Land Sales and Rental Markets in Transition: Evidence from Rural Vietnam

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Abstract

Impact and desirability of land transfers in post-socialist transition economies have been subject to considerable debate. We use data from Vietnam to identify factors conducive to the development of land markets and to assess potentially differential impacts of rental and sales. Results show that both rental and sales transfer land to more productive producers but that rental is more important for the poor to access land that becomes available as the non-farm economy develops. The fact that secure land rights significantly increase supply of land to the rental market suggests that government has a key role in facilitating emergence and functioning of efficiency-enhancing land markets.

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1. Introduction

During the last decade, countries whose rural sector had been collectivized have made considerable, though uneven, progress towards establishing private property rights and restructuring of agricultural production. Even before the collapse of the Soviet Union and the large-scale, though uneven, move towards individual property rights that is described elsewhere (Csaki *et al.* 2004, Rozelle and Swinnen 2004), China has, in 1978, established the Household Responsibility System, leading to a large surge in agricultural production (Lin 1992, McMillan *et al.* 1989). Other Asian countries such as Vietnam, Laos, and Cambodia, have abandoned collectivization and moved towards formulation of new land laws. Problems associated with collective farming also led to the disappearance of collectives in Ethiopia, Mozambique, and Nicaragua, three countries that made the transition towards individual land rights in the 1990s (Nega 2002, Tanner 2002, Deininger *et al.* 2003b). This is similar to a strengthening of private land use rights adopted elsewhere, e.g. in the context of Mexico's 1992 Constitutional Reforms (World Bank 2002).

Although all of these reforms have improved individuals' authority to make decisions on land use, the extent to which land can be transferred, either through rentals or sales, still varies widely across countries. In fact, many countries continue to impose restrictions on households' ability to transfer land either through land rental or sale (Prosterman and Hanstad 1999) even though there is now increasing evidence that such restrictions are often either difficult to enforce (Andre 2002) or ineffective (Woodhouse 2003). One of the justifications for such restrictions is that liberalization of land sales markets can, in the absence of markets for insurance lead to distress sales or speculative land accumulation negative consequences on equity as well as efficiency (Platteau 1996, Manji 2003). At the same time, there is evidence suggesting that, in a post-transition context, explicit restrictions on land sales markets, high transaction taxes and registration fees in these markets, and biased access to public goods reduce opportunities for productive farmers to increase their income through market-based land acquisition (Csaki and Lerman 2002).

Given that conclusions from theoretical models are ambiguous and likely to be dependent on the specific conditions, empirical evidence would be particularly relevant, However, the available evidence to support such judgments is subject to two shortcomings. On the one hand, the distinction between land transfers through rental and sales is often not clearly drawn out even though, *a priori*, one would expect the two markets to respond quite differently to the market imperfections commonly encountered in rural areas of developing countries. Even though there is a growing consensus on the positive impact of land rental markets (Sadoulet *et al.* 2001, Deininger *et al.* 2003b), much less is known on the performance of sales markets and there are hardly any studies that compare the performance of rental and sales markets in the same environment, thus ensuring comparability. On the other hand, geographical coverage of existing

evidence, especially on the performance of land sales markets, is quite uneven. Most studies relating to land sales originate from Latin America, a continent that is characterized by high inequality in access to land, a long history of distortions in agricultural markets, a tradition of weak property rights, and often significant entry barriers into the rural non-farm sector (Reardon *et al.* 2001). This evidence e.g. from Chile (Echenique and Rolando 1991) and Honduras (Carter and Salgado 2001) seems to confirm that land sales markets do not necessarily increase efficiency although examples from Paraguay (Carter and Galeano 1995) and Guatemala (Barham *et al.* 1995) imply that under some circumstances well-functioning land sales markets may also transfer land to more productive producers. Further empirical evidence regarding the factors underlying the performance of land sales and rental markets as well as their impact, especially for transition countries, would therefore be of considerable interest. Such analysis would have to explore the extent to which markets contribute to equity, i.e. provide land access to the poor and contribute to greater efficiency, and whether there are potential trade-offs between these goals.

