The results of CTA-SEM confirmed that these measurement models have a formative model specification because at least one of the tetrad's residual values in each of the country-specific models is significantly different from zero. The assessment of collinearity issues in formative constructs for the Kazakhstan model revealed that one of the indicators has a high VIF that is above the threshold of five. The violation of renting out with a VIF of 5.954 was excluded from the Restrictions Violation model. This item produced an extremely high correlation (0.88) with the violation of selling state land. Although the right to rent out is different from the right to sell state land, they both measure the concept of land transferability; which leads to a multi-collinearity in our case. In the Uzbekistan model, all the formative indicators in the Rights Underuse model and the Restrictions Violation model yielded VIF values below five ensuring that multicollinearity is not an issue.

Convergent validity of formative constructs is a requirement that shows whether the formative indicators jointly represent the construct properly (Cheah et al., 2018). Since we miss a 'global' item summarizing the essence of the formative constructs, or the reflective-multi-item measure of our composite variables, we cannot carry out the redundancy analysis using the multiple indicators multiple causes model (Jöreskog and Goldberger, 1975). Instead, we follow MacCallum and Browne's (1993) suggestions to achieve identification in formative constructs through adding at least two unrelated reflective measurement models. Thus, a model with formative indicators should predict at least two latent variables with reflective construct to gather convergent and discriminant validity. Perceived LR, Rights Underuse, and Restrictions Violation in the TPB framework emit at least two paths to reflective constructs and, therefore, are identified.

The final step in assessing the validity of formative constructs is testing the statistical significance of the estimated indicator weights in the context of a structural model that are determined by means of bootstrapping. The significance of the paths from indicator to the construct indicates the validity coefficient (Table B6 in the Appendix B). Although only several perceived land rights and discrepancies have significant impacts on their formative constructs, we retain all non-significant indicators to avoid the changes in the conceptual domain of formative measurement models (Henseler and Sarstedt, 2013; Jarvis et al., 2003). The co-occurrence of negative and positive coefficients demonstrates that bivariate correlations – albeit at allowable levels – between indicators distort the estimates of the weak indicators.[12] This situation can be explained by the fact, that land rights from the same bundle reflect a common concept. We keep all items in formative constructs because the present collinearity evidence poses a threat only to the interpretation of individual formative indicators, but structural effects between constructs remain unaffected (Cenfetelli and Bassellier, 2009; Chin, 1998).

3.7.4.2 Structural models

To assess the structural model of TPB, we followed procedures proposed by Hair et al. (2017). We estimated basic and extended TPB models to investigate the influence of additional constructs on the overall model performance. Examination of the extended country-specific models for collinearity showed that the tolerance (VIF) value for each predictor construct in basic and extended models for Kazakh and Uzbek farmers lies between 0.20 and 5, that proves no collinearity issue in the structural models. Table 3.8 presents the results of PLS-SEM for basic and extended TPB models. Using the 5000 bootstrap re-samples, we tested the significance of individual path coefficients of the PLS structural models, that

12 Indicators in a formative construct may have all negative or all positive weights depending on the coding direction.

are actually standardized coefficients of ordinal least squares regressions (Henseler and Sarstedt, 2013).

Path coefficients in the basic model of Kazakh farmers have expected positive signs (column 1). The most influential determinant of farmers' intention is attitude, followed by subjective norms. PBC presents a low mean for Kazakh farmers. This can be explained by the fact that respondents could not judge their control over the future behavior (land intensification) at the time of survey. Another reason can be the multicollinearity issue with other constructs. Attitude and subjective norms towards land intensification have similar results in extended models with Perceived LR and with discrepancies. PBC in the extended model with Perceived LR and the model with Rights Underuse and Restrictions Violation have negative but not a statistically significant sign (columns 2 and 3). Attitudes play a predominant role in predicting Kazakh farmers' intentions in basic and extended models, followed by subjective norms. Perceived LR in the extended model (column 2) have significant positive impact on attitude, subjective norms, and PBC but have no direct effect on Kazakh farmers' intention. Rights Underuse as well as Restrictions Violation also has no direct effect on farmers' intention (column 3). However, Rights Underuse have negative significant impact on the three predictors of intention with largest impact in subjective norms and smallest impact on PBC. Restrictions Violation only has a significant positive effect on attitude and subjective norms of Kazakh farmers.

The basic and extended structural models of Uzbek farmers produced statistically significant and expected path coefficients from the three TPB constructs to the farmers' intentions. Subjective norms are relatively more important in basic model and the model with Perceived LR (columns 4 and 5). Perceived LR is important predictor for Uzbek farmers' intention as well as for attitude, subjective norms, and PBC (column 5). However, unlike in Kazakhstan, Perceived LR has a negative impact on these constructs. The results of extended model with discrepancies (column 6) reveal that Restrictions Violation has a negative and statistically significant impact on all TPB constructs. No paths from Rights Underuse to the TPB construct including intention are significant in a statistical sense. One

might assume that the negative impact of Restrictions Violation on the TPB variables in case of Uzbek farmers explains the contradictory impact of Perceived LR, since violations are actually farmers' perceptions exceeding legal limits. To check this assumption, we run additional extended model with Perceived LR and Restrictions Violation. The results in column 7 show that after adding Restrictions Violation, Perceived LR has no longer statistically significant impact on intention and PBC; however, it preserves the negative effect on attitude and subjective norms. This is attributable to the fact that Restrictions Violation partly absorbs the negative effect of Perceived LR. Thus, we can state that part of Uzbek farmers with higher Perceived LR violate legal restrictions facing more risks due to the strong law enforcement.

Table 3.8: Path coefficients of the basic and extended PLS model

	Kazakh farmers		
Relations	**Basic model (1)**	**Model with Perceived LR (2)**	**Model with discrepancies (3)**
Attitude -> Intention	0.472 (0.000)	0.468 (0.000)	0.466 (0.000)
SN-> Intention	0.272 (0.000)	0.265 (0.000)	0.257 (0.000)
PBC-> Intention	0.024 (0.496)	-0.000 (0.999)	-0.007 (0.872)
Perceived LR ->Intention		0.030 (0.654)	
Perceived LR -> Attitude		0.388 (0.000)	
Perceived LR ->SN		0.471 (0.000)	
Perceived LR ->PBC		0.320 (0.000)	
Rights Underuse ->Intention			-0.078 (0.214)
Rights Underuse -> Attitude			-0.295 (0.000)
Rights Underuse ->SN			-0.371 (0.000)
Rights Underuse ->PBC			-0.274 (0.003)
Restrictions Violation -> Intention			-0.028 (0.553)
Restrictions Violation -> Attitude			0.121 (0.011)
Restrictions Violation ->SN			0.145 (0.004)
Restrictions Violation ->PBC			0.112 (0.173)
R2 for Intention	0.457	0.456	0.461

Uzbek farmers			
Basic model (4)	**Model with Perceived LR (5)**	**Model with discrepancies (6)**	**Model with Perceived LR and Violation (7)**
0.358 (0.000)	0.361 (0.000)	0.392 (0.000)	0.377 (0.000)
0.472 (0.000)	0.367 (0.000)	0.337 (0.000)	0.359 (0.000)
0.147 (0.000)	0.101 (0.005)	0.073 (0.037)	0.081 (0.025)
	-0.220 (0.000)		0.000 (0.998)
	-0.268 (0.000)		-0.431 (0.002)
	-0.538 (0.000)		-0.511 (0.000)
	-0.372 (0.000)		-0.137 (0.200)
		0.071 (0.430)	
		-0.006 (0.948)	
		0.283 (0.346)	
		0.161 (0.368)	
		-0.231 (0.000)	-0.262 (0.000)
		-0.173 (0.021)	0.188 (0.112)
		-0.302 (0.000)	-0.031 (0.692)
		-0.304 (0.000)	-0.270 (0.004)
0.617	0.648	0.666	0.663

Country-specific basic and extended models have a satisfactory level of predictive accuracy for the farmers' intention to intensify land use. The increase in the predictive power from basic to extended models in Kazakhstan is negligible compared to Uzbekistan. The explained variance of Kazakh farmers' intention to intensify land use remains almost the same when the TPB model is extended with Perceived LR, and increases only from 45.7 per cent to 46.1 per cent when the model is extended with Rights Underuse and Restrictions Violation. The R-squared value for the Uzbek farmers' intention increases from 0.617 to 0.648 with adding Perceived LR to the basic model, to 0.666 with adding Rights Underuse and Restrictions Violation, and to 0.663 with adding Perceived LR and Restrictions Violation, confirming a substantial advancement in the predictive power of TPB model.

The results of the f^2 effect sizes presented in Table B7 in Appendix B indicate a medium effect of attitude on intention in all models for both countries. Subjective norms have a medium effect on intention in case of Kazakh and Uzbek farmers; however, the effect is large in the basic TPB model. Perceived LR have a medium effect on attitude, subjective norms, and PBC in case of Kazakh farmers but, for Uzbek farmers, they have a large effect on subjective norms and a medium effect on PBC. Rights Underuse and Restrictions Violations have mainly a small or no effect on the endogenous constructs. Stone-Geisser's Q2 values of all dependent constructs in both models are above zero indicating the predictive relevance of these constructs.

3.7.4.3 Robustness check: endogeneity

Several studies on the relationship between land rights and land investment reveal the potential endogeneity of rights that might arise from the reverse causality (Besley, 1995; Brasselle et al., 2002; Twerefou et al., 2011). Under an indigenous tenure system, for example, farmers make land improvements (such as planting trees, building fences) to enhance their tenure security. Since land intensification involves investments in land improvements, the possible endogeneity of Perceived LR, Rights

Underuse, and Restrictions Violation – since they have direct effects on intention – poses a threat to the correctness of the PLS-SEM results. To assess the potential endogeneity and to check the robustness of our results, we follow the recommendations of Hult et al. (2018) that employ the Gaussian copula approach of Park and Gupta (2012) to model the correlation between the endogenous variables and the error term by means of a copula. If the endogenous variable is correlated with the error term, the coefficient estimates are biased and inconsistent. The copula should be included as an independent variable into the regression model to control for the correlation. This approach requires the endogenous variable to be nonnormally distributed. Therefore, firstly, we undertook the Kolmogorov–Smirnov test with Lilliefors correction (Sarstedt and Mooi, 2019) on the standard composite scores of Perceived LR, Rights Underuse and Restrictions Violation. The test revealed that the distributions of these latent variables are not normal and thus can be considered as endogenous in the Gaussian copula analysis.

Table 3.9 shows that three Gaussian copulas (for Perceived LR, Rights Underuse, and Restrictions Violation) in the models of Kazakh farmers are not statistically significant, indicating the absence of endogeneity issue and the robustness of the structural model results (columns 1 and 2). In the model of Uzbek farmers, the Gaussian copula of Perceived LR is statistically significant in the model with Perceived LR, confirming the possibility of endogeneity (column 3). The copula of Restrictions Violation in two models of Uzbek farmers (columns 4 and 5) has a statistically significant impact, indicating the endogeneity issue and, hence, biased and inconsistent parameter estimates of PLS-SEM for Uzbek farmers. Due to the lack of valid and strong instruments in this study, we prefer to use the results of the models with copulas in case of Uzbekistan because controlling for endogeneity helps to adjust the magnitude of the potentially endogenous variables. The coefficients of attitude appear to be slightly overvalued in the original PLS-SEM models for Uzbek farmers, and the coefficients of subjective norms are slightly reduced. Since endogeneity is not an issue for Kazakhstan models, the Gaussian copula approach produced results that are consistent with the original models.

