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Abstract
This paper provides new evidence on the caste-related land productivity differential and its explanations in rural Nepal using household plot panel data. Low-caste households are found to have significantly higher land productivity on their owner-operated plots as compared to high-caste households. A comparison between the rented in land of low-caste and the owner-operated land of high-caste households showed that the former has significantly higher land productivity. No significant Marshallian inefficiency was found in the case of low-caste tenant households. Land productivity differences are explained by transaction costs in the labor market and caste discrimination rather than the disincentive effect of sharecropping.

Key words: land productivity; high-caste landlords; low-caste tenants; transaction costs; sharecropping; market imperfections; Nepal

JEL classification codes: Q12, Q15

1. Introduction

Land productivity is a serious concern for rural households in Nepal as they remain highly dependent on agriculture for their livelihood. Further, rural farm households face multiple market imperfections and thus, the distribution of assets can influence their efficiency of land use (Sadoulet et al., 1996). This also implies that not only the physical factors but also the socio-economic and institutional factors may affect land productivity. On this backdrop, the

caste[1] system that is closely associated with the access to and the distribution of land and other economic resources (including labor market participation) in Nepal can influence land productivity in rural areas.

In Nepal there are differences between *Dalits* (low-caste) and non-*Dalits* (high-caste) with regard to income, land holding, participation in markets and social life. The incidence of income poverty is about 46 percent for *Dalits* whereas it is only 18 percent in the case of high-caste people (World Bank, 2006). In addition, *Dalits* are land-poor and commonly rent in (additional) land, typically from high-caste households with excess land (Wily et al., 2008). In Hindu societies, differences in the average land holdings between high- and low-caste are not accidental but fundamental to the caste structure (George, 1987; Dahal, 1995; Hazari and Kumar, 2003).

In South Asia, climbing of the agricultural ladder is difficult due to the caste system and past land reform legislation (Otsuka et al., 1992). Land ownership in South Asia is largely hereditary, transferring from parents to their children. Such transfers therefore do not mitigate the past inequality in ownership land holdings. On the other hand, past land-to-the-tiller policy has distorted the land rental market, reducing the possibility of the poor's access to land through land renting. Under a situation where the land rental market is either

[1] The caste system that prevails in the Hindu religion, divides people into vertical hierarchies placing *Brahmins* on the top, *Chhetries* second, *Vaishyas* third and *Sudras (Dalits* or low-caste*)* at the lowest rank. *Dalits* are considered as untouchables under the traditional and conservative Hindu caste system. Therefore, other high-caste groups do not eat any cooked food touched by them. As a person attains caste position by birth, there is no way to move upward through any other means such as acquiring higher education or earning a higher level of income. However, the detailed discourse related to caste system is beyond the scope of this paper. This paper divides all castes/ethnic households in to two major categories: high-caste household and low-caste household. In this division, high-caste comprises all castes/ethnic groups except the *Dalits*, while the low-caste includes all those falling under *Dalits*. For the analytical purpose of this paper, it is assumed that the division is appropriate, because the gap between high-caste and low-caste households with regard to access and ownership of resources is very wide.

institutionally repressed or highly imperfect, inefficiency is bound to arise (Otsuka et al., 1992). Studies from Indian villages showed that caste affects the leasing behavior in the land rental market (Bliss and Stern, 1982; Skoufias, 1995), and the soil and water conservation investment (Pender and Kerr, 1998). Similarly, studies in Nepal showed that caste affects the adoption of improved soil conservation technology (Tiwari et al., 2008), land management practices (Paudel and Thapa, 2004; Aryal and Holden, 2011a) and land rental market participation (Aryal and Holden, 2010, 2011b).

Low-caste households face severe discrimination in the labor market. National data in Nepal revealed that there were almost no *Dalits* in senior positions in constitutional bodies, cabinet, court or in a party leadership until 2000 (Gurung, 2005). Studies from India (Banerjee and Knight, 1985; Munshi and Rosenzweig, 2006; Madheswaran and Attewell, 2007; Ito, 2009) showed that caste discrimination exists in the labor market and persons of low-caste origin face considerable inconvenience in finding regular employment (Ito, 2009). In India, Madheswaran and Attewell (2007) found that low-caste individuals receive 15 percent lower wages as compared to equally qualified high-caste individuals due to caste discrimination. They observed caste discrimination both in the public and private sector job markets, but it is higher in the private sector. In Nepal, caste discrimination is observed in the labor market such that a high-caste individual is paid higher than a Dalit (Hatlebakk, 2002). Such discrimination is also found in the informal credit market because Dalits are charged higher interest rates as compared to others (Hatlebakk, 2009).

If caste affects several factors like land ownership, land rental market participation, labor market access and participation, and investment behavior such as on soil conservation technology adoption and land management, it is likely that caste-related differentiation also has impact on land productivity. However, to our knowledge, there exist no such studies related to land productivity in South Asia (Sen, 1962; Bardhan, 1973; Deolalikar, 1981;

Acharya and Ekelund, 1998). This study is therefore a contribution to fill this research gap by assessing the impact of the caste on land productivity differential. Additionally, this paper contributes to theory by demonstrating how labor market imperfections affect land productivity. Particularly labor market conditions have not been fully examined in connection with land productivity in the literatures before.

Using data from Nepal this study assessed how caste-related productivity differences are associated with caste-related differences in endowments and in market access. As low-caste households have lower land endowment and poorer access to skilled off-farm employment, they are more likely to concentrate their labor in farming. Under such a condition we put forth the hypothesis that low-caste households achieve higher land productivity as compared to high-caste households. On the other hand, if these low-caste households get access to land through sharecropping contracts, this may reduce their incentives to enhance land productivity. We analyzed this using both parametric and nonparametric methods. Results showed that low-caste households have significantly higher land productivity as compared to high-caste households both on their own land and on the rented in land. This indicates that transaction costs in the labor market are high and that dominates over the disincentive effect of sharecropping in the case of low-caste tenants.

The rest of the paper is organized as follows. Section two covers the theoretical framework of the study. A general introduction of the study area and data are provided in section three, followed by the empirical estimation methods in section four. Section five presents the major results and discussion, and the last section concludes the study.

2. Theoretical Framework

Consider that all sample households can be classified into two major caste groups: high-caste household *C* and low-caste household *c*. For simplicity, consider only two resources, land and

labor, and access to land and land rental market by these caste groups. The distribution of ownership land holding $\overline{A}$ is such that $\overline{A}^{C} > \overline{A}^{c}$.

Assume that high-caste households have access to off-farm employment while this is not the case for low-caste households. There are labor market imperfections also such that hired labor is not a perfect substitute for family labor. There are transaction costs for hiring in labor such as monitoring and supervision costs. Assuming linear transaction costs, cost of hiring in farm labor can be expressed as: $(\omega_a + \tau_a) L^h$ where ω_a, τ_a and L^h refer to wage, transaction costs of hiring in labor and units of labor hired respectively. There are also transaction costs in hiring out agricultural labor. Therefore, the earnings obtained from hiring out agricultural labor can be expressed as: $(\omega_a - \upsilon_a) L_g$ where υ_a and L_g refer to transaction costs of hiring out agricultural labor and units of labor hired out respectively. Likewise, there are also transaction costs in the off-farm labor market such as search costs and costs involved in travelling. Therefore, wage income obtained by hiring out labor to the off-farm sector can be expressed as: $(\omega_o - \tau_o) L_o$ where subscript *o* refers to off-farm sector and all other symbols are as mentioned earlier. The total time endowment *T* of a household is divided into labor *L* and leisure L_e.