In this paper, we address this issue by providing evidence on the functioning of land rental and sales markets separately and by using a measure of households' productive efficiency for the case of Vietnam, one of the few transition countries where, even though land ownership remains with the state, short term rentals and permanent transfers of use rights are both allowed. Conceptually, and in line with the literature, we assume that land markets are driven by three factors, households' agricultural ability which is unobserved; labor market imperfections in the form of supervision constraints; and capital market imperfections (Deininger and Jin 2004). Empirically, a large and nationally representative panel data set is used to illustrate the evolution of markets over time and derive a proper measure of producers' ability that can be used to make inferences on the productivity impact of land markets.

The paper is structured as follows: Section two provides background on Vietnamese land policy, the conceptual framework and the econometric approach. Section three describes the data used and reports summary statistics on socio-economic characteristics and land market participation by sample households. Section four discusses the econometric evidence on demand and supply of land in sales and rental markets, respectively. Section five concludes with a number of implications for policy.

2. Background and conceptual framework

We set the scene by describing recent land policy initiatives in Vietnam and then presenting the conceptual model and the estimation strategy underlying our empirical analysis, based on a general discussion of land and other factor markets in developing countries. From 1981, Vietnam has embarked on a process of gradually strengthening individuals' transfer rights, allowing both rentals and sales. To

compare outcomes in rental and sales markets, we use farmers' (unobserved) ability, the level of off-farm development, and government policies as key determinants of the functioning of rental markets and discuss how initial wealth, incidence of shocks, and access to credit will affect outcomes observed in land sales markets, deriving a number of empirically testable hypotheses.

2.1 Land policy and broader economic environment in Vietnam

From 1981, Vietnam started to transform its rural sector from collectivized agricultural production to a system based on households initiative, a move that culminated in the passage of the 1988 Land Law (World Bank 2000). Studies have shown that this led to significant increases in overall rural productivity, although pre-existing differences between North and South were not eliminated (Pingali and Xuan 1992, Tran 1998). After 1988, further policy reforms were initiated to increase security of land use rights and to liberalize input and output markets. A new land law was enacted in July 1993 to address factors such as perceived threats from administrative reallocation, short duration of use rights, lack of transferability and an inability to use land as collateral, all of which were perceived to discourage investment and preclude further development of land markets. This law establishes the right to inherit, transfer, sell, lease or mortgage land use (though not ownership) rights and to receive compensation in case of expropriation. It also extended the duration of land use rights to 20 years for annual 50 years for perennial crops. All of these reforms together have greatly increased the transferability of land rights, providing a near-ideal case to compare in practice the functioning of sales and rental markets.

The literature suggests that the equitable allocation of individual land use rights after collectivization had considerable equity benefits (Ravallion and de Walle 2003) without negatively impacting productivity. Higher levels of issuance of land-use certificates to indicate more secure land rights have been found to be associated, at the community level, with higher levels in the share of total area devoted to perennials and some increase in irrigation investment (Do and Iyer 2002).[1] Partly as a consequence, Vietnam has achieved tremendous increases in output and transformed itself from a net importer of rice to the world's second largest exporter (Tran 1998) and increased its share in a number of key agricultural export markets, making it one of the fastest growing economies in the world during the 1990s. With a fairly egalitarian land distribution, such growth was translated into broad poverty reduction; the poverty headcount dropped from 58% in 1992-1993 to 37% in 1997-1998 (Phong and Glewwe 2002).

In the context of our investigation it is of particular interest to note how Vietnam's egalitarian pattern of land access and the rapid growth of the non-agricultural sector are likely to affect the operation of land markets. A relatively egalitarian distribution of land use rights is likely to reduce barriers to entry into

[1] Reform of property rights in both the rural and urban sector has been credited with a key role in overall growth, accounting for 2.6% of the overall growth rate, the biggest contribution among reform policies, and twice as big as the contribution of trade liberalization (Dollar 2002).

land markets and the costs of transferring land as compared to situations, e.g. in Latin America, where land ownership patterns are more skewed. Rapid non-agricultural development during the period under concern, together with a comparatively high tax on land, implies that the use of land for speculative investment would have to compete with a variety of other vehicles that are likely to yield higher pecuniary returns. In situations characterized by lower levels of economic growth, a less vibrant off-farm economy, and more limited incentives for bringing land into productive use, the attractiveness of speculative investment may be higher.