Table 3.9: Assessment of endogeneity using the Gaussian copula approach

Endogenous variable / Variable	Kazakh farmers		Uzbek farmers		
	Perceived LR (1)	**Underuse, Violation (2)**	**Perceived LR (3)**	**Underuse, Violation (4)**	**Perceived LR, Violation (5)**
Attitude	0.468 (0.000)	0.465 (0.000)	0.351 (0.000)	0.373 (0.000)	0.357 (0.000)
SN	0.266 (0.000)	0.258 (0.000)	0.377 (0.000)	0.346 (0.000)	0.372 (0.000)
PBC	0.000 (0.996)	-0.006 (0.876)	0.102 (0.004)	0.086 (0.014)	0.096 (0.006)
Perceived LR	0.027 (0.861)		-0.504 (0.000)		-0.069 (0.622)
Underuse		-0.015 (0.941)		0.043 (0.703)	
Violation		0.008 (0.923)		-0.439 (0.000)	-0.425 (0.000)
C Perceived LR	0.002 (0.984)		0.297 (0.006)		0.068 (0.559)
C Underuse		-0.067 (0.693)		0.022 (0.842)	
C Violations		-0.027 (0.591)		0.241 (0.001)	0.207 (0.012)

Note: C indicates the copula term.

3.7.5 Discussion

This study widens the scope of TPB application in analysing farmers' behaviour by incorporating perceived land rights and discrepancies between legal and perceived land rights as background factors influencing directly and indirectly farmers' intentions to intensify land use. This is the first study to consider farmer's perception of land rights beyond tenure security as an important factor in the formation of farmers' behaviour. Our findings suggest that land intensification and increasing land use productivity depends on the farmers' attitudes and motivation from social environment. The perception of capability to perform land intensification carries importance for Uzbek farmers but not for Kazakh farmers.

Extending the TPB model produced interesting results indicating a substantial importance of land rights perception in the formation of

behavioural, normative, and control beliefs regarding land intensification. Perceived land rights have proven to have an impact on psychological constructs determining farmers' willingness to intensify, with largest influence on subjective norms. In addition, the path coefficient from subjective norms to intention in extended models appear to be lower, especially for Uzbek farmers; this fact indicates overestimation of intentions when institutions are neglected. However, while higher perception has positive association with land intensification in Kazakhstan, Uzbek farmers with higher perception manifested lower willingness to intensify.

Considering differences in law-enforcement environment and agricultural market system in these two countries, we used discrepancies between legal and perceived land rights to explain controversial effects of perceived land rights on farmers' intention. Positive discrepancies have a negative impact on behavioural attitude to land intensification, subjective norms, and the perceived own capability of Kazakh farmers, weakening thus the direct effects of these psychological constructs on the behavioural intention. For Uzbek farmers, positive discrepancies have no statistically significant effect on any of the three conceptual components. This situation can be explained by the fact that most of Uzbek farmers in our sample are cotton producers who had to follow the quota system. Although the National Land Code of Uzbekistan grants particular land rights to farmers, additional legislative documents impose contradictory rules on the cotton producers. As a result, Uzbek farmers comply with these contradictory documents producing positive discrepancies that do not carry importance for farmers' intention. In addition, Uzbek farmers, who are more compliant with law, expressed higher willingness to intensify land use. The findings from Table 3.8 (column 7) confirm that such behaviour could be affected not only by social desirability of higher land intensification but also by the threat of sanctions stemming from breaching land use regulations.

The composite variable of negative discrepancies has been proven to be a significant predictor of attitudes and subjective norms in the case of Kazakh farmers, and all three conceptual components of intention, including intention itself, for Uzbek farmers. The reason of the controversial

effects of negative discrepancies might lie again in different levels of law enforcement. In pursuit of higher economic profit, the Uzbek government strictly monitors farmers' compliance with the law, imposing penalties for non-compliance or seizing the land from farmers. Therefore, Uzbek farmers, who consciously violate legal restrictions, would perceive higher tenure insecurity that affects negatively farming behaviours. The positive effect of negative discrepancies on the TPB constructs in the case of Kazakh farmers confirms the claim of Satpayev (2014) which states that overall the law enforcement in practice is ignored in Kazakhstan. Thus, the violation of restrictions does not generate risks of sanctions for Kazakh farmers.

Cross-country differences in coefficients of attitudes and subjective norms show that the intention of Kazakh farmers is driven more by behavioural attitudes and the intention of Uzbek farmers is driven more by subjective norms. This variation can be explained by cross-cultural and institutional differences. Members of individualistic cultures tend to make decisions on the basis of behavioural beliefs about personal gains, whereas members of collectivistic cultures prioritize social goals over personal benefits (Park, 2000; Triandis, 1989). The fact that normative components for Uzbek farmers are more important than personal outcomes may indicate a more collectivistic culture in Uzbekistan. However, taking into account the frequent interventions of the Uzbek government into agricultural production, we are inclined to believe that this difference could be determined by institutional settings rather than by cultural characteristics.

4 CONCLUSIONS

This section summarizes findings of the three studies and discusses their contribution to the literature of the relevant research area. In addition, policy implications of the findings are presented following by limitations and recommendations for future research.

4.1 CONTRIBUTIONS TO SCIENCE AND SOCIETY

4.1.1 Scientific contribution

Shifting from central planning to liberal market brought not only structural changes in economies of former socialist countries, but also troubles in reorganisation and establishment of new formal institutions that regulate agricultural sector. Besides socio-economic and biophysical drivers, analysing differences in agricultural tenure system can help to comprehend the role of institutional drivers in land use change. The main goal of this dissertation was to better understand the institutional determinants of land use change in transition economies. By using multi-level approach, the impact of land tenure settings on agricultural land use was revealed to be relevant at the country and individual levels.

The assessment method proposed by Lerman et al. (2004) for the operationalisation of land ownership and land transferability indicators at the country level was used in empirical analysis to investigate the relationship between land rights and agricultural land use at the macro perspective. This study employs a PCSE estimator to reveal the impact of land ownership and land transferability on land use change. The main hypothesis of the study is that the improvement of land tenure rights and protection prevents abandonment of arable land and promotes recultivation of agricultural land. The results reveal the contradiction between theory and empirics and provide an evidence that land reforms are not always accompanied by secure transferable property rights and

proper demographic and economic conditions. The estimation results present that institutional drivers of land use change are as important as socio-economic factors. Providing property rights to land users that are not backed by the right to transfer this property leads to distorted incentives by creating an insecure tenure environment and decreasing the value of future returns from farming. As mentioned above, observed negative relation between individual land ownership rights and land use change can also be explained by reallocation of production factors to more fertile locations or by reallocation of land to more productive users, which is possible in regions with improved land rights. In other words, regions with less improved land rights may experience less land abandonment due to missing economic opportunities.

To dig deeper into what happens at individual level, Chapter 3 examines the role of the discrepancies between formal land rights and individual perceptions of these rights in forming the willingness to intensify agricultural production. As empirical evidence from Kazakhstan and Uzbekistan reveals, farmers' perceptions of land rights deviates in two directions: 1) farmers engage in activities which they are not allowed to be, and 2) farmers do not use all the opportunities provided by the national land legislation. The deviations may reduce the efficiency of land reforms and policies by creating a threat to a secure tenure environment. Results show that most discrepancies induce a negative impact on land intensification, regardless of whether the discrepancy is negative or positive. However, in some cases, discrepancies might generate a positive impact on farmers' intentions. These findings empirically prove the assumption made by Klümper et al. (2018) that mismatches between customary claims and property rights lead to a reduction in productivity and less investment. We demonstrate that their innovative approach to evaluating legal land rights and perceived property rights can be used in empirical and descriptive studies. In addition, analysing the extended list of rights provides detailed insights in regards to which land rights to what extend are being implemented by land users.

Comparative analysis of the discrepancies reveals that Kazakh farmers have a higher propensity to violate limitations in land rights, in

comparison with Uzbek farmers. This fact proves that Uzbekistan has a strong law enforcement in the agricultural sector. Furthermore, we found inconsistencies between land code and decrees on strategic crops in Uzbekistan. Particularly, cotton and wheat producers are exposed to stronger limitations and government interventions in land use. Kazakh farmers demonstrate that limitations in the right to change land use and the right to lease land from other farmers, who rent state land, are not enforced sufficiently. In addition, Kazakh land tenants, who have limitations for land transactions, perceive that they can violate these limitations. This situation verifies previous claims about the ineffectiveness of land reforms in Central Asian countries (Lerman and Sedik, 2018; Oshakbayev et al., 2018).

Analysing the role of perceived land rights and discrepancies in the psychological context, Chapter 3 also indicates that farmers' perception of land rights is an important factor in the formation of farmers' behaviours. Since the TPB allows to explore additional latent constructs in decision making process, this study introduced perceived land rights and discrepancies between formal and perceived land rights into the TPB model as background factors that influence directly and indirectly farmers' intentions to intensify land use. The findings show that higher perceived land rights positively influence intentions to increase production of Kazakh farmers; yet, Uzbek farmers with higher perceived land rights demonstrate lower intention. More detailed analysis reveals that the insufficient application of land rights by Kazakh farmers reduces their willingness to increase production, but have no statistically significant effect on the willingness of Uzbek farmers. The violation of law restriction related to land use have opposite impact increasing willingness of Kazakh farmers and reducing the willingness of Uzbek farmers to increase production. The strongest impact of perceived land rights on land intensification occurs through the influence on subjective norms. Moreover, perceived land rights and negative discrepancies appear to be endogenous in the case of Uzbek farmers implying that perception of land rights is dependent on farmers' intention to increase production.

In summary, all the above findings confirm the need to include institutional settings into decision-making models that explain farmers' behaviours. By applying alternative econometric models and the operationalisation techniques to measure land rights, we could obtain a wider view on the impact of land rights. Although this impact may differ from country to country, the common fact derived from the three studies is that the direction of the impact is a subject to change with land use effectiveness. In transition economies with better market settings, more improved land rights resulted in land abandonment but land that remained in use is actively utilized. Transition economies with strong government interventions experienced less land abandonment but farmers' willingness to increase production remains weak; in addition, missing economic opportunities for land aggravate effective land use.

4.1.2 Policy recommendations

Multi-level approach presented in this dissertation reveals the strong importance of land tenure settings for agricultural land use. This allows us to derive general policy recommendations related to land rights of agricultural land users in transition economies, and more specific and detailed policy recommendations related to farmers' land rights in Kazakhstan and Uzbekistan.

Firstly, land policies in countries aiming at transition to a market-oriented economy should be reconsidered in order to facilitate effective land use and governments should provide land rights that enable farmers to transfer land. The right to sell and the right to sublease land should be granted to farmers and the necessary conditions should be created to activate land markets to enable effective land reallocation.

When it comes to Kazakhstan and Uzbekistan, recommendations can be given not only to policy-makers but also to policy executives. Policy-makers should consider redesigning legal restrictions in land law, that are constantly being violated by farmers use, in how far they are necessary to reach policy objectives. In Kazakhstan, more attention should

be paid to restrictions related land transactions among land users. Policy-makers in Uzbekistan should review the strict restrictions in land use legislation regarding land management and investment activities that play a crucial role in agricultural productivity.

Regarding land rights that are widely underused by farmers, several measurements can be undertaken. The first is that local executive authorities should verify whether farmers are aware of current land rights. The perception of land rights is dependent on the level of legal literacy and farmers may be not really aware of details and amendments. Timely provision of land law amendments and access to communication sources would facilitate effective land use.

Anecdotal evidence suggests that the abuse of power by local authorities is widespread practice in both countries. Therefore, central government should monitor whether local executives misuse their authorities creating barriers for farmers to freely exercise land rights. In addition, government should verify whether land reforms are implemented equally across the country. Such measures are important not only for effective land use but also to strengthen the rule of law and trust to institutions.

Furthermore, governments in both countries should reform the judicial system, in particular enabling farmers and land users to appeal to courts for dispute resolutions in an effective, transparent, and fair manner.