It is assumed that a farm household maximizes a utility function: $U = U(Y, L_e)$ subject to *Y*, the net income from both agricultural production and off-farm work and that the utility function is concave: $\frac{\partial U}{\partial Y} > 0, \frac{\partial U}{\partial L_e} > 0, \frac{\partial^2 U}{\partial Y^2} < 0$ and $\frac{\partial^2 U}{\partial L_e^2} < 0$. For agricultural production, the household uses two inputs: land *A* and farm labor L_a. The operational land *A* is the sum of the own land $\overline{A}$ and rented-in land A^{ri} minus the rented-out land A^{ro}. For simplicity, we assume uniform land quality. The production function is: $q = q(L_a, A); \frac{\partial q}{\partial L_a} > 0, \frac{\partial q}{\partial A} > 0, \frac{\partial^2 q}{\partial L_a^2} < 0$ and

$\frac{\partial^2 q}{\partial A^2} < 0$. Assuming constant returns to scale, the production function can be expressed in terms of farm productivity, $q = q(l_a)\,A$ where $q(l_a)$ refers to farm productivity per unit land and l_a is labor use per unit land.

As there are imperfect land rental (sharecropping contract) and labor markets, we formulate the theoretical model to represent both market conditions and the differences between low-caste and high-caste households with regard to land and labor endowment, and labor market access. We thus, present two models: one for high-caste households and one for low-caste households. For simplicity, we assume high-caste households as landlord and low-caste households as tenants.

2.1 For high-caste households (C)

Assume that high-caste household can rent out its land, hire in labor for farming and sell its labor in the off-farm sector. Therefore, its net income is obtained by subtracting the cost of hired labor used in own land from the sum of the value of output from its own land, value of its share of output in rented-out land, and the earning from the off-farm jobs. The household allocates its labor time to farming own land, working off-farm and to leisure. Therefore, the households' utility maximization problem is given by:

$$\underset{\{l_a^f,\, l_a^h,\, L_o,\, A^{ro}\}}{Max}\; U^C = U(Y, L_e) \quad \text{subject to}$$

$$Y^C = p_q\, q(l_a^f + l_a^h)(\overline{A} - A^{ro}) + (1-\alpha)\, p_q q^{ro}\left(l_a^c\right) A^{ro} + L_o(\omega_o - \tau_o) - l_a^h(\omega_a + \tau_a)(\overline{A} - A^{ro})$$

$$T^C = l_a^f(\overline{A} - A^{ro}) + L_o + L_e;\; l_a = l_a^f + l_a^h;\; l_a \geq 0;\; L_o \geq 0$$

where p_q refers to price of agricultural goods; and superscripts f and h denote family and hired components of the concerned variable, respectively. All other notations are as defined earlier. By substitution, we obtain:

$$1)\quad U^C = U\begin{bmatrix} p_q\, q(l_a^f + l_a^h)(\overline{A} - A^{ro}) + \\ (1-\alpha)\, p_q q^{ro}\left(l_a^c\right) A^{ro} + L_o(\omega_o - \tau_o) - l_a^h(\omega_a + \tau_a)(\overline{A} - A^{ro}); \\ T^C - l_a^f(\overline{A} - A^{ro}) - L_o \end{bmatrix}$$

The Kuhn-Tucker first order conditions are as follows:

$$1.1)\ \frac{\partial U}{\partial Y} p_q \frac{\partial q}{\partial l_a}(\overline{A} - A^{ro}) - \frac{\partial U}{\partial L_e}(\overline{A} - A^{ro}) \le 0 \perp\ l_a^f \ge 0$$

$$1.2)\ \frac{\partial U}{\partial Y}\left[p_q \frac{\partial q}{\partial l_a}(\overline{A} - A^{ro}) - (\omega_a + \tau_a)(\overline{A} - A^{ro}) \right] \le 0 \perp\ l_a^h \ge 0$$

$$1.3)\ \frac{\partial U}{\partial Y}\left[(1-\alpha)\, p_q q^{ro}\left(l_a^c\right) - p_q q(l_a^f + l_a^h) + l_a^h(\omega_a + \tau_a) \right] + l_a^f \frac{\partial U}{\partial L_e} \le 0 \perp\ A^{ro} \ge 0$$

$$1.4)\ \frac{\partial U}{\partial Y}(\omega_o - \tau_o) - \frac{\partial U}{\partial L_e} \le 0 \perp\ L_o \ge 0$$

Rearranging equations 1.1 to 1.4 with an interior solution, we obtain:

$$1a)\ \omega_o - \tau_o = \omega^{*C} = \frac{\partial U^C / \partial L_e}{\partial U^C / \partial Y^C} = \omega_a + \tau_a = p_q \frac{\partial q}{\partial l_a} = \frac{p_q q(l_a^f + l_a^h) - (1-\alpha) p_q q^{ro}\left(l_a^c\right) - (\omega_a + \tau_a) l_a^h}{l_a^f}$$

where ω^{*C} denotes the price of labor for the high-caste household. The result shows that a high-caste household hires labor to the point where the marginal cost of hired labor is equal to the marginal opportunity cost of family time. It implies that a household that has better access to off-farm employment may divert its labor to the off-farm sector; given that the wage rate in off-farm employment is higher and hires agricultural labor at a lower wage in the agricultural labor market. Transaction costs in relation to participation in the two labor markets determine whether and to what extent such households both hire out and hire in labor at the same time and/or rent out land instead of hiring in labor.

However, there are the following two special cases that create corner solutions.

i) The household participates in agricultural labor market (i.e., $l_a^h > 0$) but not in the land rental market (i.e., $A^{ro} = 0$). Under this case, we obtain the following from the interior solutions of the Kuhn-Tucker first order conditions,

$$\omega_o - \tau_o = \omega^{*C} = \frac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega_a + \tau_a = p_q \frac{\partial q}{\partial l_a}$$

This implies that high-caste households hire labor up to the point where the marginal cost of hired labor is equal to the marginal opportunity cost of family time off-farm and balances with the preferences for leisure and income, and the marginal return to labor in agriculture for own and hired labor. This shows how the adjustment takes place between family labor and hired labor in farming, off-farm engagement and leisure time.

ii) The household participates in the land rental market (i.e., $A^{ro} > 0$) but not in the agricultural labor market (i.e., $l_a^h = 0$). In this case, we obtain the following

$$\frac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega^{*C} = \omega_o - \tau_o = p_q \frac{\partial q}{\partial l_a^f} = p_q \frac{q\left(l_a^f\right)}{l_a^f} - (1-\alpha) p_q \frac{q^{ro}\left(l_a^c\right)}{l_a^f}$$

The result shows that a household allocates its family labor to the farm and off-farm up to the point where the cost of labor is equal to the marginal value product of labor in agriculture and off-farm, taking into account the preferences for leisure. This formulation allows for Marshallian inefficiency.