2.2 Land and other factor markets in rural areas of developing countries

To motivate the separate treatment of land sales and rental markets, we discuss the differences in endowments as well as ability that would encourage households to participate in such markets, the way in which market imperfections commonly observed in rural areas of developing countries would affect such participation decisions, and some of the empirical evidence available from the literature.

One key rationale for households to engage in markets for productive inputs, according to the literature, is the desire to adjust for differences in their existing endowments of land or, if a non-agricultural labor market exists, agricultural ability. In a purely agricultural economy with perfect information and complete markets, with zero transaction costs and constant returns to scale for agricultural production, land ownership alone does not have any implication for efficiency or equity. With one imperfectly marketable factor such as family labor, the ownership distribution of land ownership will affect households' welfare but will not matter for efficiency outcomes, as all producers will adjust to operate an "optimum" farm size through temporary transactions in land markets (Feder 1985). A number of studies have confirmed a negative farm-size productivity relationship for all but the smallest farm size classes (Berry and Cline 1979, Carter 1984, Newell *et al.* 1997, Kutcher and Scandizzo 1981, Burgess 2001), or have not been able to reject the hypothesis of constant returns to scale in agricultural production (Lanjouw 1999, Feder *et al.* 1992). In this case, labor market imperfections would tend to transfer land from large producers who would have to rely on wage labor to "poor but efficient" small producers whose family labor is not fully utilized by cultivating their endowment. Giving households the opportunity of engaging in non-agricultural employment will imply that differences in agricultural ability would have to be added as those with low levels of ability would tend to pursue off-farm jobs while those with higher levels of ability would aim to increase the amount of land cultivated (Carter and Yao 2002). The importance of development of the rural economy and the associated opportunities for off-farm employment, is supported by the high volume of land market activity in many developing as well as developed countries (de Janvry *et al.* 2001).

Risk and credit market imperfections can offset or even eliminate supervision cost advantages of family farmers or the impact of ability. For example, if there is a need for up-front working capital (e.g. to acquire inputs in addition to land and labor) and credit markets do not function well so that access to capital depends on initial wealth, the optimal size of the operational land holding would vary systematically with the size of land owned even if land rental markets were to operate perfectly. This can give rise to a positive relationship between farm size and productivity, as is indeed confirmed by studies from environments characterized by high risk (Kevane 1996, Dorward 1999, Bezemer 2004) or in regions and sectors where capital intensity is very high (Schumacher and Marsh 2003, Rezitis *et al.* 2003, Gorton and Davidova 2004). High risk, imperfect markets for credit and insurance, limited ability to use land as a collateral to obtain credit, and non-agricultural demand for land, may imply that agricultural sales markets could encourage speculative land accumulation that may not always be socially optimal. At the same time, even in situations where this is the case, informal exchange or formal land rental can do much to facilitate temporary land transfers that can significantly increase productive efficiency and equity. Temporary exchanges of land, possibly in on an informal basis, offer greater flexibility that makes them less affected by market imperfections than sales markets.

Indeed, available studies suggest that, in areas subject to high risk but with poorly developed capital markets, land sales will likely be few and limited mainly to distress sales. In India, distress sales have had a major impact on the evolution of the land ownership distribution (Kranton and Swamy 1999). Distress sales, often in response to health shocks (Cain 1981), continue to be a prevalent form of land transactions in backward areas (Bidinger *et al.* 1991, Sarap 1998); in fact farmers who experienced two consecutive droughts were 150% more likely than others to sell their land (Rosenzweig and Wolpin 1985). Even under favorable circumstances, reliance on land sales markets to overcome inequalities in asset ownership that are characteristic of many agrarian economies and to reduce the significant efficiency losses associated with these will be a long and arduous process (Carter and Zimmerman 2000). To the extent that land is valued as an asset, in addition to its use as an input into agricultural production, non-agricultural land demand, (tax and subsidy) policies, and macro-economic conditions can increase land values over and above the present value of profits from agricultural production for specific groups but not for others (Robison *et al.* 1985, Gunjal *et al.* 1996), making it more difficult for productive farmers to acquire land. If risk and subsistence constraints cause different agent's optimal portfolio strategies to diverge from each other, it may not be feasible at all (Zimmerman and Carter 2003)