4.2 RESEARCH LIMITATIONS AND OUTLOOK FOR FURTHER RESEARCH

Despite the clear evidence of the importance of land rights for agricultural land use, the above studies have several limitations that can be addressed in future research. The first limitation is related to the measuring of the focus variables. At the country level, land rights are assessed only in the formal context neglecting actual conditions of tenure settings. Moreover, the Lerman's approach to measuring land ownership and land

transferability is rough and does not capture such details as limitations in the possession of private land for households and commercial farmers. The indicator of land transferability does not cover the right to transfer the land for households; whereas households might be dominant land users in some countries. Further country-level studies on agricultural land use can be complemented by integrating additional measurements on the actual land tenure settings at the country level that would produce the broader picture of the tenure-cultivation interrelationship. Furthermore, since land transferability assessment is performed only for commercial farmers, the special attention should be paid to the land rights of households.

Another limitation of the cross-country study is that land rights can be characterized as a slow-moving institution. Therefore, the influence of changes in land rights is hard to detect if the time period in panel data is not sufficiently long. Extending the panel data over a longer period of time would provide a better understanding of whether the negative impact of land ownership on land use is a result of the slow response of land users to policy reforms, the shift to the more intensified agriculture, outmigration, or other consequences of structural transformation of economies.

Two studies presented at the individual level also have several limitations. The first is a possible biasedness in the cross-sectional data due to several unidentified reasons. There might be farmers with an already high level of intensification having no plans to increase agricultural productivity in the next year. This situation may lead to the understatement of the willingness to intensify. On the other hand, land intensification could have been seen as a socially desirable behaviour and, hence, farmers could overdraw their intentions. Future research should incorporate indicators that measure the individual level of social desirability.

Another important limitation is related to the estimation method used to reveal the role of land rights in the formation of farmers' intentions; in particular, the estimation of additional latent constructs in the TPB model. The presence of negative and positive path weights of indicators in Perceived LR, Rights Underuse, and Restrictions Violation makes

it difficult to interpret these indicators. Future research, therefore, should consider incorporating additional questions measuring global single items into the survey questionnaire to enable the redundancy analysis of formative constructs.

Since the analysis of the perception of land rights does not highlight the reasons for the underuse of land rights by farmers, detecting these reasons would considerably improve the interpretation of results. Additional open questions about the potential barriers to the use of land rights during the elicitation study or post-survey interviews could help to fill the gap.

Disaggregated results of PLS-SEM show that the intention of Kazakh farmers is driven more by behavioural attitudes, whereas the intention of Uzbek farmers is determined more by subjective norms. As mentioned above, the reason for such variation might be cultural differences between two countries that exist despite the common socialistic past. However, we lack information to make a better interpretation regarding this issue. The TPB model could be further improved not only by extending with indicators of perceived land rights but also with indicators measuring whether farmers behave in an individualistic or collectivistic manner.

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APPENDIX A

Table A1: Agrarian characteristics of transition economies in 2015

	Country	Income per capita[13] (const. 2011)	Share of rural population[4]	% of agriculture in GDP[4]	% of sown area in agricultural land[14]	Percentage in global agricultural production[15]
	Transcaucasia					
1	Armenia	8196	36.92	17.2	19	0.06
2	Azerbaijan	16699	45.29	6.2	34	0.11
3	Georgia	9025	42.55	7.9	11	0.03
	Balkans					
4	Albania	10970	42.56	19.8	35	0.06
5	Bulgaria	16999	26.01	4.1	66	0.14
6	Romania	20666	46.11	4.2	60	0.38
7	Slovenia	29038	46.22	2	28	0.03
8	Croatia	21026	43.85	3.5	54	0.07
9	Macedonia	12761	42.59	9.7	15	0.04
	Baltics					
10	Estonia	27550	31.28	2.7	62	0.03
11	Latvia	23019	32.02	3.6	61	0.05
12	Lithuania	27046	32.77	3.4	77	0.10
	Central Asia					
13	Kazakhstan	23524	42.81	4.7	10	0.37
14	Kyrgyzstan	3238	64.22	14.1	11	0.08
15	Tajikistan	2641	73.26	21.9	17	0.08
16	Turkmenistan	14992	49.68	9.3	5	0.11
17	Uzbekistan	5700	49.25	16.6	14	0.58

Table A1: Agrarian characteristics of transition economies in 2015 (continued)

	Country	Income per capita[13] (const. 2011)	Share of rural population[4]	% of agriculture in GDP[4]	% of sown area in agricultural land[14]	Percentage in global agricultural production[15]
	Central Europe					
18	Czech Republic	30605	26.52	2.2	70	0.16
19	Hungary	25034	29.5	3.7	82	0.24
20	Poland	25307	39.72	2.2	72	0.82
21	Slovakia	28309	46.11	3.4	65	0.06
	East Asia					
22	Mongolia	11412	31.77	13.4	0.4	0.04
23	China	13569	44.5	8.83	32	23.7
24	Viet Nam	5554	66.19	17	96	1.3
25	Lao PDR	5755	66.89	17.6	64	0.11
	European CIS					
26	Belarus	17219	22.82	6.3	68	0.30
27	Republic of Moldova	4747	57.51	12.2	61	0.06
28	Russian Federation	24517	25.95	4.1	36	2.32
29	Ukraine	7465	30.94	12.1	66	1.16

13 World Development Indicators
14 Statistical Yearbooks of countries, 2014
15 FAOSTAT 2015, Gross Agricultural Production Value (constant 2004-2006 1000 I$)

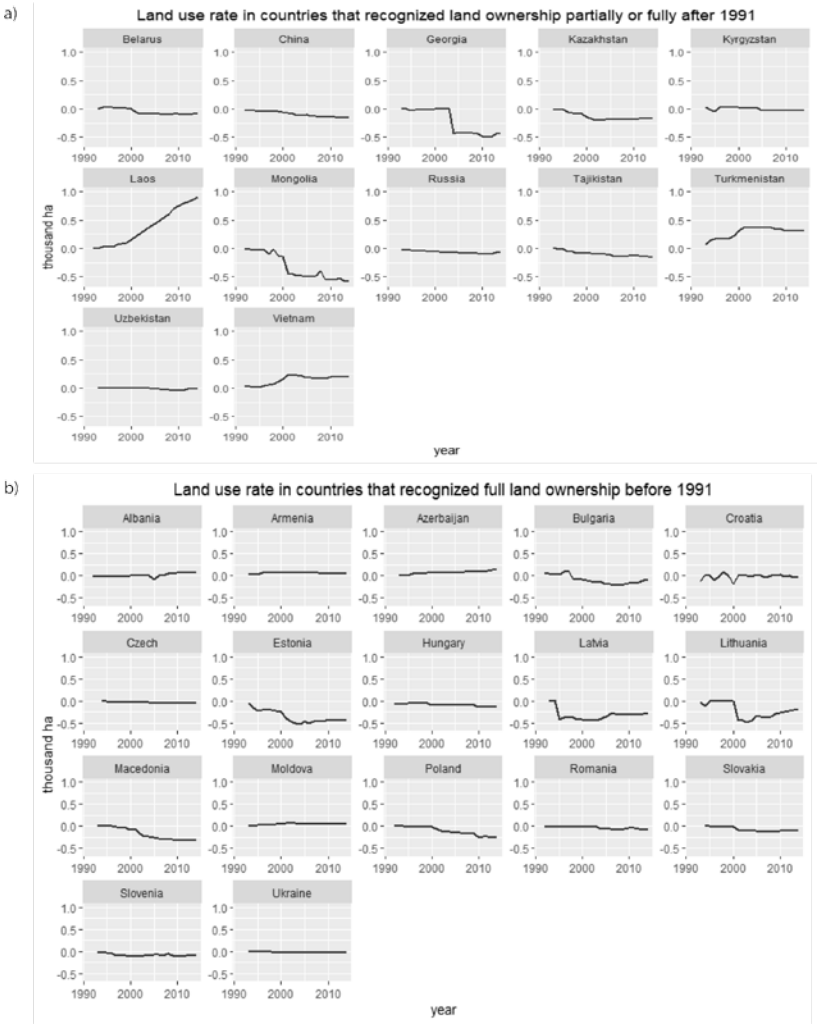

Figure A1: Land use rate in transition countries during the period of 1991-2014

Note: base year = 1990; source FAOSTAT

Table A2: List of land codes and documents related to the land ownership and transferability

Country	Legal base of agricultural land ownership and transfer rights
Albania	Land Law No. 7501 (19/07/1991): land ownership, land only for use; Law no. 7983 (1995) for buying and selling agricultural land, meadows and pastures.
Armenia	Law "On peasant and peasant collective economies" (1991): land ownership; Moratorium on land sales expired in February 1994.
Azerbaijan	Land Code (1991): land ownership; Law on Land Reforms (1996): land transferability.
Belarus	Law "About peasant farm" (1991): land use; Land Code (1999): ownership only for households
Bulgaria	Land ownership existed before 1990; 1993, land restitution completed. Guideline on Technical Land Prices was issued.
Croatia	Land ownership and transferability existed before 1990.
Czech Republic	Land ownership and transferability existed before 1990.
Estonia	Law on Land Reform (1991): land ownership and transferability.
Georgia	Land Privatization Decree (1992): land ownership for households; Law of Agricultural Land Ownership (1996): land transferability.
Hungary	Land ownership and transferability existed before 1990; Act LV of 1994 on Arable Land: land transferability.
Kazakhstan	Presidential Decree on Land Reform (1994): land use for farmers; ownership for households; Land code (2003): land ownership and transferability for all land.
Kyrgyzstan	Law on peasant farms (1991): land redistribution; Land of land reform (1991); Presidential Decree "Measures on Promoting Land and Agrarian Reforms (1994): transfer land to households; Land Code (1999): full land ownership and transferability; Moratorium on land selling (1999-2001); Moratorium was lifted (2002).
Latvia	Land Reform in Rural Areas Act (1990): full land ownership and transferability.
Lithuania	Law on Land Reform (1991) full land ownership and transferability.
Macedonia	1986 Law on Protection and Use of Agricultural Land of 1986
Moldova	Law on Property (1991); Land Code (1991): full land ownership and transferability.
Mongolia	Law on Land (1994): land ownership only for households; land possession right may be transferred by inheritance.

Table A2: List of land codes and documents related to the land ownership and transferability (continued)

Country	Legal base of agricultural land ownership and transfer rights
Poland	Land ownership and transferability existed before 1990.
Romania	Land ownership and transferability existed before 1990; Law No 54 "On the Legal Circulation of Land" (1998).
Russian Federation	Law on Land Reform (1990).
Slovakia	Land ownership and transferability existed before 1990.
Slovenia	Land ownership and transferability existed before 1990.
Tajikistan	Law on Land Reform, 1992: the right to sublease land for dehkans; Land Code (1996).
Turkmenistan	Constitution (1992): land ownership; all land transactions are prohibited
Ukraine	Law "On Land Reform" (1990): land ownership; Law on Forms of Land Ownership (1992); Decree "On Privatization of Land Allotments" (1992: land transferability only for households.
Uzbekistan	Constitution (1992): state ownership of land; all land transactions are prohibited.
China	Household Responsibility System reform (1979): all rural land is owned by rural collectives: farmers are allowed to sublease their land.
Laos	Decree by the Prime Minister on land (1992): state ownership of land; farmers are allowed to transfer land use right; Program "Land and Forest Allocation" for rural areas.
Vietnam	Land Law of (1987); Land Law (1993): land transferability.