2.2 For low-caste households (c)

Low-caste households can rent in land and hire out its unskilled labor as agricultural worker. So, the total income is given by the summation of value of agricultural output in its own land, value of its share of output in rented-in land, and the earnings from the agricultural wage labor. The household allocates the time for own farming, working in the rented-in land,

working as agricultural labor to other households, and the leisure. Therefore, the utility maximization problem of the low-caste household can be expressed as:

$$2)\ \underset{\{l_a^f, l_a^{ri}, L_g, A^{ri}\}}{Max} U^c = U(Y, L_e) \quad \text{subject to}$$

$$Y^c = p_q\, q(l_a^f)\,\overline{A} + \alpha p_q\, q^{ri}(l_a^{ri})A^{ri} + L_g(\omega_a - \upsilon_a) \text{ and}$$

$$T^c = l_a^f\,\overline{A} + l_a^{ri}A^{ri} + L_g + L_e$$

Hence, the Kuhn-Tucker first order conditions are:

$$2.1)\ p_q \frac{\partial q}{\partial l_a^f}\overline{A}\frac{\partial U}{\partial Y} - \overline{A}\frac{\partial U}{\partial L_e} \le 0 \perp l_a^f \ge 0$$

$$2.2)\ \alpha p_q \frac{\partial q^{ri}}{\partial l_a^{ri}}\overline{A}\frac{\partial U}{\partial Y} - \overline{A}\frac{\partial U}{\partial L_e} \le 0 \perp l_a^{ri} \ge 0$$

$$2.3)\ (\omega_a - \upsilon_a)\frac{\partial U}{\partial Y} - \frac{\partial U}{\partial L_e} \le 0 \perp L_g \ge 0$$

$$2.4)\ \alpha p_q\, q^{ri}(l_a^{ri})\frac{\partial U}{\partial Y} - l_a^{ri}\frac{\partial U}{\partial L_e} \le 0 \perp A^{ri} \ge 0$$

Rearranging equations 2.1 to 2.4 with an interior solution, we get:

$$2a)\quad \omega^{*c} = \frac{\partial U^c/\partial L_e}{\partial U^c/\partial Y^c} = p_q\frac{\partial q}{\partial l_a^f} = \omega_a - \upsilon_a = \alpha p_q\frac{\partial q^{ri}}{\partial l_a^{ri}} = \alpha p_q\frac{q\left(l_a^{ri}\right)}{l_a^{ri}}$$

where ω^{*c} represents the net price of labor for low-caste households. Equation (2a) implies that a household will allocate its labor off-farm (here, we mean hiring out of agricultural labor/unskilled labor supply by low-caste households to high-caste households) up to the point where the marginal return to labor on farm reaches to this low-caste net wage. Equation (2a) implies that low-caste households have unrestricted access to land and allocate labor to rented land up to the point where its net opportunity cost of labor in the labor market is equal to the marginal value product of its share in output from rented in land. This has been referred to as the case of Marshallian inefficiency. However, the lower wage rate of low-caste households pulls up land productivity as they have incentives to work harder than high-caste households.

There are the following two special cases that create corner solutions.

a) The household participates in agricultural labor market (i.e., $L_g > 0$) but not in the land rental market (i.e., $A^{ri} = 0$). Under this case, we obtain the following:

$$\omega^{*c} = \frac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega_a - \upsilon_a = p_q \frac{\partial q}{\partial l_a^f}$$

The results imply that the household will allocate its labor off-farm (here it implies hiring out agricultural labor) up to the point that the marginal return to labor on farm falls to this low-caste net wage.

b) The household participates in the land rental market (i.e., $A^{ri} > 0$) but not in the agricultural labor market (i.e., $L_g = 0$). In this case, we obtain the following:

$$\frac{\partial U/\partial L_e}{\partial U/\partial Y} = \omega^{*c} = p_q \frac{\partial q}{\partial l_a^f} = \alpha p_q \frac{\partial q^{ri}}{\partial l_a^{ri}} = \alpha p_q \frac{q^{ri}\left(l_a^{ri}\right)}{l_a^{ri}}$$

This implies that the low-caste household applies labor on own and rented in land till the marginal returns to its labor are the same on the two types of land. When there is unrestricted access to land to rent in, the amount of land rented in adjusts to the point where average return to the household per unit labor on rented in land is equal to its marginal return to labor on the land. This implies that low-caste (tenant) households have higher land productivity on their own land than on rented-in land. This is the standard Marshallian inefficiency result (Marshall, 1920) which has been widely debated and tested (Shaban, 1987; Otsuka and Hayami, 1988; Otsuka et al., 1992; Otsuka, 2007).

From models presented so far, we observe that the net wage for low-caste household is less than the net wage for high-caste households: $\omega^{*C} > \omega^{*c}$ when $\tau_a > 0$ and/or $\upsilon_a > 0$. Using the

results of these models, we can derive the following productivity related implications. Rearranging equation (1a) we obtain:

$$3)\quad q(l_a^f + l_a^h) - q^{ro}\left(l_a^c\right) = \frac{\partial q}{\partial l_a}(l_a^f + l_a^h) - \alpha q^{ro}\left(l_a^c\right)$$

Combining the high-caste and low-caste models (matched households), we get $q^{ro}\left(l_a^c\right) = q^{ri}\left(l_a^{ri}\right)$. Therefore, equation 3 can be expressed in terms of the opportunity cost of labor for high-caste and low-caste households. In order to do this, we rearrange equation (2a) as follows:

$$4)\ \omega^{*c} = \alpha p_q \frac{q\left(l_a^{ri}\right)}{l_a^{ri}} \Rightarrow \alpha q\left(l_a^{ri}\right) = \frac{\omega^{*c}}{p_q} l_a^{ri}$$

Substituting equation (4) into equation (3) we obtain:

$$5)\ q(l_a^f + l_a^h) - q^{ro}\left(l_a^c\right) = \frac{\omega^{*C}}{p_q} l_a - \frac{\omega^{*c}}{p_q} l_a^{ri} = \frac{(\omega_o - \tau_o)}{p_q} l_a - \frac{(\omega_a - \upsilon_a)}{p_q} l_a^{ri} = \frac{(\omega_a + \tau_a)}{p_q} l_a - \frac{(\omega_a - \upsilon_a)}{p_q} l_a^{ri}$$

Equation 5 shows the productivity difference between owner-operated land of high-caste households and the rented in land of low-caste households (alternatively, this can also be interpreted as the rented out land of high-caste household). According to the equation 5, the productivity difference is explained by their relative opportunity costs multiplied by labor intensities per unit land in farming. This also exhibits that the transaction costs related to both farm and off-farm employment influence land productivity through the effects on opportunity costs of labor and labor intensity on owner-operated and rented land. Whether land productivity is lower or higher on owner-operated land of high-caste households than on their rented out land remains theoretically ambiguous; thereby, requires empirical testing. High transaction costs in the agricultural labor market pull in direction of low-caste households having higher land productivity on both their owned and rented in land while Marshallian inefficiency pulls in the direction that land productivity is higher on owner-operated land of

high-caste households than on their rented out land. Empirically we test the following hypotheses:

Test whether the initial assumptions of our theoretical models are correct:

H1: Low-caste households have lower land endowment, poor access to skilled off-farm employment, and are more likely to rent in additional land and work as agricultural laborers.

H2: High-caste households are more likely to rent out land and/or hire in agricultural labor to balance land and labor endowments.

H3: Sharecropping (the dominant land renting arrangement) is associated with Marshallian inefficiency.

Given that the above hypotheses are confirmed, the following theoretical implications are tested:

H4: Land productivity is higher on owner-operated land of low-caste households than on owner-operated land of high-caste households (due to high transaction costs in the labor market).

H5: Land productivity is higher on rented-in land of low-caste households than on owner-operated land of high-caste households (due to high transaction costs in the labor market that dominate over the Marshallian inefficiency effect on land productivity on rented land).

The hypotheses will first be assessed by a descriptive analysis of the survey data from the study area before they are further tested through non-parametric and parametric methods.