By contrast, empirical evidence suggests that land rental markets are likely to have a more favorable impact on efficiency and equity. In China, where land sales are impossible, development of the off-farm sector has given rise to large differences in labor productivity across producers, implying that elimination of obstacles

to the functioning of land rental markets could help realize significant productivity improvements (Benjamin and Brandt 2002, Deininger and Jin 2004). Households who participate actively in off-farm markets may be more likely to supply land to the rental market (Kung 2002) and restrictions on land rental may well limit the scope for off-farm development in Ethiopia (Deininger *et al.* 2003a). A positive impact of land rental emerges also from other studies, leading us to expect that rental markets will be more able than sales markets to transfer land to poor but productive producers. However, while this would lead one to expect sales and rental markets to have quite different outcomes, few if any empirical studies are able to compare both of them directly.

2.3 Conceptual model

To formalize these ideas, we first consider land rental markets and then add some of the additional factors that have to be taken into account for land sales. The former builds on modeling strategies used for China's land transfer market (Carter and Yao 2002, Deininger and Jin 2004). Let household *i* be endowed with fixed amounts of labor ($\overline{L}_i$) and land ($\overline{A}_i$), and a given level of agricultural ability (α_i). Relative land scarcity makes cultivation based on hired labor undesirable and implies that additional labor is largely through informal exchange or to break seasonal bottlenecks (Binswanger *et al.* 1995), as is indeed consistent with survey evidence.[2] Households can allocate their labor endowment between farming their own land and off-farm employment at an exogenous wage (w_i). Renting out or in of land incurs transaction costs (T^{in} or T^{out}) which are assumed to be proportional to the amount of land transferred.[3] We also allow for the fact that the impacts of T^{in} and T^{out} are not symmetric. Following similar models in the literature (Carter and Yao 2002), we assume that households have the possibility of structuring rental contracts in a way that allows those lacking liquidity to defer rental payments until the harvest.[4] With this, household *i* will choose $l^{a}*$, l^{o*} as well as $A*$ by solving the maximization problem:

$$\underset{l^a, A}{Max}\; pa_i f(l_i^{\,a}, A_i) + wl_i^{\,o} - I^{in}(A_i - \overline{A}_i)(r + T^{in}) + I^{out}(\overline{A} - A_i)(r - T^{out}) \qquad \text{(P)}$$

[2] According to the 1998 data, only 27% of the sample reported any wage income during the preceding 12-month period, and of these only 9% (i.e. less than 3% of the sample) received wages from agricultural activities. Less than 1.1% of households devoted more than 30 weeks in total to agricultural labor during the 12 month period preceding the survey.

[3] The transaction costs include at least three elements the incidence of which differs between landlords and tenants. The first one, availability of information and ease of contract enforcement, is more akin likely to a fixed cost. The cost of negotiating a contract depends on the number of parties involved, something that is in turn likely to be affected by the land ownership structure - and would be the closer to a proportional cost, the more fragmented the latter. Finally, there is a risk of land loss either through breach of contract (such as failure by the tenant to vacate the land at the end of the contract period) or through other means (e.g. village-wide reallocations) which is clearly proportional to the amount of land transacted. This implies that, in the Vietnamese context (as distinct from, say Latin America), the assumption of proportional transaction cost seems more defensible than a fixed cost. Distinguishing between these two types of transaction cost empirically is difficult.

[4] This is consistent with the survey data which reveal that 70% of rent-out transactions are paid in kind, presumably after the harvest.

where p is the price of agricultural goods, l^o is the amount of time allocated to off-farm labor ($=\overline{L}_i - l_i^a$), I^{in} is an indicator for rent-in (=1 for rent-in, and 0 otherwise), similarly I^{out} is an indicator for rent-out (=1 for rent-out, and 0 otherwise), T^{in} and T^{out} are the transactions costs respectively associated with rent-in and rent-out, all other variables in (a) are as defined above. The optimal choices of l_i^{a*}, l_i^{o*} and A_i^* will solve the first order conditions (FOC) of problem (P), i.e.