Table A3: Indicator of land ownership (1991-2014)

Country Code	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
ALB	2	2	2	2	2	2	2	2	2	2	2	2
ARM	2	2	2	2	2	2	2	2	2	2	2	2
AZE	2	2	2	2	2	2	2	2	2	2	2	2
BLR	0	0	0	0	0	0	0	0	1	1	1	1
BGR	2	2	2	2	2	2	2	2	2	2	2	2
CHN	0	0	0	0	0	0	0	0	0	0	0	0
HRV	2	2	2	2	2	2	2	2	2	2	2	2
CZE	2	2	2	2	2	2	2	2	2	2	2	2
EST	2	2	2	2	2	2	2	2	2	2	2	2
GEO	0	1	1	1	1	2	2	2	2	2	2	2
HUN	2	2	2	2	2	2	2	2	2	2	2	2
KAZ	0	0	0	1	1	1	1	1	1	1	1	1
KGZ	1	1	1	1	1	1	1	1	2	2	2	2
LAO	0	0	0	0	0	0	0	0	0	0	0	0
LVA	2	2	2	2	2	2	2	2	2	2	2	2
LTU	2	2	2	2	2	2	2	2	2	2	2	2
MKD	2	2	2	2	2	2	2	2	2	2	2	2
MDA	2	2	2	2	2	2	2	2	2	2	2	2
MNG	0	0	0	1	1	1	1	1	1	1	1	1
POL	2	2	2	2	2	2	2	2	2	2	2	2
ROM	2	2	2	2	2	2	2	2	2	2	2	2
RUS	1	1	1	1	1	1	1	1	1	1	1	1
SVK	2	2	2	2	2	2	2	2	2	2	2	2
SVN	2	2	2	2	2	2	2	2	2	2	2	2
TJK	0	0	0	0	0	0	0	0	0	0	0	0
TKM	0	2	2	2	2	2	2	2	2	2	2	2
UKR	2	2	2	2	2	2	2	2	2	2	2	2
UZB	0	0	0	0	0	0	0	0	0	0	0	0
VNM	0	0	0	0	0	0	0	0	0	0	0	0

Table A3: Indicator of land ownership (1991-2014, continued)

Country Code	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALB	2	2	2	2	2	2	2	2	2	2	2	2
ARM	2	2	2	2	2	2	2	2	2	2	2	2
AZE	2	2	2	2	2	2	2	2	2	2	2	2
BLR	1	1	1	1	1	1	1	1	1	1	1	1
BGR	2	2	2	2	2	2	2	2	2	2	2	2
CHN	0	0	0	0	0	0	0	0	0	0	0	0
HRV	2	2	2	2	2	2	2	2	2	2	2	2
CZE	2	2	2	2	2	2	2	2	2	2	2	2
EST	2	2	2	2	2	2	2	2	2	2	2	2
GEO	2	2	2	2	2	2	2	2	2	2	2	2
HUN	2	2	2	2	2	2	2	2	2	2	2	2
KAZ	2	2	2	2	2	2	2	2	2	2	2	2
KGZ	2	2	2	2	2	2	2	2	2	2	2	2
LAO	0	0	0	0	0	0	0	0	0	0	0	0
LVA	2	2	2	2	2	2	2	2	2	2	2	2
LTU	2	2	2	2	2	2	2	2	2	2	2	2
MKD	2	2	2	2	2	2	2	2	2	2	2	2
MDA	2	2	2	2	2	2	2	2	2	2	2	2
MNG	1	1	1	1	1	1	1	1	1	1	1	1
POL	2	2	2	2	2	2	2	2	2	2	2	2
ROM	2	2	2	2	2	2	2	2	2	2	2	2
RUS	2	2	2	2	2	2	2	2	2	2	2	2
SVK	2	2	2	2	2	2	2	2	2	2	2	2
SVN	2	2	2	2	2	2	2	2	2	2	2	2
TJK	0	0	0	0	0	0	0	0	0	0	0	0
TKM	2	2	2	2	2	2	2	2	2	2	2	2
UKR	2	2	2	2	2	2	2	2	2	2	2	2
UZB	0	0	0	0	0	0	0	0	0	0	0	0
VNM	0	0	0	0	0	0	0	0	0	0	0	0

Note: authors' assessment. Country codes are taken from the World Development Indicators.

Table A4: Indicator of land transferability (1991-2014)

Country Code	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
ALB	1	1	1	1	2	2	2	2	2	2	2	2
ARM	1	1	1	2	2	2	2	2	2	2	2	2
AZE	1	1	1	1	1	2	2	2	2	2	2	2
BLR	1	1	1	1	1	1	1	1	1	1	1	1
BGR	1	1	1	2	2	2	2	2	2	2	2	2
CHN	0	0	0	0	0	0	0	0	0	0	0	0
HRV	2	2	2	2	2	2	2	2	2	2	2	2
CZE	2	2	2	2	2	2	2	2	2	2	2	2
EST	2	2	2	2	2	2	2	2	2	2	2	2
GEO	0	0	0	0	0	2	2	2	2	2	2	2
HUN	1	1	1	2	2	2	2	2	2	2	2	2
KAZ	0	0	0	1	1	1	1	1	1	1	1	1
KGZ	0	0	1	1	1	1	1	1	0	0	0	2
LAO	1	1	1	1	1	1	1	1	1	1	1	1
LVA	2	2	2	2	2	2	2	2	2	2	2	2
LTU	2	2	2	2	2	2	2	2	2	2	2	2
MKD	1	1	1	1	1	1	1	1	1	1	1	1
MDA	2	2	2	2	2	2	2	2	2	2	2	2
MNG	0	0	0	1	1	1	1	1	1	1	1	1
POL	2	2	2	2	2	2	2	2	2	2	2	2
ROM	1	1	1	1	1	1	1	2	2	2	2	2
RUS	1	1	1	1	1	1	1	1	1	1	1	1
SVK	2	2	2	2	2	2	2	2	2	2	2	2
SVN	2	2	2	2	2	2	2	2	2	2	2	2
TJK	1	1	1	1	1	1	1	1	1	1	1	1
TKM	0	0	0	0	0	0	0	0	0	0	0	0
UKR	1	1	1	1	1	1	1	1	1	1	1	1
UZB	0	0	0	0	0	0	0	0	0	0	0	0
VNM	0	0	2	2	2	2	2	2	2	2	2	2

Table A4: Indicator of land transferability (1991-2014, continued)

Country Code	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
ALB	2	2	2	2	2	2	2	2	2	2	2	2
ARM	2	2	2	2	2	2	2	2	2	2	2	2
AZE	2	2	2	2	2	2	2	2	2	2	2	2
BLR	1	1	1	1	1	1	1	1	1	1	1	1
BGR	2	2	2	2	2	2	2	2	2	2	2	2
CHN	0	0	0	0	0	0	0	0	0	0	0	0
HRV	2	2	2	2	2	2	2	2	2	2	2	2
CZE	2	2	2	2	2	2	2	2	2	2	2	2
EST	2	2	2	2	2	2	2	2	2	2	2	2
GEO	2	2	2	2	2	2	2	2	2	2	2	2
HUN	2	2	2	2	2	2	2	2	2	2	2	2
KAZ	2	2	2	2	2	2	2	2	2	2	2	2
KGZ	2	2	2	2	2	2	2	2	2	2	2	2
LAO	1	1	1	1	1	1	1	1	1	1	1	1
LVA	2	2	2	2	2	2	2	2	2	2	2	2
LTU	2	2	2	2	2	2	2	2	2	2	2	2
MKD	1	1	1	1	1	1	1	1	1	1	1	1
MDA	2	2	2	2	2	2	2	2	2	2	2	2
MNG	1	1	1	1	1	1	1	1	1	1	1	1
POL	2	2	2	2	2	2	2	2	2	2	2	2
ROM	2	2	2	2	2	2	2	2	2	2	2	2
RUS	2	2	2	2	2	2	2	2	2	2	2	2
SVK	2	2	2	2	2	2	2	2	2	2	2	2
SVN	2	2	2	2	2	2	2	2	2	2	2	2
TJK	1	1	1	1	1	1	1	1	1	1	1	1
TKM	0	0	0	0	0	0	0	0	0	0	0	0
UKR	1	1	1	1	1	1	1	1	1	1	1	1
UZB	0	0	0	0	0	0	0	0	0	0	0	0
VNM	2	2	2	2	2	2	2	2	2	2	2	2

Table A5: Descriptive statistics of key variables and their sources

Variable	Description	Source		Mean	SD	Min	Max	Observations
Land use rate	Rate 0-1	FAOSTAT	overall	-0.07	0.18	-0.59	0.91	N = 578
			between		0.15	-0.36	0.37	n = 26
			within		0.11	-0.45	0.46	
Land ownership	No ownership=0; full ownership=2	Land codes	overall	1.61	0.72	0.00	2.00	N = 604
			between		0.69	0.00	2.00	n = 26
			within		0.23	0.18	2.18	
Land transferability	Non-transferable=0; transferable=2	Land codes	overall	1.53	0.67	0.00	2.00	N = 604
			between		0.60	0.00	2.00	n = 26
			within		0.32	-0.12	2.14	
Rule of law	Governance performance: 0-10	WGI	overall	4.60	1.48	2.05	7.75	N = 494
			between		1.46	2.39	7.05	n = 26
			within		0.37	3.30	6.20	
Temperature	log of Fahrenheit	CCKP	overall	3.84	0.20	3.01	4.34	N = 604
			between		0.21	3.12	4.32	n = 26
			within		0.03	3.73	3.95	
Precipitation	log of mm	CCKP	overall	3.91	0.50	2.42	5.24	N = 604
			between		0.49	2.82	5.03	n = 26
			within		0.14	3.48	4.35	
Population density	log of persons per km2	WDI	overall	3.99	1.07	0.36	4.98	N = 604
			between		1.08	0.47	4.91	n = 26
			within		0.06	3.76	4.17	
Rural population	% of total population	WDI	overall	42.91	12.64	23.31	84.22	N = 604
			between		12.52	26.17	75.86	n = 26
			within		2.79	28.50	55.44	
Road density	log of km per 100 km2	Statistical yearbooks	overall	3.51	1.14	0.94	5.42	N = 604
			between		1.13	1.13	5.11	n = 26
			within		0.29	2.50	4.44	

GDP per capita	log of $ (2011)	PWT	overall	9.05	0.77	7.21	10.37	N = 604
			between		0.69	7.76	10.09	n = 26
			within		0.38	8.11	10.20	
RER *NI	log of RER*net import (dummy)	PWT	overall	0.69	0.65	-0.37	2.53	N = 604
			between		0.46	-0.01	1.38	n = 26
			within		0.48	-0.67	2.29	
RER *NX	log of RER*net export (dummy)	PWT	overall	0.41	0.67	-0.28	2.50	N = 604
			between		0.50	-0.01	1.45	n = 26
			within		0.45	-0.95	2.00	
Military conflicts	log of number of deaths	PRIO, UCDP & HSR	overall	0.60	1.68	0.00	8.73	N = 604
			between		1.28	0.00	5.92	n = 26
			within		1.11	-4.62	8.63	bar = 23.2308
TOT	log of Rate 0-1	UN MAD	overall	0.22	0.32	-0.98	1.50	N = 604
			between		0.17	-0.11	0.61	n = 26
			within		0.28	-0.90	1.28	
Yield of cereals	log of kg per ha	WDI	overall	7.92	0.48	6.16	8.80	N = 604
			between		0.43	6.81	8.55	n = 26
			within		0.22	7.27	8.52	

Note: WDI, the World Bank – World Development Indicators; WGI, Worldwide Governance Indicators; CCKP, Climate Change Knowledge Portal; UN MAD, United Nations Main Aggregates Database; PWT, Penn World Table (9.0); PRIO, UCDP & HSR, the Peace Research Institute Oslo, The Uppsala Conflict Data Program and Human Security Reports; FAOSTAT, Food and Agriculture Organization of the United Nations.