3. Study Area and Data

Data for this study was collected in 2003 from 500 households in the Mardi watershed area located in the western hills of Nepal. The data were collected both at the household level and at the farm plot level. This paper uses information from a subsample (see following tables) of a total sample of 489 households (data from the 11 households were not used due to

inconsistency) and a total of 1131 plots. The household level data covered a wide range of household characteristics such as household composition, consumption expenditure, income from different sources, sales and purchases, credit, and household preferences. The plot level data included the biophysical characteristics, trade information, inputs applied, and outputs. The settlements of the Mardi watershed are located 15-45 km from the district center, Pokhara. Hills and mountains higher than 1200 m are the major topographical features of this region (Thapa and Weber, 1995). This area lies in the highest rainfall region of Nepal. As in other parts of Nepal, monsoon season starts in early June and lasts until mid-September. Agriculture is the main economic activity in this area. The households practice traditional cropping systems for agricultural production. The most common crops in the valley are paddy and wheat while maize and millet are common in the terraced land. Farmers practice crop rotation systems, growing one to three crops per year. Livestock is a major component in farming as it is essential for traction power and manure.

Table 1 presents the basic characteristics of the sample households by caste.

Table 1 Major household characteristics variable by caste

Variables	High-caste	Low-caste	All sample	Test
Number of Households	382	107	489	-
Ownership holding (in hectare)	0.64	0.17	0.54	9.02***
Operational holding (in hectare)	0.62	0.34	0.56	5.93***
Male head dummy (%)	20	65	30	82.72***
Literate head (%)	35	19	31	10.40***
Standard labor unit	3.81	3.98	3.85	0.85
Standard consumer unit	4.93	5.2	4.99	1.09
Farm income (in Rs.)	32035	15312	28376	6.44***
Remittance income (in Rs.)	20127	3449	16478	4.42***
Total income (in Rs.)	72360	30929	63295	8.15***
Value of asset (in Rs.)	38581	15360	33500	8.22***
Agricultural wage employment (unskilled) (%)	12.3	69.8	24.9	7.16***
Non-agricultural wage employment (unskilled) (%)	34.2	25.6	32.3	3.78***
Regular salary jobs (at least one member) (%)	41.3	9.2	26.6	5.71***
At least one member earning pension (%)	26.7	5.6	22.1	3.96***

Notes:
1. Test shows the difference between high-caste and low-caste households; t-test is used for continuous variables and chi-square test for categorical variables.
2. Regular salary jobs include the jobs both in and outside the country

It is observed that average ownership land holding of high-caste households is more than three times as large as that of low-caste households. The operational land holding of low-caste households is almost double of their own land holding implying that land rental market has contributed to reducing the inequality in operational holding of land. The Gini-coefficient for the ownership land holding is 0.46 whereas it is 0.37 for the operational land holding. Furthermore, low-caste households are more likely to earn income as agricultural workers while high-caste households are more likely to have other forms of off-farm employment. Table 2 presents the combined picture of land rental and agricultural labor market participation for the sample households by caste. The categories marked in yellow are those that the theoretical models have attempted to capture.

Table 2 Land rental and agricultural labor market participation of sample households

	Land Rental Market											
	High-caste HHs						Low-caste HHs					
Agricultural	Landlord		Non-Participant		Tenant		Landlord		Non-participant		Tenant	
Labor market	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Net seller	0	0	21	5.5	22	5.7	4	3.7	37	34.6	48	44.9
Non-participant	48	12.6	50	13.1	13	3.4	2	1.9	8	7.5	5	4.7
Net buyer	28	7.3	171	44.8	29	7.6	0	0	3	2.8	0	0
Total	76	19.9	242	63.4	64	16.8	6	5.7	48	44.9	53	49.5

Table 2 shows that nearly 20 percent of the high-caste households are landlords while about 60 percent hire in agricultural labor and only about 7 percent rent out land as well as hire in labor. This implies that about 65 percent (high-caste households marked in yellow in Table 2) of the high-caste households fall in the three categories of households that we have modeled in the theory section that either hire in agricultural labor or rent out land or both, demonstrating the relevance of our theoretical framework. Likewise, about 50 percent of the low-caste households are tenants while 83 percent hire out agricultural labor. Nearly 84 percent of the low-caste households' fall within the three categories of households modeled

in our theoretical framework as either hiring out agricultural labor or renting in land or both, demonstrating that theory capture the dominant pattern in the study area. Based on the information in Table 1 and 2, hypotheses H1 and H2 cannot be rejected.

As the paper tries to examine whether land productivity is different between low-caste and high-caste households due to differences in opportunity costs of labor, Marshallian inefficiency, and transaction costs in the labor markets, we need to analyze the major characteristics of these households as defined in theoretical models (i.e., participate in agricultural labor market but not land rental market, participate in the land rental market but not in agricultural labor market, and participate in both markets). Table 3 presents the major characteristics of high-caste households classified on the basis of theoretical models.

Table 3 Major characteristics of high-caste households classified on the basis of theoretical models

Relevant variables	Renting in agricultural labor but no land market participation	Renting out land but no agricultural labor market participation	Renting out land and hiring in agricultural labor
Number of households	171	48	28
Owned land holding (in ha)	0.59 (0.04)	0.89 (0.07)	1.14 (0.12)
Operated land holding (in ha)	0.59 (0.04)	0.76 (0.06)	0.73 (0.09)
Standard labor unit/operated land holding	12.22 (1.14)	5.61 (0.55)	7.13 (1.11)
Standard labor unit/owned land holding	12.22 (1.14)	5.44 (0.69)	5.22 (1.15)
Male head (%)	0.27 (0.03)	0.21 (0.06)	0.21 (0.08)
Literate head (%)	0.37 (0.04)	0.42 (0.07)	0.421(0.089)
Age of HH head (in years)	48.5 (0.89)	51.2 (1.49)	49.8 (1.91)
Value of Asset (in Rs.)	41683 (2187)	50348 (2051)	70550 (6770)
Household participating in off-farm employment (%)	39	31	67
Average annual income from off-farm employment (in Rs.)	23761 (5230)	27693 (3427)	45321 (6132)
Land productivity (in Rs. per hectare) on owner-operated land (not rented out)	66142 (3146)	47096 (3010)	43550 (3601)

Note: Standard errors in parentheses

Table 3 shows that mean land productivity, value of output per hectare, on owner-operated land of high-caste households that rent in agricultural labor but do not rent out land is 66,142 Rs./ha while it is only 43,550 and 47,096 Rs./ha for high-caste households that rent out land and that do not hire or hire agricultural labor. It appears that the first group has significantly more family labor available on its farms and still hires additional labor that contributes to enhance labor productivity. Similarly, a significant difference can be seen in the ownership holding of land between the high-caste households that rent in agricultural labor but do not participate in the land rental market and the high-caste households that rent out land and hire in agricultural labor, also pointing in direction of more labor intensive production in the first group.

Table 4 shows the major characteristics of the low-caste households that are classified on the basis of the theoretical models as defined earlier in section 3.