$$p\alpha_i f_{l_i^a}(l_i^a, A_i) = w \qquad (1)$$

plus, for households who rent in, $$p\alpha_i f_{A_i}(l_i^a, A_i) = r + T^{in} \qquad (2a)$$

or for households who rent out, $$p\alpha_i f_{A_i}(l_i^a, A_i) = r - T^{out} \qquad (2b)$$

and for autarkic households, $$r - T^{out} < p\alpha_i f_{A_i}(l_i^a, A_i) < r + T^{in} \qquad (2c)$$

The first order conditions allow to derive three empirically testable propositions (see the appendix for a more detailed derivation) as follows:

Proposition 1. The amount of land rented in is strictly increasing in ability, α, and strictly decreasing in their land endowment $\overline{A}$. Rental markets will thus transfer land to "poor but efficient" producers.

Proposition 2. Transaction costs drive a wedge between those renting in and those renting out with any increase in T decreasing α_l and increasing α_u,[5] thereby expanding the range of producers who remain in autarky, reducing the number of households who participate in rental markets, as well as the amount of land transacted through rental markets. Reduction in transaction cost will therefore increase social welfare.

Proposition 3. Increases of the wage for off-farm employment will increase the amount of land transacted in rental markets and overall welfare. This will be associated with a decrease in the equilibrium rental rate and, in a risk-free environment, will make everybody better off.

We use an estimate of producers' agricultural ability to test proposition one. We also assume that experience with exchange of land use rights leads to a reduction in the transaction costs of transferring land among producers and approximate the risk of land loss by the share of villagers who have received long-term and more secure land rights -which reduces the risk of loss- as well as whether land has in the past been reallocated in the community, which increases it. While increases in transaction costs will

[5] We denote by α_l ()and α_u() the level of ability where households with given other characteristics switch from rent out land to autarky or from autarky to renting in land, respectively. In other words, households with $\alpha_i < \alpha_l$ will rent out land, those with $\alpha_i > \alpha_u$ rent in, and those with $\alpha_u > \alpha_i < \alpha_l$ stay autarky. We can solve for α_u, and α_l jointly with $\bar{l}_i^a$ from the FOCs : $\alpha_l = \dfrac{r - T}{pf_A(\bar{l}_i^a, \overline{A}_i)}$, $\alpha_u = \dfrac{r + T}{pf_A(\bar{l}_i^a, \overline{A}_i)}$.

unambiguously reduce the number of rental transactions, higher levels of tenure security are likely to be of greater importance for landlords who, with insecure tenure, run the risk of not getting land back that has been transferred to others, than for tenants. The local wage rate is approximated by the level of off-farm development at the village level as well as households' past employment in the non-farm sector.

For land sales markets, we follow the literature on inter-temporal asset accumulation which implies that household *i's* choice of consumption, land accumulation and saving each period together solve life time utility maximization:

$$\text{Max} \qquad V = E_t \sum_{k=0}^{T-t} (1+\delta)^{-k} U(c_{t+k}) \tag{3}$$

$$\text{Subject to} \qquad c_{t+k} + (\overline{A}_{t+k} - \overline{A}_{t+k-1}) p_{t+k} + (\overline{S}_{t+k} - \overline{S}_{t+k-1}) \leq Y_{t+k}(\overline{A}_{t+k}) \tag{3a}$$

$$\text{and} \qquad \overline{A}_{t+k} \geq 0 \tag{3b}$$

where $U(c_t)$ is one period utility function, c_t is the level of consumption, δ is the rate of time preference, $\overline{A}_t$ is amount of land owned in time t, $\overline{S}_t$ is amount of saving in time t, $Y_t(\overline{A}_t)$ is the amount of income household i generate in time t which itself is a function of the land household *i* owns in that period (assume household self-cultivates all the land endowment). (3b) is a form of borrowing constraints, restricting the end stock of tradable assets to be nonnegative in each period.