Table A6: Individual means and standard deviations of variables

	Albania		Armenia		Azerbaijan		Belarus	
Variable	m	sd	m	sd	m	sd	m	sd
land use rate	0.02	0.04	0.06	0.02	0.08	0.03	-0.05	0.05
log of temperature	3.98	0.02	3.83	0.03	3.97	0.02	3.81	0.02
log of precipitation	4.38	0.16	3.78	0.15	3.61	0.12	3.96	0.11
log of popul. density	4.71	0.04	4.68	0.06	4.61	0.08	3.88	0.03
log of road density	4.17	0.03	3.51	0.12	3.33	0.33	3.57	0.25
log of GDP pc	8.65	0.40	8.39	0.45	8.59	0.77	9.30	0.34
log of RER*NI	1.26	0.46	1.42	0.50	1.35	0.58	1.19	0.76
Log of RER*NX	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.44
rural population	54.82	6.27	35.38	1.27	47.40	0.93	28.72	3.20
Log of TOT	0.44	0.58	0.04	0.29	0.34	0.51	-0.03	0.22
log of yield of cereals	8.11	0.26	7.60	0.25	7.70	0.21	7.86	0.23
log of military conflicts	0.08	0.40	0.77	1.37	3.19	1.91	0.00	0.00
land ownership	2.00	0.00	2.00	0.00	2.00	0.00	0.67	0.48
land transferability	1.83	0.38	1.88	0.34	1.79	0.41	1.00	0.00
Rule of law	3.65	0.38	4.15	0.12	3.13	0.32	2.84	0.33
	Hungary		**Kazakhstan**		**Kyrgyzstan**		**Laos**	
Variable	m	sd	m	sd	m	sd	m	sd
land use rate	-0.09	0.03	-0.13	0.07	-0.01	0.03	0.37	0.32
log of temperature	3.94	0.03	3.78	0.03	3.62	0.03	4.32	0.01
log of precipitation	3.94	0.18	3.05	0.12	3.49	0.18	5.03	0.13
log of popul. density	4.73	0.02	1.76	0.05	3.27	0.08	3.17	0.12
log of road density	4.49	0.95	1.32	0.24	2.25	0.02	2.47	0.41
log of GDP pc	9.77	0.24	9.24	0.51	7.95	0.35	7.76	0.44
log of RER*NI	0.00	0.00	0.49	0.61	0.88	0.89	1.37	0.59
Log of RER*NX	0.77	0.33	0.67	0.71	0.89	1.00	0.22	0.59
rural population	33.43	1.90	43.62	0.40	64.28	0.68	75.86	5.66
Log of TOT	0.30	0.27	0.26	0.29	0.64	0.46	0.06	0.18
log of yield of cereals	8.40	0.19	6.91	0.27	7.82	0.14	8.07	0.22
log of military conflicts	0.00	0.00	0.00	0.00	0.56	1.38	0.62	1.07
land ownership	2.00	0.00	1.38	0.71	1.67	0.48	0.00	0.00
land transferability	1.88	0.34	1.38	0.71	1.33	0.82	1.00	0.00
Rule of law	6.69	0.28	3.17	0.43	2.99	0.49	3.00	0.26
	Romania		**Russia**		**Slovakia**		**Slovenia**	
Variable	m	sd	m	sd	m	sd	m	sd
land use rate	-0.03	0.03	-0.06	0.02	-0.07	0.05	-0.08	0.03
log of temperature	3.90	0.03	3.12	0.06	3.85	0.03	3.90	0.02
log of precipitation	4.00	0.16	3.61	0.03	4.14	0.14	4.70	0.13
log of popul. density	4.54	0.05	2.18	0.02	4.72	0.01	4.60	0.01
log of road density	3.48	0.09	1.41	0.35	4.15	0.44	4.95	0.44
log of GDP pc	9.21	0.44	9.59	0.35	9.79	0.28	10.07	0.20
log of RER*NI	1.06	0.52	1.09	0.42	0.88	0.52	0.44	0.31
Log of RER*NX	0.06	0.19	0.00	0.00	0.00	0.00	0.00	0.00
rural population	46.46	0.43	26.50	0.18	44.31	0.89	48.51	1.02
Log of TOT	0.33	0.27	0.14	0.23	0.32	0.25	0.20	0.19
log of yield of cereals	7.97	0.23	7.50	0.19	8.32	0.17	8.55	0.17
log of military conflicts	0.00	0.00	5.92	1.88	0.00	0.00	0.00	0.00
land ownership	2.00	0.00	1.50	0.51	2.00	0.00	2.00	0.00
land transferability	1.71	0.46	1.50	0.51	2.00	0.00	2.00	0.00
Rule of law	4.86	0.25	3.25	0.19	5.85	0.29	7.04	0.18

Bulgaria		China		Croatia		Czech		Estonia		Georgia	
m	sd	m	sd	m	sd	m	sd	m	sd	m	sd
-0.09	0.09	-0.09	0.05	-0.01	0.06	-0.03	0.01	-0.36	0.14	-0.22	0.23
3.95	0.02	3.80	0.01	3.96	0.02	3.86	0.03	3.76	0.03	3.80	0.03
3.95	0.20	3.87	0.05	4.50	0.16	4.02	0.12	4.03	0.13	4.35	0.11
4.28	0.05	4.91	0.05	4.38	0.03	4.89	0.01	3.49	0.05	4.32	0.09
3.16	0.34	3.09	0.56	3.88	0.03	5.11	0.03	4.80	0.13	3.36	0.05
9.34	0.26	8.60	0.50	9.63	0.28	9.97	0.13	9.64	0.40	8.41	0.48
0.00	0.00	0.53	0.57	0.69	0.34	0.78	0.50	0.65	0.39	1.32	0.29
1.35	0.55	0.74	0.83	0.00	0.00	0.06	0.30	0.05	0.24	0.00	0.00
30.05	2.14	60.16	8.52	46.23	1.37	25.80	0.55	30.79	0.98	45.77	1.34
0.31	0.25	-0.11	0.11	0.11	0.09	0.40	0.25	0.40	0.44	0.37	0.28
8.08	0.23	8.53	0.10	8.50	0.15	8.36	0.09	7.71	0.28	7.57	0.16
0.00	0.00	0.58	1.46	0.74	2.02	0.00	0.00	0.00	0.00	1.68	2.50
2.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	1.75	0.53
1.88	0.34	0.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	1.58	0.83
4.76	0.16	3.99	0.12	4.99	0.52	6.81	0.24	6.91	0.50	3.79	0.96

Latvia		Lithuania		Macedonia		Moldova		Mongolia		Poland	
m	sd	m	sd	m	sd	m	sd	m	sd	m	sd
-0.32	0.12	-0.21	0.17	-0.18	0.14	0.04	0.02	-0.33	0.23	-0.11	0.09
3.78	0.03	3.81	0.03	3.93	0.02	3.92	0.03	3.50	0.04	3.86	0.03
4.02	0.09	4.01	0.10	3.96	0.19	3.77	0.15	2.91	0.15	3.92	0.11
3.61	0.08	3.98	0.08	4.39	0.02	4.84	0.01	0.47	0.08	4.83	0.01
4.55	0.03	4.75	0.16	3.86	0.16	3.72	0.09	1.13	0.05	4.82	0.05
9.52	0.35	9.57	0.40	9.06	0.22	7.96	0.31	8.31	0.59	9.59	0.34
0.00	0.19	0.47	0.58	1.08	0.33	0.07	0.36	0.69	0.63	0.49	0.55
-0.01	0.13	0.42	0.52	0.06	0.31	1.39	0.46	0.55	0.68	0.33	0.35
31.79	0.44	33.00	0.27	41.88	0.91	55.83	1.64	38.74	4.66	38.69	0.40
0.19	0.39	0.30	0.21	-0.06	0.15	0.30	0.39	0.14	0.28	0.08	0.18
7.79	0.24	7.89	0.25	7.98	0.16	7.89	0.16	6.81	0.36	8.04	0.14
0.00	0.00	0.00	0.00	0.32	0.97	0.27	1.30	0.00	0.00	0.00	0.00
2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	0.88	0.34	2.00	0.00
2.00	0.00	2.00	0.00	1.00	0.00	2.00	0.00	0.88	0.34	2.00	0.00
6.11	0.52	6.26	0.35	4.29	0.29	4.28	0.32	4.79	0.49	6.34	0.30

Tajikistan		Turkmenistan		Ukraine		Uzbekistan		Vietnam	
m	sd	m	sd	m	sd	m	sd	m	sd
-0.09	0.05	0.28	0.09	-0.02	0.01	-0.01	0.01	0.14	0.08
3.67	0.03	4.11	0.02	3.88	0.03	4.02	0.02	4.33	0.01
3.76	0.15	2.51	0.22	3.85	0.09	2.82	0.20	5.04	0.11
3.85	0.13	2.28	0.10	4.43	0.05	4.09	0.11	5.55	0.10
				3.38	0.01	2.70	0.24		
7.72	0.31	9.16	0.41	8.86	0.32	8.50	0.25	7.85	0.44
1.22	0.88	0.40	0.65	0.21	0.57	0.46	0.74	0.08	0.28
0.60	0.96	1.16	0.96	1.21	0.55	1.30	0.88	1.52	0.58
72.58	1.46	53.28	1.65	32.34	0.76	52.85	3.13	73.81	3.90
0.30	0.29	0.00	0.00	0.35	0.40	0.44	0.35	-0.07	0.10
7.47	0.45	7.51	0.40	7.91	0.22	8.08	0.36	8.37	0.18
2.77	2.89	0.00	0.00	0.35	1.71	0.67	1.59	0.00	0.00
0.00	0.00	1.92	0.41	2.00	0.00	0.00	0.00	0.00	0.00
1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.83	0.56
2.43	0.35	2.08	0.19	3.32	0.23	2.39	0.21	4.01	0.17

Table A7: Correlation matrix

	Land use rate	log temperature	log precipitation	log population density
Land use rate	1			
log temperature	0.47	1		
log precipitation	0.11	0.37	1	
log population density	0.16	0.48	0.56	1
log road density	-0.11	0.38	0.51	0.72
log GDP pc	-0.32	-0.16	0.04	0.06
log RER*NI	0.12	-0.14	0.05	-0.04
log RER*NX	0.18	0.20	-0.22	-0.01
rural population	0.43	0.43	0.19	0.10
log TOT	-0.01	-0.13	-0.10	0.01
log yield of cereals	0.16	0.43	0.55	0.70
log military conflicts	0.05	-0.40	-0.08	-0.14
land ownership	-0.23	-0.12	-0.02	0.13
land transferability	-0.21	-0.01	0.47	0.32
rule of law	-0.44	-0.04	0.36	0.26
	rural population	**Log TOT**	**log yield cereals**	**log military conflicts**
rural population	1			
log TOT	-0.01	1		
log yield of cereals	0.08	-0.19	1	
log military conflicts	0.00	0.08	-0.21	1
land ownership	-0.56	0.10	0.03	-0.10
land transferability	-0.29	-0.01	0.18	-0.10
Rule of law	-0.45	0.00	0.36	-0.30

log road density	log GDP pc	logRER* NI	logRER* NX
1			
0.50	1		
-0.15	-0.20	1	
-0.24	-0.38	-0.67	1
-0.26	-0.69	0.09	0.26
0.01	-0.14	0.20	0.09
0.57	0.34	-0.19	-0.07
-0.29	-0.12	0.25	-0.10
0.48	0.51	-0.11	-0.24
0.46	0.34	-0.10	-0.30
0.70	0.65	-0.29	-0.27
land ownership	**land transferability**	**Rule of law**	
1			
0.60	1		
0.44	0.56	1	

Table A8: Results of PCSE (AR1) without control variables

	Model I			Model II		
Dependent Variable: Land use rate	**Coeff**	**p-value**	**95 % CI**	**Coeff**	**p-value**	**95 % CI**
land ownership	-0.0482	0.001	-0.076 – -0.021	-0.0234	0.054	-0.047 – 0.0004
land transferability	0.0063	0.436	-0.003 – 0.022	0.0096	0.222	-0.006 – 0.025
rule of law				-0.0379	< 0.001	-0.058 – -0.017
Constant	-0.0037	0.830	-0.038– 0.030	0.1143	0.001	0.033 – 0.195
Observations	494			494		

Table A9: Results of PCSE (AR1) with control variables

	Model I			Model II		
Dependent Variable: Land use rate	**Coeff**	**p-value**	**95 % CI**	**Coeff**	**p-value**	**95 % CI**
land ownership	-0.0532	0.001	-0.083 – -0.023	-0.0494	0.001	-0.078 – -0.021
land transferability	0.0446	0.001	-0.017 – 0.072	0.0518	0.001	0.022 – 0.082
rule of law				-0.0377	< 0.001	-0.058 – -0.017
log of temperature	0.1676	0.002	0.059 – 0.276	0.1456	0.010	0.035 – 0.256
log of precipitation	0.0208	0.152	-0.008 – 0.049	0.0224	0.132	-0.006 – 0.052
log of population density	0.0553	0.001	0.022 – 0.088	0.0419	0.010	0.009 – 0.074
rural population	0.0023	0.013	0.0004 – 0.004	0.0025	0.007	0.0007 – 0.004
log of road density	-0.0421	0.003	-0.070 – -0.014	-0.0139	0.308	-0.041 – -0.013
log of GDP pc	-0.0213	0.237	-0.057 – 0.014	-0.0004	0.980	-0.039 – 0.038
log of RER*NI	0.0455	0.039	0.002 – 0.088	0.0342	0.136	-0.011 – 0.079
log of RER*NX	0.0438	0.050	-0.000 – 0.088	0.0351	0.132	-0.011 – 0.081
Log of TOT	0.0194	0.400	-0.026 – 0.064	0.0281	0.230	-0.018 – 0.074
log of yield of cereals	0.0233	0.070	-0.002 – 0.049	0.0261	0.049	0.0001 – 0.052
log of military conflicts	0.0027	0.374	-0.003 – 0.009	0.0021	0.469	-0.003 – 0.007
Constant	-0.9954	0.002	-1.615 – -0.375	-1.0218	0.002	-1.656 – -0.387
Observations	494			494		
R2/Pseudo R2	0.2296			0.2553		
Wald (Chi2)	110.81***			115.45***		

Note: In Wald test, *** denotes significance level of 1%.