Table 4 Major characteristics of low-caste households classified on the basis of theoretical models

Relevant variables	Hiring out agricultural labor but no land market participation	Renting in land but no agricultural labor market participation	Renting in land and hiring out agricultural labor
Number of households	37	5	48
Owned land holding (in ha)	0.21 (0.03)	0.10 (0.04)	0.11 (0.03)
Operated land holding (in ha)	0.21 (0.03)	0.66 (0.26)	0.37 (0.04)
Standard labor unit/operated land holding	28.27 (7.73)	24.70 (11.59)	14.52 (1.36)
Standard labor unit/owned land holding	28.27 (7.73)	86 (38.79)	43.18 (7.94)
Male head (%)	0.57 (0.08)	0.80 (0.20)	0.73 (0.07)
Literate head (%)	0.24 (0.07)	0.20 (0.20)	0.17 (0.05)
Age of HH head (in years)	49.9 (1.93)	50.8 (4.95)	46.96 (1.69)
Value of Asset (in Rs.)	15279 (1552)	25282 (7440)	13123 (916)
Average annual income from hiring out agricultural labor (in Rs)	9475 (1031)	0	8733 (1735)
Land productivity (in Rs per ha) on owner operated land	82065 (10075)	71601 (40551)	80527 (7644)
Land productivity (in Rs. per ha) on rented in land	-	68287 (10419)	76891 (3974)

Note: Standard errors in parentheses

There are no significant differences in land productivity between the low-caste households that hire out agricultural labor but do not participate in land rental market and the low-caste households that rent in land and hire out labor as well. There is also no significant difference in land productivity between owner-operated land and rented in land. This implies that there is no significant Marshallian inefficiency related to land renting by low-caste tenants.

4. Empirical Methods and Variable Specification

We applied both non-parametric and parametric techniques in the analyses. Stochastic dominance analysis (SDA) and propensity score (PS) matching are the non-parametric methods used in the empirical analysis.

4.1 Stochastic Dominance Analysis

Using SDA, we compared the total value of output distribution between high-caste and low-caste households based on cumulative distribution functions, CDFs. There are two criteria for comparing the stochastic dominance- first order stochastic dominance (FSD) criterion and second order stochastic dominance (SSD) criterion. Assume that *c(y)* and *C(y)* are cumulative distribution functions for low-caste and high-caste households respectively. Under FSD criterion, the distribution *c(y)* dominates *C(y)* if $C(y) - c(y) \geq 0$, $\forall_y \in \Re$, with strict inequality for some $y \in \Re$. It means the distribution with lower density function dominates the distribution with higher density function. In this case, *c(y)* dominates *C(y)* if the CDF of yield for high-caste *C(y)* is greater than the CDF of yields for low-caste *c(y)* for all level of yields (Mas-Colell et al., 1995). The FSD criterion fails to give a decision if the graphs of the CDFs intersect each other. Under such a situation, we call for second order stochastic dominance (SSD). The SSD criterion compares the area under the CDFs. The decision rule appears similar as in the case of FSD. The distribution with larger area under the CDF is dominated by the distribution with smaller area under the CDF. Hence, under SSD criterion, the

distribution *c(y)* dominates *C(y)* if $\int_{-\infty}^{y} \left(C(y)-c(y)\right)dy \geq 0,\ \forall_y \in \Re$, with strict inequality for some $y \in \Re$.

4.2 Propensity Score and Matching Methods

Most of the sample households have multiple plots and the quality of land may vary over plots. In order to control for plot quality differences, this study used the propensity score (PS) matching method and examined whether the data under study satisfied the balancing requirement and also invoked the common support requirement. Matching methods are used to estimate the average treatment effect based on PS.

The PS matching provides a method to correct the estimation of treatment effects by controlling for the existence of confounding factors (Becker and Ichino, 2002). The basic idea behind it is to reduce the bias that may occur while comparing the outcomes of treated and control groups. Matching subjects on an *n*-dimensional vector of characteristics is usually not viable as *n* becomes larger. To overcome this problem of dimensionality, the matching method therefore summarizes pre-treatment characteristics of each subject into a single index variable, the PS (Becker and Ichino, 2002). The PS is defined as the conditional probability of receiving a treatment given the pre-treatment characteristics (Rosenbaum and Rubin, 1983):

$$p(X) = \Pr\{D = 1 \mid \mathbf{X}\} = E\{D \mid \mathbf{X}\}$$

Where, $D = \{0,1\}$ is the indicator variable representing exposure to treatment and **X** is the multidimensional vector of pre-treatment characteristics. Given this, the average effect of treatment on the treated (*ATT*) is given by:

$$ATT = E\left\{E\left\{Y_{1i} \mid D_i = 1, p\left(X_i\right)\right\} - E\left\{Y_{0i} \mid D_i = 0, p\left(X_i\right)\right\} \mid D_i = 1\right\}$$

The basic logic is that for a given PS, the exposure to treatment is random and in general the treated and control groups should have identical observable characteristics. As PS can be estimated by using any standard probability model, we used the binary logit model in this paper. The estimate of PS should satisfy the balancing property and common support requirements to ensure that treated and untreated observations are comparable.

The following variables were used to construct the propensity score: three slope dummies (foot-hill, mid-hill, and steep-hill), four soil type dummies, two dummies for soil depth (swallow and medium), dummy for irrigation status of plot, and distance to plot from homestead. We estimated propensity score for three different cases: for rented in plots versus the owner-operated plots of low-caste households, for owner operated plots of high-caste versus low-caste, and for owner-operated plots of high-caste versus rented in plots of low-caste. The results of the propensity score are presented in Appendix 1. It can be seen that the balancing property was satisfied in all three estimations. However, while estimating propensity score for owner-operated plots of high-caste versus low-caste, we dropped irrigation dummy as an explanatory variable because the balancing property was not satisfied when we included it. For the same reason, we could not include irrigation dummy and distance to plot from homestead while estimating propensity score for rented in plots of low-caste households versus the owner-operated plots of high-caste households. The common support requirements were also invoked in all of these estimations.

4.3 Parametric Method

In order to test the robustness of the result obtained from non-parametric methods, we apply parametric methods for empirical analysis. As there are multiple farm plots per households, we were able to carry out panel data models. We applied random effects (RE) models because the variable caste is plot invariant and thus fixed effects (FE) models cannot be estimated that could otherwise have been used for controlling the intra-group correlation that

may arise due to unobserved cluster effects (Udry, 2000; Wooldridge, 2002). While estimating the RE model, only those sample plots were considered for analyses that satisfy common support obtained after estimating PS matching models. This provides a way to compare if the plot quality differences explain the land productivity differential. Hence, the models become:

$$Y_{ip} = \alpha + \beta_1 X_i + \beta_2 X_{ip}^{sq} + \beta_3 X_{ip}^{h} + \zeta S + \mu_i + \varepsilon_{ip} \quad \text{where } S = \begin{cases} 1 & \text{common support is satisfied} \\ 0 & \text{otherwise} \end{cases}$$

$$Y_{ip} = \alpha + \beta_1 X_i + \beta_2 X_{ip}^{sq} + \beta_3 X_{ip}^{h} + \gamma D + \zeta S + \mu_i + \varepsilon_{ip} \quad \text{where } D = \begin{cases} 1 & \text{low caste} \\ 0 & \text{otherwise} \end{cases}$$

Where Y_{ip} is the value of output obtained from plot *p* per unit of land for household *i*, X_i refers to farm size, X_{ip}^{sq} is a vector of observed plot characteristics, X_{ip}^{h} is vector of plot invariant farm household characteristics, μ_i is unobserved plot invariant household attributes and unobserved plot variant attributes, and ε_{ip} the error term. For the estimation, we assumed that μ_i is uncorrelated with X_{ip}^{h}.

4.4 Variable Specification

Productivity is measured as the total value of output of crops per unit of land. Land is measured in hectare. Output value is calculated by multiplying crop produce by average local producer prices. Same average prices for both seller and buyers of the agricultural outputs are used because all outputs in the study area are traded in the local market. Therefore, this study assumes low transaction costs in these output markets.