Table A10: Results of PCSE (AR1) with disaggregated land rights

	Model with partial and full rights			Model with no rights		
Dependent Variable: Land use rate	**Coeff**	**p-value**	**95 % CI**	**Coeff**	**p-value**	**95 % CI**
partial ownership	-0.1222	0.001	-0.195 – -0.050			
full ownership	-0.1174	0.003	-0.194 – -0.041			
no ownership				0.1141	0.001	0.046 – 0.182
partial transferability	0.1674	<0.001	0.091 – 0.244			
full transferability	0.1642	<0.001	0.076 – 0.253			
no transferability				-0.1564	< 0.001	- 0.235 – - 0.077
rule of law	-0.0363	<0.001	-0.057 – -0.016	-0.0365	< 0.001	-0.056 – -0.017
log of temperature	0.1150	0.027	0.013 – 0.217	0.1155	0.026	0.014 – 0.217
log of precipitation	0.0146	0.336	-0.015 – 0.044	0.0145	0.327	-0.014 – 0.043
log of population density	0.0494	0.002	0.018 – 0.081	0.0489	0.002	0.017 – 0.080
rural population	0.0030	0.001	0.001 – 0.005	0.0030	0.001	0.001 – 0.005
log of road density	-0.0176	0.195	-0.044 – -0.009	-0.0166	0.219	-0.043 – 0.010
log of GDP pc	0.0098	0.595	-0.026 – 0.046	0.0085	0.653	-0.029 – 0.046
log of RER*NI	0.0378	0.087	-0.005 – 0.081	0.0365	0.096	-0.006 – 0.080
log of RER*NX	0.0413	0.067	-0.003 – 0.085	0.0396	0.075	-0.004 – 0.083
Log of TOT	0.0336	0.157	-0.013 – 0.080	0.0326	0.165	-0.013 – 0.079
log of yield of cereals	0.0296	0.025	0.004 – 0.056	0.0284	0.029	0.003 – 0.054
log of military conflicts	0.0028	0.359	-0.003 – 0.009	0.0026	0.390	-0.003 – 0.008
Constant	-1.0925	<0.001	-1.676 – -0.509	-1.0243	0.001	-1.608 – 0.440
Observations	494			494		
R2/Pseudo R2	0.3058			0.2930		
Wald (Chi2)	145.88***			129.30***		

Note: In Wald test, *** denotes significance level of 1%.

Table A11: Reason of abnormal drop in the area of arable land

Country	Year	Reason
Albania	2004	Principles of the European Statistics Code of Practice were incorporated into the National Statistics System (INSTAT, 2015).
Bulgaria	1998	Implementation of Special Accessions Programme for Agriculture and Rural Development. New methodologies in agricultural census (ESI, 2007).
Croatia	2000	Non-cultivated arable land was separated from the arable land and gardens (Eurostat, 2017; FAO, 2019)
Georgia	2004	Territories of Abkhazia and the former South Ossetia were excluded from assessment of agricultural statistics (FAO, 2015).
Latvia	1995	Land use statistics have been re-calculated in 1995 excluding the unutilized agricultural area (FAO, 2019).
Lithuania	2001	Kitchen garden were excluded from calculations (Eurostat, 2017).
Mongolia	2001	Updating survey methodologies initiated by UNDP (UNDP, 2011, p. 43).
Romania	2004	Incorporation of the methodology of the Economic Accounts for Agriculture for the EU Member States (EC, 2003).

Note: the sharp decreases in Kyrgyzstan in 1994 and Uzbekistan in 2005 were not included because of the evidences that two countries experiences physical decrease in agricultural land use (Muradov and Ilkhamov, 2014; Spoor, 1999; USAID, 2011).

Table A12: Results of PCSE (AR1) with dummy variable that indicates methodological changes in agricultural land use

	Model I			Model II		
Dependent Variable: Land use rate	**Coeff**	**p-value**	**95 % CI**	**Coeff**	**p-value**	**95 % CI**
land ownership	-0.0558	0.001	-0.087 – -0.025	-0.0526	0.001	-0.082 – -0.023
land transferability	0.0493	0.001	0.021 – 0.078	0.0571	< 0.001	0.026 – 0.088
rule of law				-0.0371	< 0.001	-0.057 – -0.018
change in methodology	-0.1060	< 0.001	-0.147 – -0.065	-0.1052	< 0.001	-0.145 – -0.066
log of temperature	0.1711	0.001	0.069 – 0.273	0.1492	0.005	0.044 – 0.254
log of precipitation	0.0254	0.077	-0.003 – 0.054	0.0270	0.067	-0.002 – 0.056
log of population density	0.0551	0.000	0.027 – 0.083	0.0414	0.003	0.014 – 0.069
rural population	0.0022	0.012	< 0.001 – 0.004	0.0025	0.006	0.001 – 0.004
log of road density	-0.0439	0.001	-0.070 – -0.018	-0.0155	0.247	-0.042 – 0.011
log of GDP pc	-0.0215	0.180	-0.053 – 0.010	-0.0008	0.962	-0.035 – 0.033
log of RER*NI	0.0455	0.028	0.005 – 0.086	0.0345	0.115	-0.008 – 0.077
log of RER*NX	0.0476	0.023	0.007 – 0.089	0.0394	0.073	-0.004 – 0.0822
Log of TOT	0.0214	0.308	-0.020 – 0.063	0.0306	0.154	-0.011 – 0.073
log of yield of cereals	0.0254	0.038	0.001 – 0.049	0.0283	0.026	0.003 – 0.053
log of military conflicts	0.0041	0.163	-0.002 – 0.010	0.0035	0.215	-0.002 – 0.009
Constant	-1.0362	0.001	-1.623 – -0.450	-1.0660	0.001	-1.667 – -0.465
Observations	494			494		
R2/Pseudo R2	0.3035			0.3290		
Wald (Chi2)	188.09***			188.82***		

Results of PCSE (AR1) with dummy variable that indicates methodological changes in agricultural land use

APPENDIX B

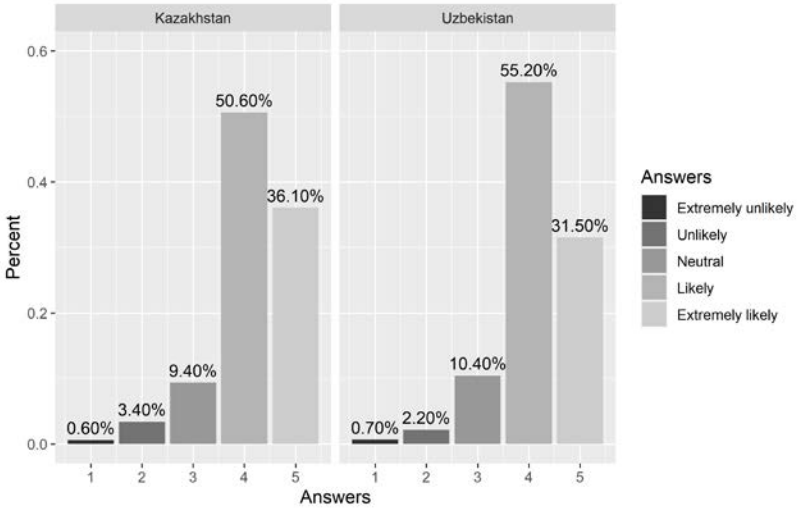

Figure B1: Percentages of responses to the question about the land intensification willingness

Table B1: Evaluation of land rights and the corresponding articles in land codes

	Kazakh farmers				Uzbek farmers	
	Landowners		Land tenants			
Rights	**Value**	**Articles**	**Value**	**Articles**	**Value**	**Articles**
Access	5	23(2)	5	12(17), 37(1)	5	17, 39, 46, 49
Withdrawal	5	25(1)	5	64(1/2)	5	39
Land use change	3	65(4), 97(3-2), 98	3	65(4), 97(3-2), 98	1	43, 49
Management	5	25(1),42(2), 64(1/1)	5	42(2), 64(1-1)	3	12
Investment	5	65(1/2.9), 25(1)	5	65(1/2,1/9)	3	13, 40
Exclusion	5	164	5	33(1), 65(1/8),164-1(1)	5	53
Income generating	5	64(1/2), 25(1)	5	64(1/2)	5	39
Reallocation	5	25(2)	1	33(2)	1	53
Sell	5	25(2)	1	33(2)	1	53
Renting out	5	25(3)	1	33(2), 38(5)	1	53
Leasing from land tenants	1	33(2), 38(5)	1	33(2), 38(5)	1	52
Inheritance	5	40	5	40	1	17,19
Protection by courts	5	5, 164	5	5, 29(2),32(1), 35(4,5), 64(1.4), 164	5	41, 83, 85, 89
Certificates importance	5	12(24), 43(10), 97(7), 171	5	12(24), 43(10), 97(7), 171	5	20, 33, 35

Table B2: Descriptive statistics of actual practices and discrepancies

a) Kazakh landowners (N=337)								
	Actual practices				Discrepancy			
Right	Min	Max	Mean	St. Dev.	Min	Max	Mean	St. Dev.
Access	1	5	4.887	0.377	0	4	0.113	0.377
Withdrawal	1	5	4.727	0.553	0	4	0.273	0.553
Land use change	1	5	4.546	0.960	-2	2	-1.546	0.960
Management	1	5	4.737	0.589	0	4	0.263	0.589
Investment	1	5	4.700	0.665	0	4	0.300	0.665
Exclusion	1	5	4.674	0.835	0	4	0.326	0.835
Income generating	1	5	4.721	0.612	0	4	0.279	0.612
Reallocation	1	5	4.009	1.507	0	4	0.991	1.507
Sell	1	5	4.208	1.459	0	4	0.792	1.459
Renting out	1	5	4.312	1.280	0	4	0.688	1.280
Leasing from land tenants	1	5	4.258	1.266	-4	0	-3.258	1.266
Inheritance	1	5	4.558	0.947	0	4	0.442	0.947
Protection by courts	1	5	3.630	0.941	0	4	1.370	0.941
Certificates importance	1	5	4.682	0.833	0	4	0.318	0.833

to be continued

b) Kazakh landleasers (N=165)								
	Actual practices				Discrepancy			
Right	Min	Max	Mean	St. Dev.	Min	Max	Mean	St. Dev.
Access	3	5	4.897	0.343	0	2	0.103	0.343
Withdrawal	2	5	4.685	0.561	0	3	0.315	0.561
Land use change	1	5	4.673	0.664	-2	2	-1.673	0.664
Management	2	5	4.758	0.404	0	3	0.242	0.404
Investment	2	5	4.618	0.694	0	3	0.382	0.694
Exclusion	1	5	4.248	1.280	0	4	0.752	1.280
Income generating	3	5	4.752	0.511	0	2	0.248	0.511
Reallocation	1	5	2.503	1.568	-4	0	-1.503	1.568
Sell	1	5	2.667	1.839	-4	0	-1.667	1.839
Renting out	1	5	3.000	1.718	-4	0	-2.000	1.718
Leasing from land tenants	1	5	3.024	1.522	-4	0	-2.024	1.522
Inheritance	1	5	3.558	1.730	0	4	1.442	1.730
Protection by courts	1	5	3.469	0.900	0	4	1.531	0.900
Certificates importance	1	5	4.485	0.853	0	4	0.515	0.853

c) Farmers in Uzbekistan (N=460)								
	Actual practices				Discrepancy			
Right	Min	Max	Mean	St. Dev.	Min	Max	Mean	St. Dev.
Access	1	5	4.915	0.427	0	4	0.085	0.427
Withdrawal	1	5	2.502	1.542	0	4	2.498	1.542
Land use change	1	5	1.470	0.927	-4	0	-0.470	0.927
Management	1	5	2.917	0.746	-2	2	0.083	0.746
Investment	1	5	4.291	1.078	-2	2	-1.291	1.078
Exclusion	1	5	4.530	1.146	0	4	0.470	1.146
Income generating	1	5	1.572	0.964	0	4	3.428	0.964
Reallocation	1	5	1.339	0.694	-4	0	-0.339	0.694
Sell	1	5	1.004	0.066	-1	0	-0.004	0.066
Renting out	1	5	1.265	0.540	-2	0	-0.265	0.540
Leasing from land tenants	1	5	1.178	0.497	-4	0	-0.178	0.497
Inheritance	1	5	1.609	0.888	-4	0	-0.609	0.888
Protection by courts	1	5	3.071	0.654	0	4	1.929	0.654
Certificates importance	1	5	4.180	0.871	0	4	0.820	0.871

Table B3: Definitions of additional explanatory variables

Variable	Description	Mean	SD
Farmer characteristics			
Educational level	Level of last completed education degree: from 1=no education to 8=university	5.6	1.7
Age	Age of farmer in years	44.5	11.9
Special agricultural education	Dummy variable for special education: 1=have; 0=otherwise	0.3	
Consultancy services	Dummy variable for using consulting services: 1=have; 0=otherwise	0.1	
Desired period	Number of years a farmer desires to use his land:1=up to 3 years, 2=up to 5 years, 3=up to 10 years, 4=more than 10 years	3.7	0.7
Farmland characteristics			
Farm size	Total land area (ha)	25.4	28.2
Distance to market	Average distance between farm and the nearest market	15.1	10.9
Soil fertility	Weighted average of soil fertility evaluation: 1=not good for cultivation, 2=good for 1 crop per year, 3=good for 2 crops per year, 4=good for >2 crops per year	2.6	0.6
Salinity	Weighted average of soil salinity evaluation: 1=non-saline, 2=low saline, 3=medium saline, 4=high saline.	2.1	1.1
Irrigation conditions	Conditions of irrigation and drainage network: 1=bad, 2=satisfying, 3=good	2.1	0.7
Regional characteristics			
Uzbekistan	Dummy variable for Uzbekistan:1=-farmer resides in Uzbekistan; 0= otherwise		

Table B4: Tests for the first stage regressions of 2SCML

Endogenous Variable	F test	Breusch-Pagan test
access positive	18.57***	86.48***
withdrawal positive	168.67***	182.22***
use change positive	1792.83***	0.00
use change violation	50.43***	295.90***
management positive	14.25***	2.48
management violation	1465.53***	0.61
investment positive	17.36***	259.52***
investment violation	4407.24***	12.55***
exclusion positive	11.77***	213.19***
income generating positive	281.76***	190.54***
reallocation positive	1532.43***	5.52 **
reallocation violation	21.62***	149.71***
sell positive	1185.21***	9.66***
sell violation	820.01***	21.17***
rent out positive	1363.39***	9.07***
rent out violation	58.80***	120.54***
lease from land tenants, violation	245.48***	655.73***
inheritance positive	2379.84***	10.34***
inheritance violation	1625.33***	0.70
protection by courts positive	14.35***	52.38***
power of certificate pos.	12.85***	160.72***

Table B5: Reliability and validity results of reflective constructs

		Kazakh farmers			Uzbek farmers		
Constructs	**Variables**	**Outer loadings**	**AVE**	**Composite reliability**	**Outer loadings**	**AVE**	**Composite reliability**
Intention	Int1	0.800	0.677	0.863	0.878	0.724	0.887
	Int2	0.813			0.832		
	Int3	0.855			0.841		
Attitude	Att1	0.818			0.923		
	Att2	0.736	0.622	0.831	0.831	0.800	0.923
	Att3	0.808			0.926		
Subjective norms	SN1	0.752			0.934		
	SN2	0.748	0.572	0.843	0.931	0.869	0.930
	SN3	0.769			-		
	SN4	0.756					
Perceived behavioural control	PBC1	0.855	0.649	0.787	0.809	0.711	0.831
	PBC2	0.753			0.877		

Table B6: Formative constructs outer weights significance testing results

	Kazakh farmers			Uzbek farmers		
Indicators	**Perceived LR**	**Rights Underuse**	**Restrictions Violation**	**Perceived LR**	**Rights Underuse**	**Restrictions Violation**
Access	0.133*	0.131		-0.128*	-0.191	
Withdrawal	0.415***	0.427***		-0.154**	0.066	
Use change	-0.022	-0.094	0.410***	0.374***		0.337***
Management	0.295***	0.374***		0.094	-0.146	0.205**
Investment	0.128	0.164		-0.321***	-0.198	-0.507***
Exclusion	-0.083	-0.049		-0.286***	-0.489	
Income generating	0.025	0.016		0.051	0.535	
Reallocation	-0.019	0.085	0.020	0.195		0.224*
Sell	-0.092	-0.192	0.362			
Rent out	0.424***	0.206		0.133		0.112
Lease from tenants	0.225*		0.763***	0.114		0.047
Inheritance	-0.228**	0.026		-0.208***		-0.289***
Protection	0.307***	0.412***		-0.118*	-0.102	
Power of certificate	-0.092	-0.046		0.396***	0.467	

Note: *, **, *** indicate significance at the 10%, 5%, 1% levels, respectively.

Table B7: f^2 effect sizes

Relations	Kazakh farmers			Uzbek farmers			
	Basic model	Model with Perceived LR	Model with discrepancies	Basic model	Model with Perceived LR	Model with discrepancies	Model with Perceived LR and Violation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Attitude -> Intention	0.265	0.254	0.256	0.241	0.265	0.318	0.298
SN-> Intention	0.085	0.074	0.071	0.376	0.203	0.172	0.202
PBC-> Intention	0.001	0.000	0.000	0.050	0.024	0.013	0.016
Perceived LR ->Intention		0.001			0.092		0.000
Perceived LR -> Attitude		0.170			0.077		0.048
Perceived LR ->SN		0.278			0.407		0.088
Perceived LR ->PBC		0.117			0.161		0.005
Rights Underuse ->Intention			0.008			0.009	
Rights Underuse -> Attitude			0.083			0.000	
Rights Underuse ->SN			0.143			0.071	
Rights Underuse ->PBC			0.070			0.020	
Restrictions Violation -> Intention			0.001			0.091	0.047
Restrictions Violation -> Attitude			0.014			0.020	0.009
Restrictions Violation ->SN			0.022			0.081	0.000
Restrictions Violation ->PBC			0.012			0.072	0.021

APPENDIX C: DO-FILE

The core Stata commands used to calculate the results for this dissertation:

1. Estimation of the Panel Corrected Standard Errors

```
///description of variables
* land_use_rate – land use rate
* ownership – land ownership
* transfer – land transferability
* rule – rule of law
* ln_tF – log of temperature in Fahrenheit
* ln_precip – log of precipitation
* ln_pop_dens – log of population density
* ln_infr – log of road length
* ln_gdp_pc -log of GDP per capita
* RERMX – real exchange rate of importer countries
* RERXM – real exchange rate of exporter countries
* rural_pop -share of rural population
* ln_tot – log of terms of trade
* ln_yield -log of yield
* ln_conflict – log of the number of state and non-state conflicts


// Specification tests for FE
xtreg land_use_rate ownership transfer rule ln_tF ln_precip ln_pop_dens
ln_infr ln_gdp_pc RERMX RERXM rural_pop ln_tot ln_yield ln_conflict, fe
xtcsd, pesaran abs  //Cross sectional dependence
xtcsd, frees
xtcsd,friedman
xttest3   //modified Wald for heteroscedasticity
```

```
// Specification tests for RE
xtreg land_use_rate ownership transfer rule ln_tF ln_precip ln_pop_dens
ln_infr ln_gdp_pc RERMX RERXM rural_pop ln_tot ln_yield ln_conflict, re
xtcsd, pesaran abs //Cross sectional dependence
xtcsd, frees
xtcsd,friedman

//Wooldridge test for Jo: no first oder autocorrelation
xtserial land_use_rate ownership transfer rule ln_tF ln_precip ln_pop_dens
ln_infr ln_gdp_pc RERMX RERXM rural_pop ln_tot ln_yield ln_conflict

// PCSE without Rule of law
xtpcse land_use_rate ownership transfer, correlation(ar1) pairwise
estimates store A
xtpcse land_use_rate ownership transfer ln_tF ln_precip ln_pop_dens
rural_pop ln_infr ln_gdp_pc RERMX RERXM ln_tot ln_yield ln_conflict,
correlation(ar1) pairwise
estimates store B
coefplot (A, label(baseline model)) (B,label(full model)), drop(_cons)
xline(0)  //Graph of coefficients, comparison

//PCSE with Rule of law
xtpcse land_use_rate ownership transfer rule, correlation(ar1) pairwise
estimates store C
xtpcse land_use_rate ownership transfer rule ln_tF ln_precip ln_pop_dens
rural_pop ln_infr ln_gdp_pc RERMX RERXM ln_tot ln_yield ln_conflict, correla-
tion(ar1) pairwise
estimates store D
coefplot (C, label(baseline model)) (D,label(full model)), drop(_cons)
xline(0)  //Graph of coefficients, comparison

// REGRESSIONS FOR ROBUSTNESS TEST
//Create DUMMIES
generate d_partown = 0  //creating dummy for partial ownership
```

```
replace d_partown= 1 if ownership==1
generate d_fullown = 0  //creating dummy for full ownership
replace d_fullown= 1 if ownership==2
generate d_parttransfer = 0  //creating dummy for partial transfer
replace d_parttransfer= 1 if transfer==1
generate d_fulltransfer = 0  //creating dummy for full transfer
replace d_fulltransfer= 1 if transfer==2
generate d_no_own = 0  //creating dummy for no ownership
replace d_no_own= 1 if ownership==0
generate d_no_transfer = 0  //creating dummy for no transferability
replace d_no_transfer= 1 if transfer==0

// PCSE with dummy variables for land rights
xtpcse land_use_rate d_fullown d_partown  d_fulltransfer d_parttransfer
rule ln_tF ln_precip ln_pop_dens rural_pop ln_infr ln_gdp_pc RERMX RERXM
ln_tot ln_yield ln_conflict,correlation(ar1) pairwise
estimates store D
xtpcse land_use_rate d_no_own  d_no_transfer rule ln_tF ln_precip
ln_pop_dens rural_pop ln_infr ln_gdp_pc RERMX RERXM ln_tot ln_yield ln_con-
flict,correlation(ar1) pairwise
estimates store F

// WITH METHODOLOGICAL CHANGES
 // PCSE with ownership and transferability without Rule
xtpcse land_use_rate ownership transfer, correlation(ar1) pairwise
estimates store A
xtpcse land_use_rate ownership transfer methodology_change1 ln_tF
ln_precip ln_pop_dens rural_pop ln_infr ln_gdp_pc RERMX RERXM ln_tot ln_
yield ln_conflict,correlation(ar1) pairwise
estimates store B
coefplot (A, label(without control variables)) (B,label(with control variables)),
drop(_cons) xline(0)  //Graph of coefficients, comparison
```