Following the theoretical framework of this study, we used a number of explanatory variables that can affect land productivity. Given that there are labor market imperfections, family labor endowment in the household is assumed to have effect on it. Therefore, we included the amount of adult male and female labor per unit of land in the analysis. As there are division of labor in farming such as transplanting of rice is done usually by female labor, ploughing is done usually by the male member of low-caste households, threshing of grains by using oxen

is also done by male members and so forth, we therefore included them separately. Another variable 'consumer-land ratio' (calculated as the ratio of standard consumer unit divided by ownership land holding) proxies the food needs per unit land of the household and is taken as a proxy for subsistence constraint.

5. Results and Discussion

As hypotheses H1 and H2 were tested in section 3, we now focus on the remaining hypotheses.

5.1 Land rental market imperfections and land productivity differences

Hypothesis H3 stated that sharecropping is associated with Marshallian inefficiency. We tested this by comparing the land productivity between the owner-operated and rented in land of low-caste households. Table 5 (part A) presents the results of propensity score matching.

Table 5 Results from propensity score matching methods

	Kernel Matching	Number of observations
A. Land Productivity (Marshallian inefficiency)		
Owner-operated plots of low-caste tenant households	79252	26
Rented in plots of low-caste tenant households	74482	62
Difference	4770	
Bootstrapped standard error	9818.5	
t-statistic	0.486	
B. Land Productivity		
Owner-operated plots of low-caste households	81834	99
Owner-operated plots of high-caste households	63783	639
Difference	18051	
Bootstrapped standard error	6601.9	
t-statistic	2.73***	
C. Land Productivity		
Rented in plots of low-caste households	77140	94
Owner-operated plots of high-caste households	63783	646
Difference	13410	
Bootstrapped standard error	4966.3	
t-statistic	2.71***	

Significance levels: *: 10% level, **: 5% level, ***:1% level

1. For Kernel matching, we reported the bootstrapped standard error with 500 replications. Though we also carried out Nearest Neighbor matching, we did not report the results here as they are very close to the results of Kernel matching.
2. In section B of the table, number of rented in plots is only 62 because we have not included those low-caste tenants who do not own land. This is done in order to compare land productivity on own land and rented in land and test for Marshallian inefficiency.

The results show no significant difference in land productivity between the owner-operated and rented in land of low-caste tenant households. Similar result is found with household random effects models (see Table 6). These findings indicate that hypothesis H3 can be rejected, implying that transaction costs in the labor market dominate over the disincentive effect of sharecropping and this is driving up the land productivity of low-caste tenants.

Table 6 Land productivity difference between own land and rented in land of low-caste tenants

	Linear relation		With plot characteristics		With plot and household characteristics	
Log of total value product/ha	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Tenure dummy (1=rented in)	-0.026	0.117	-0.115	0.127	-0.047	0.160
Plot size (in ha)			0.010	0.109	0.333	0.203
Village (Rivan)			0.421**	0.186	0.458***	0.178
Village (Lwang-Ghalel)			0.388**	0.183	0.443***	0.144
Distance to plot (in minutes)			0.056	0.058	0.062	0.060
Slope (foot-hill)			0.121	0.167	0.071	0.170
Slope (mid-hill)			-0.131	0.142	-0.072	0.174
Slope (steep-hill)			-0.173	0.128	-0.131	0.126
Soil type 2			-0.380**	0.170	-0.278	0.191
Soil type 3			-0.541***	0.146	-0.528***	0.145
Soil type 4			0.000	0.000	0.000	0.000
Soil type 5			-0.208	0.128	-0.120	0.141
Irrigation dummy (1=yes)			0.403	0.289	0.259	0.321
Soil depth (swallow)			0.046	0.110	0.062	0.100
Soil depth (medium)			0.017	0.124	0.037	0.144
Oxen holding/ha					-0.135	0.237
Value of asset/ha					0.125	0.082
Consumer-own land ratio					-0.006	0.023
Number of adult female/ha					0.208**	0.094
Number of adult male/ha					0.169***	0.051
Male head dummy (1)					0.205	0.208
Constant	11.16***	0.111	10.80***	0.355	9.56***	0.936
Number of observations	88		88		88	

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms

From Table 6, we can see that low-caste tenants in Rivan and Lwang-Ghalel villages have significantly higher land productivity as compared to those in Lahachok village (used as baseline village). This may be due to the fact that Lahachok village is relatively near to the market center, which offers better opportunities to engage in off-farm work even for low-

caste households and thereby increases the opportunity cost of labor. Household labor endowment, both male and female, is found to be significantly positively associated with land productivity, indicating more abundant labor and a lower opportunity cost of labor.

5.2 Labor market imperfections and land productivity differences

We tested hypothesis H4 that land productivity is higher on owner-operated land of low-caste households than on owner-operated land of high-caste households. Figure 1 presents the results of the stochastic dominance analysis. In Figure 1, the CDF of yield for low-caste households lies to the right of the CDF of yield for high-caste households, implying that the land productivity on owner-operated land of low-caste households is stochastically dominating that of high-caste households.

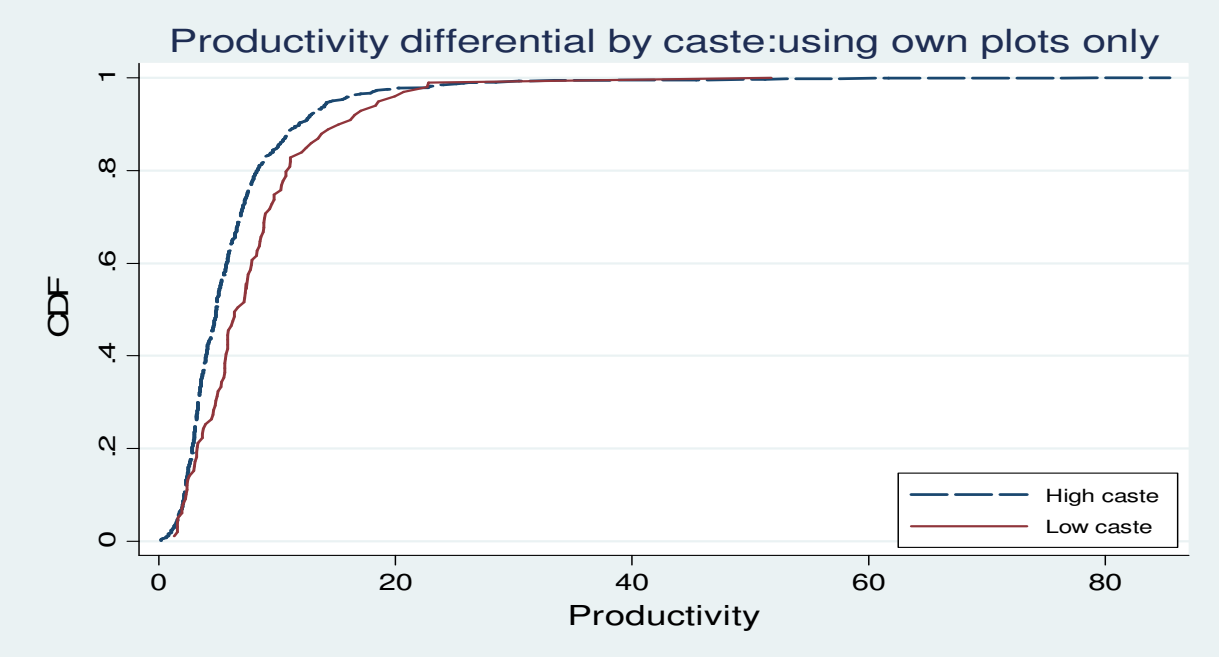

Figure 1: First order stochastic dominance analysis for owner operated plots of high-caste and low-caste households

The same is found with the propensity score matching method (see Table 5 part B). From Table 5 part B, we see that low-caste households produced an output equivalent to Rs. 81834 per hectare on their own land while high-caste households produced an output equivalent to Rs. 63783 per hectare on owner-operated land. Therefore, hypothesis H4 cannot be rejected,

indicating that there are significant transaction costs in the labor market, which prevents productivity equalization across these households. The same findings are obtained from the parametric methods presented in Table 7.

Table 7 Land productivity of low-caste and high-caste households on their owner-operated plots

	Linear relation		With plot characteristics		With plot and Household characteristics	
Log of total value product/ha	Coef.	S. E.	Coef.	S. E.	Coef.	S. E.
Caste dummy (1=Low-caste)	0.300***	0.081	0.153***	0.041	0.093***	0.025
Plot size (in ha)			-0.018	0.038	0.077	0.058
Village (Rivan)			0.043	0.082	0.107	0.079
Village (Lwang-Ghalel)			0.066	0.057	0.058	0.055
Distance to plot (in minutes)			-0.069***	0.026	-0.054**	0.025
Slope (foot-hill)			0.069	0.088	0.044	0.089
Slope (mid-hill)			-0.105*	0.062	-0.102*	0.061
Slope (steep-hill)			-0.174***	0.061	-0.162***	0.058
Soil type 2			-0.096	0.069	-0.078	0.067
Soil type 3			-0.072	0.085	-0.005	0.088
Soil type 4			-0.019	0.106	-0.018	0.097
Soil type 5			-0.025	0.064	0.003	0.063
Soil depth (swallow)			-0.640***	0.060	-0.636***	0.059
Soil depth (medium)			0.129*	0.077	0.110	0.073
Oxen holding/ha					0.006	0.024
Value of asset/ha					0.089**	0.041
Off-farm dummy(1=Has access)					0.019	0.059
Consumer-own land ratio					0.259***	0.039
Number of adult female/ha					0.028	0.051
Number of adult male/ha					0.125***	0.042
Male head dummy (1)					-0.020	0.070
Constant	10.812***	0.034	11.582***	0.116	10.201***	0.444
Number of observations	738		738		738	

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms

Table 7 shows that the land productivity differential between high-caste and low-caste households on owner-operated land was reduced from about 30 percent to about 15 percent when we control for land quality. This difference reduced to 9.3 percent when we controlled for land quality, household endowments and market access. This implies that we need to include additional controls in order to know the reasons why the mean productivity difference between high-caste and low-caste remained significant even after controlling for the market

access and endowment characteristics. One of the possible reasons is that our variables might not fully capture labor market access or land use intensity due to unobserved heterogeneity and possible endogeneity. The variable consumer-own land ratio was found to have significant positive association with land productivity implying that households with more family members to feed per unit own land used the land more intensively. Labor-rich households had higher land productivity and this is likely because they applied more labor due to their lower opportunity cost (of labor). Most of the high-caste households were engaged in off-farm activities, especially jobs outside the village. This enhanced their family labor scarcity per farm size as compared to low-caste households and this is likely to have affected their land productivity negatively.

Besides the availability of labor, the attitude towards farming may influence land productivity. High-caste people consider farming to be inferior work and do not want to work as farm labor if they get any other jobs. Still, working as a ploughman is considered as an impure job and high-caste people rarely perform it. This sort of segmentation of work by caste might have reduced the average land productivity of high-caste households. In addition, low-caste households migrate less because of discrimination against them in regular employment. As a result, they may concentrate their labor in farming, leading to higher land productivity.

5.3 Land rental and labor markets imperfections, and land productivity differences

Hypothesis H5 stated that land productivity is higher on rented in land of low-caste (tenant) households than on owner-operated land of high-caste households. Figure 2 shows the results of stochastic dominance analysis for the land productivity difference between owner-operated land of high-caste households and rented in land of low-caste households. In Figure 2, the CDF of output value per hectare for rented in plots of low-caste households stochastically dominates the owner-operated plots of high-caste households.

A similar result is found with matching methods in Table 5 part C, which shows that low-caste households produce an output equivalent to Rs. 77139 per hectare on their rented in land against Rs. 63783 per hectare on owner-operated land of high-caste households. This productivity difference is significant at 1 percent level. This difference implies that transaction costs in the labor market exceed the Marshallian inefficiency of sharecropping and we cannot reject hypothesis H5. This makes sense since hypothesis H3 had to be rejected (no significant Marshallian inefficiency on the rented in land of low-caste households).

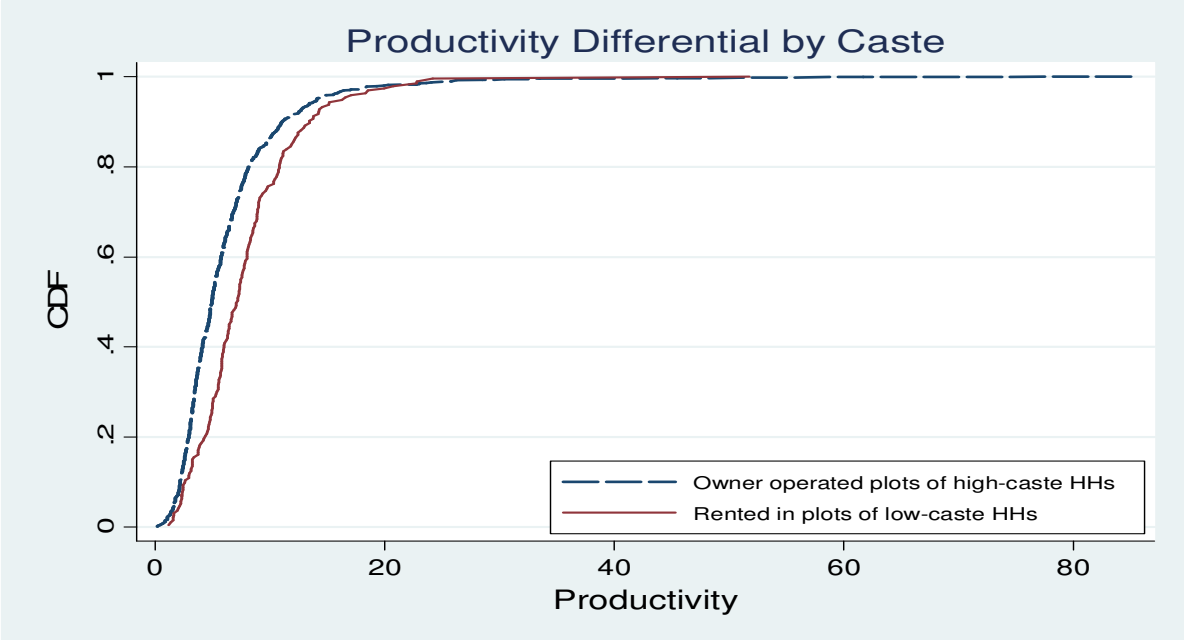

Figure 2: First order stochastic dominance analysis for owner operated plots of high-caste households and rented in plots of low caste households

The results of the random effect models are presented in Table 8. The land productivity differential is significant when we compare the owner-operated land of high-caste households with the rented in land of low-caste households. Even when we controlled for land quality, household endowments, and labor market access, the land productivity difference remains to be about 24 percent.

Households participating in off-farm employment are found to have significantly lower productivity as compared to those who do not participate in off-farm employment. The results show that households with more family labor per unit of land have higher land productivity.