2. Two-step conditional maximum likelihood (2SCML) with Lewbel's heteroscedasticity-based instrumental method

/ ///description of variables

* access - positive discrepancy for the right to access land
* withdrawal -
* pos_usechange - positive discrepancy for the right to chnage the use of land
* violate_usechange
* pos_management - positive discrepancy for the right to manage
* violate_management
* pos_investment - positive discrepancy for the right to invest
* violate_investment
* pos_exclusion - positive discrepancy for the right to exclude
* pos_income_gen - positive discrepancy for the right to generate income
* pos_reallocaton - positive discrepancy for the right to reallocate
* violate_reallocaton
* pos_sell - positive discrepancy for the right to sell
* violate_sell
* pos_rentout - positive discrepancy for the right to rent out
* violate_rentout
* violate_lease_other
* pos_inheritance - positive discrepancy for the right to inherit
* violate_inheritance
* pos_protection - positive discrepancy for the right to government protection
* pos_certificate - positive discrepancy for the right to reliable land certificates

*age -age of farmer
*education – education level
*logsize – log of Farm size
*logdistance – log of distance to the nearest market

```
*specEdu - Special agricultural education
*desiredPeriod - Number of years farmer desires to use his land
*agronom -using extension services of agricultural specialists
*irrigation – irrigation conditions
*salinity – soil salinity level
*fertility – soil fertility level
*uzb – dummy for Uzbek farmers


// Creating global list of exogenous variables and standardizing
global xlist2 age education logsize logdistance specEdu desiredPeriod
agronom irrigation salinity fertility uzb
center $xlist2, prefix(z_)
global zxlist z_age z_education z_logsize z_logdistance z_specEdu
z_desiredPeriod z_agronom z_irrigation z_salinity z_fertility z_uzb

// Creating global list of discrepancies for four bundles of rights
global uselist access withdrawal pos_usechange violate_usechange
global dmlist pos_management violate_management pos_investment
violate_investment pos_exclusion pos_income_gen
global alienlist pos_reallocaton violate_reallocaton pos_sell violate_sell
pos_rentout violate_rentout violate_lease_other pos_inheritance
violate_inheritance
global securlist pos_protection pos_certificate

// Creating instruments with Lewbel's 1st stage to use them in 2SCML 1st stage
// Access
reg access $xlist2
predict r_acc, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen a`var'= `var'* r_acc}
reg acess $xlist az_*
hettest
predict r_acc2, residuals  // residuals for 2nd stage
```

```
// Withdrawal
reg withdrawal $xlist2
predict r_with, residuals
foreach var in $zxlist {
gen w`var'= `var'* r_with}
reg withdrawal $xlist wz_*
hettest
predict r_with2, residuals


//pos_usechange
reg pos_usechange $xlist2
predict r_pus, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen pus`var'= `var'* r_pus}
reg pos_usechange $xlist pusz_*
hettest
predict r_pus2, residuals   // residuals for 2nd stage

//violate_usechange
reg violate_usechange $xlist2
predict r_vus, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen vus`var'= `var'* r_vus}
reg violate_usechange $xlist vusz_*
hettest
predict r_vus2, residuals   // residuals for 2nd stage

//pos_management
reg pos_management $xlist2
predict r_pm, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen pm`var'= `var'* r_pm}
reg pos_management $xlist pmz_*
```

```
predict r_pm2, residuals   // residuals for 2nd stage
hettest

// violate_management
reg violate_management $xlist2
predict r_vm, residuals //1st staeg Lewbel's
foreach var in $zxlist {
gen vm`var'= `var'* r_vm}
reg violate_management $xlist vmz_*
predict r_vm2, residuals   // residuals for 2nd stage
hettest

// pos_investment
reg pos_investment $xlist2
predict r_pi, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen pi`var'= `var'* r_pi}
reg pos_investment $xlist piz_*
predict r_pi2, residuals   // residuals for 2nd stage
hettest

// violate_investment
reg violate_investment $xlist2
predict r_vi, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen vi`var'= `var'* r_vi}
reg violate_investment $xlist viz_*
predict r_vi2, residuals   // residuals for 2nd stage
hettest

// pos_exclusion
reg pos_exclusion $xlist2
predict r_pe, residuals //1st stage Lewbel's
foreach var in $zxlist {
```

```
gen pe`var'= `var'* r_pe}
reg pos_exclusion $xlist pez_*
predict r_pe2, residuals   // residuals for 2nd stage
hettest

// pos_income_gen
reg pos_income_gen $xlist2
predict r_pig, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen pig`var'= `var'* r_pig}
reg pos_income_gen $xlist pigz_*
predict r_pig2, residuals   // residuals for 2nd stage
hettest

// pos_reallocaton
reg pos_reallocaton $xlist2
predict r_pr, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen pr`var'= `var'* r_pr}
reg pos_reallocaton $xlist prz_*
predict r_pr2, residuals   // residuals for 2nd stage
hettest

// violate_reallocaton
reg violate_reallocaton $xlist2
predict r_vr, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen vr`var'= `var'* r_vr}
reg violate_reallocaton $xlist vrz_*
predict r_vr2, residuals   // residuals for 2nd stage
hettest

// pos_sell
reg pos_sell $xlist2
```

```
predict r_ps, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen ps`var'= `var'* r_ps}
reg pos_sell $xlist psz_*
predict r_ps2, residuals   // residuals for 2nd stage
hettest

// violate_sell
reg violate_sell $xlist2
predict r_vs, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen vs`var'= `var'* r_vs}
reg violate_sell $xlist vsz_*
predict r_vs2, residuals   // residuals for 2nd stage
hettest

// pos_rentout
reg pos_rentout xlist2
predict r_pro, residuals //1st staeg Lewbel's
foreach var in $zxlist {
gen pro`var'= `var'* r_pro}
reg pos_rentout $xlist proz_*
predict r_pro2, residuals   // residuals for 2nd stage
hettest

// violate_rentout
reg violate_rentout $xlist2
predict r_vro, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen vro`var'= `var'* r_vro}
reg violate_rentout $xlist vroz_*
predict r_vro2, residuals   // residuals for 2nd stage
hettest
```

```
// violate_lease_other
reg violate_lease_other $xlist2
predict r_vlo, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen vlo`var'= `var'* r_vlo}
reg violate_lease_other $xlist vloz_*
predict r_vlo2, residuals   // residuals for 2nd stage
hettest

// pos_inheritance
reg pos_inheritance  $xlist2
predict r_ph, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen ph`var'= `var'* r_ph}
reg pos_inheritance $xlist phz_*
predict r_ph2, residuals   // residuals for 2nd stage
hettest

// violate_inheritance
reg violate_inheritance $xlist2
predict r_vh, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen vh`var'= `var'* r_vh}
reg violate_inheritance $xlist vhz_*
predict r_vh2, residuals   // residuals for 2nd stage
hettest

// pos_protection
reg pos_protection $xlist2
predict r_pp, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen pp`var'= `var'* r_pp}
reg pos_protection $xlist ppz_*
predict r_pp2, residuals   // residuals for 2nd stage
```

```
hettest

// pos_certificate
reg pos_certificate $xlist2
predict r_pc, residuals //1st stage Lewbel's
foreach var in $zxlist {
gen pc`var'= `var'* r_pc}
reg pos_certificate $xlist pcz_*
predict r_pc2, residuals   // residuals for 2nd stage
hettest

// -Final Results Lewbel's & 2SCML, Aggregated model for Kazakhstan and Uzbekistan
oglm Intention_ordered acess r_acc2 ///
                                withdrawal r_with2 ///
                                pos_usechange r_pus2 ///
                                violate_usechange r_vus2 $xlist2, link(probit) robust
predict phat, xb
gen reg1resid=Intention_ordered-phat
kdensity reg1resid, normal
qnorm reg1resid
sktest reg1resid
swilk reg1resid


oglm Intention_ordered pos_management r_pm2 ///
                                violate_management r_vm2 ///
                                pos_investment r_pi2 ///
                                violate_investment r_vi2 ///
                                pos_exclusion r_pe2 ///
                                pos_income_gen r_pig2 $xlist2, link(probit) robust
predict phat2, xb
gen reg2resid=Intention_ordered-phat2
kdensity reg2resid, normal
qnorm reg2resid
```

```
sktest reg2resid
swilk reg2resid

oglm Intention_ordered pos_reallocaton r_pr2 ///
                                violate_reallocaton r_vr2 ///
                                pos_sell r_ps2 ///
                                violate_sell r_vs2 ///
                                pos_rentout r_pro2 ///
                                violate_rentout r_vro2 ///
                                violate_lease_other r_vlo2 ///
                                pos_inheritance r_ph2 ///
                                violate_inheritance r_vh2 $xlist, link(probit) robust
predict phat3, xb
gen reg3resid=Intention_ordered-phat3
kdensity reg3resid, normal
qnorm reg3resid
sktest reg3resid
swilk reg3resid

oglm Intention_ordered pos_protection r_pp2 ///
                                        pos_certificate   r_pc2   $xlist,   link(probit)
robust
predict phat4, xb
gen reg4resid=Intention_ordered-phat4
kdensity reg4resid, normal
qnorm reg4resid
sktest reg4resid
swilk eg4resid
```

```
// Final Results Lewbel's & 2SCML for Uzbekistan (Instruments for Uzbek model
were constructed in the same way as for aggregated model with Lewbel's 1st
stage)
oglm Intention_ordered acess r_acc2 withdrawal r_with2 violate_usechange
r_vus2 $xlist, link(probit) robust


oglm Intention_ordered pos_management r_pm2 ///
                                violate_management r_vm2 ///
                                pos_investment r_pi2 ///
                                violate_investment r_vi2 ///
                                pos_exclusion r_pe2 ///
                                pos_income_gen r_pig2 $xlist, link(probit)
robust

oglm Intention_ordered violate_reallocaton r_vr2 ///
                        violate_rentout r_vro2 ///
                        violate_lease_other r_vlo2 ///
                        violate_inheritance r_vh2 $xlist, link(probit) robust

oglm Intention_ordered pos_protection r_pp2 ///
pos_certificate r_pc2 $xlist, link(probit) robust


// Final Results Lewbel's & 2SCML for kazakhstan (Instruments for Kazakh mod-
el were constructed in the same way as for aggregated model with Lewbel's 1st
stage)
oglm Intention_ordered acess r_acc2 ///
                        withdrawal r_with2 ///
                        pos_usechange r_pus2 ///
                        violate_usechange r_vus2 $xlist, link(probit) robust

oglm Intention_ordered pos_management r_pm2 ///
                        pos_investment r_pi2 ///
```

```
                    pos_exclusion r_pe2 ///
                    pos_income_gen r_pig2 $xlist, link(probit) robust

oglm Intention_ordered pos_reallocaton r_pr2 ///
                    violate_reallocaton r_vr2 ///
                    pos_sell r_ps2 ///
                    violate_sell r_vs2 ///
                    pos_rentout r_pro2 ///
                    violate_rentout r_vro2 ///
                    violate_lease_other r_vlo2 ///
                    pos_inheritance r_ph2 $xlist, link(probit) robust
oglm Intention_ordered pos_protection r_pp2 pos_certificate r_pc2 $xlist,
link(probit) robust
```

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