Table 8 Land productivity difference between owner-operated plots of high-caste households and rented in plots of low-caste households

	Linear relation		With plot characteristics		With plot and Household characteristics	
Log of total value product/ha	Coef.	S. E.	Coef.	S. E.	Coef.	S. E.
Plot type/Caste dummy (1=Rented in/Low-caste)	0.358***	0.065	0.132**	0.066	0.237***	0.097
Plot size (in ha)			-0.002	0.037	0.077	0.059
Village (Rivan)			0.093	0.079	0.131*	0.076
Village (Lwang-Ghalel)			0.117**	0.058	0.125**	0.059
Slope (foot-hill)			0.134	0.090	0.129	0.089
Slope (mid-hill)			-0.110*	0.057	-0.114**	0.056
Slope (steep-hill)			-0.174***	0.056	-0.174***	0.055
Soil type 2			0.041	0.067	0.048	0.066
Soil type 3			-0.214***	0.079	-0.178**	0.081
Soil type 4			0.100	0.116	0.110	0.115
Soil type 5			-0.030	0.062	-0.020	0.062
Soil depth (swallow)			-0.599***	0.055	-0.593***	0.055
Soil depth (medium)			0.102	0.064	0.092	0.062
Oxen holding/ha					0.003	0.024
Value of asset/ha					0.051	0.042
Off-farm dummy(1=Has access)					-0.132***	0.047
Consumer-own land ratio					0.123***	0.024
Number of adult female/ha					0.129***	0.052
Number of adult male/ha					0.138***	0.042
Male head dummy (1)					-0.011	0.085
Constant	10.811***	0.034	11.274***	0.077	10.481***	0.433
N	740		740		740	

Significance levels: *: 10% level, **: 5% level, ***:1% level and all continuous variables are in logarithms

Notes:

1. The plot type/caste dummy has two alternatives: rented in plots of low-caste households (1) and owner operated plots of high-caste households (0).
2. Number of observations is reduced from 764 to 740 because we considered only those observations for which common support is satisfied while performing propensity score matching.

High productivity in rented-in land may be due to the fact that many of the low-caste tenants are very land-poor and thus, rely more on what they produce on rented in land for their subsistence. Poor tenant households may use the land more intensively to cope with the situation of extreme poverty (Pagiola and Holden, 2001). In a study of land lease market in

Ethiopia, Pender and Fafchamps (2006) argue that if transaction costs (related to monitoring and enforcement of tenant's use of inputs on the plot) is positive for landlord or if the monitoring cost is a decreasing function of the share of output received by tenant, tenant's yield on the rented land can be higher than landlord's yield on their land. There are therefore still omitted variables (unobserved heterogeneity) that may explain the significance of the tenancy/caste variable.

6. Conclusion

This paper assessed and looked for possible explanations for the land productivity differential between high-caste and low-caste farm households. Land and labor market imperfections are among the major explanations for this difference. Close to 60 percent of high-caste households hired in agricultural labor while about 20 percent rented out land. About 83 percent of low-caste households sold their labor in the agricultural labor market while about 50 percent rented in land. This indicates that adjustment of land and labor endowments were more common through the labor market than through the land rental market. However, the land rental market has improved the access to land for low-caste households as they were able to almost double their operational holding of land by participating in the land rental market. The key results of the analyses are: i) low-caste households have significantly higher land productivity on their owner-operated (28 percent higher) and sharecropped in (21 percent higher) land as compared to on owner-operated land of high-caste households, and ii) in the case of low-caste households, land productivity on their owned land and on sharecropped in land are not significantly different, implying no significant Marshallian inefficiency.

From the analyses, we come with three basic reasons behind the difference in land productivity between high-caste and low-caste households. Firstly, the agricultural production in the study area requires substantial amounts of human labor for operations such

as tilling land, managing land, applying manure and fertilizer, carrying inputs to plots, water management and harvesting. The technology is also such that labor-intensification is feasible. Hence, labor and land market imperfections cause low-caste households with relatively more family labor per unit of land to apply more labor to cultivate land intensively and achieve higher land productivity. Households with less endowment of family labor can hire in labor but it is difficult to monitor hired labor in spatially-dispersed agricultural environments, except perhaps for simple tasks such as ploughing. Hiring of labor is thus associated with search, monitoring and enforcement costs (Hayami and Otsuka, 1993) and this may explain the lower labor-intensity and land productivity of high-caste households despite their high rate of participation in the agricultural labor market. High transaction cost in the labor market is thus a possible explanation for land productivity difference between high-caste and low-caste households. The land rental market is not fully compensating for the labor market imperfections although Marshallian disincentive effects of sharecropping were not found to have a strong negative effect on land productivity on rented (sharecropped) land.

The other side of the coin of this productivity difference is the differences in opportunity cost of labor. Low-caste households have lower opportunity cost of labor due to discrimination in non-agricultural labor markets, especially in regular off-farm employment. Thus, they concentrate their labor in farming and in the seasonal agricultural labor market where they have an 'advantage' because high-caste households consider some of these works to be below their dignity. The less land endowment of low-caste households contributes to their labor supply in the agricultural labor market and low wage rates there. Furthermore, the persistence of the land productivity differential even after the participation in the land rental market indicates significant transaction costs in the land rental market (Holden et al., 2008). This is investigated in another paper by the authors (Aryal and Holden, 2010).

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Appendix 1

Table A.1
Estimations of propensity scores

	Owner-operated vs. rented in plots of low-caste Tenants (Case I)		Owner-operated plots of low-caste vs. owner-operated plots of high-caste (Case II)		Rented in plots of low-caste vs. owner-operated plots of high-caste (Case III)	
Dependent variables	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Slope (foot-hill)	-0.106	0.553	0.016	0.249	-0.137	0.258
Slope (mid-hill)	0.008	0.495	-0.102	0.196	-0.045	0.184
Slope (steep-hill)	-0.497	0.399	0.473***	0.163	0.049	0.173
Soil type 2	-0.274	0.387	0.796***	0.145	0.152	0.184
Soil type 3	1.645***	0.554	-0.154	0.355	1.348***	0.192
Soil type 4			-0.443	0.402	-0.759	0.498
Soil type 5	-0.100	0.549	-0.030	0.203	0.113	0.201
Soil depth (swallow)	-0.747*	0.386	-1.032***	0.154	-1.110***	0.153
Soil depth (medium)	-0.336	0.472	-0.075	0.226	-0.084	0.211
Distance to plot (minutes)	0.002	0.002	0.001	0.001		
Irrigated plot dummy (1)	-0.318	0.942				
Constant	0.825*	0.472	-0.881***	0.169	-0.703***	0.160
Number of observations	90.000		769.000		764.000	
Other Outputs						
Number of observations before invoking Common Support	90		769		764	
Number of Treated (1)	62		99		94	
Number of control (0)	28		670		670	
Balancing property	Satisfied		Satisfied		Satisfied	
Total number of observation after invoking Common Support	88		738		740	
Number of Treated (1)	62		99		94	
Number of control (0)	26		639		646	

Significance levels: *: 10% level, **: 5% level, ***:1% level
Note:
1. Dependent variable is different for each case. For case I, it is *tenuretype* (where 0 refers to owner-operated plot and 1 refers to rented in plot of low-caste households). For case II, it is *ownertype* (where 0 refers to owner-operated plots of high-caste households and 1 refers to owner-operated plots of low-caste households) and for case III, it is *ownhcrentlc* (where 0 refers to owner-operated plot of high-caste households and 1 refers to rented in plots of low-caste households).
2. In case II, irrigation dummy is not included because balancing property is not satisfied when it is included. For the same reason, distance to plot and irrigation dummy are not included in case III.