If income is stochastic, an analytical solution to this problem can not be derived (Zeldes 1989) and the literature has resorted to simulation to obtain solutions under general assumptions (Deaton 1991, Zeldes 1989, Rosenzweig and Wolpin 1993, Carter and Zimmerman 2000). We note that if land rights are secure and long-term rental as well as credit markets function well (allowing, in particular, the use of future rental income as a collateral), no land sales markets would be needed as all the outcomes from such markets could be brought about by long-term rentals. With secure land rights but credit market imperfections, the only reason to sell land would be as response to a shock that threatens to push consumption below the minimum needed for survival. We would therefore predict that land sales, as compared to rentals, would be undertaken only by households who experienced critical shocks and who are unable to borrow against their land because the financial infrastructure is incomplete. Purchase of land will, in such an environment, require higher levels of wealth or access to credit markets. Thus, whether or not a household experience shocks, as well as credit market access and initial wealth are thus variables that are unlikely to affect rental markets but would be predicted to have a significant impact on land sales and purchases.

2.4 Estimation strategy

To obtain an estimate of households' agricultural ability, we use the fact that we have a panel of households to estimate a production function with household fixed effects. Let technology be represented by the Cobb-Douglas production function

$$Q_{ijt} = \exp(\alpha_i + \alpha_j) A_{ijt}^{\theta_1} L_{ijt}^{\theta_2} K_{ijt}^{\theta_3} \qquad (4)$$

where Q_{ijt} is agricultural output produced by household i in village j in year t; A_{ijt}, L_{ijt} and K_{ijt} are the land, labor and capital used to produce this output Q, with technical coefficients θ_1, θ_2, and θ_3, and $exp(\alpha_i+\alpha_j)$, is the efficiency parameter which consists of a household-and a village-specific element reflecting access to infrastructure and markets, soil quality, climate, etc. Taking logs of both sides of equation (4), adding a time trend and an *iid* error term, and letting $\alpha_{ij} = \alpha_i + \alpha_j$, we obtain an estimable equation for production by household i in village j at time t as follows.

$$q_{ijt} = \alpha_{ij} + \theta_1 a_{ijt} + \theta_2 l_{ijt} + \theta_3 k_{ijt} + \phi t + \varepsilon_{ijt} \qquad (5)$$

where lower case letters refer to the logarithm of the quantities referred to above. Availability of multiple observations per household in the panel allows us to estimate this equation using household fixed effects.

$$q_{ijt} - \bar{q}_{ij} = \alpha_{ij} - \bar{\alpha}_{ij} + \theta(\mathbf{Z_{ijt}} - \bar{Z}_{ij}) + \phi(t - \bar{t}) + \varepsilon_{ijt} - \bar{\varepsilon}_{ij} \qquad (6)$$

where $\mathbf{Z}_{ijt}$ is a vector including a, l, k and θ is the corresponding coefficient vector to be estimated. In addition to irrigated and unirrigated land and household composition to proxy for labor use in the absence of information on detailed labor input into production activities, $\mathbf{Z}_{ijt}$ includes chemical fertilizer, organic manure, pesticides, and seeds as well as fixed capital, approximated by the value of all crop production assets, and a dummy indicating whether the household owned draft animals since the survey did not contain information on animal values. Since $\alpha_{ij} - \bar{\alpha}_{ij} = 0$, Equation (6) can then be simplified to:

$$q_{ijt} - \bar{q}_{ij} = \theta(\mathbf{Z_{ijt}} - \bar{Z}_{ij}) + \phi(t - \bar{t}) + \varepsilon_{ijt} - \bar{\varepsilon}_{ij} \qquad (7)$$

Equation (7) allows us to estimate all θs and ϕ in Equation (5). The estimated parameters in turn allows us to recover the composite efficiency parameter α_{ij} in Equation (5). As this variable still includes unobservable characteristics at the village level (e.g. infrastructure access), we use a similar procedure to estimate the production function using village fixed effect to obtain α_j, the subtraction of which from α_{ij} provides an estimate of α_i, the pure idiosyncratic term for each producer in the sample.

According to equations 2a-2c, a household's decision to enter land rental markets depends on his or her marginal productivity in autarky compared to the effective land rental, either the rental payment inclusive of transaction costs $r^{in}(T)$ for those renting in or the rental net of transaction costs $r^{out}(T)$ for those renting out. In addition to agricultural ability (α), the productivity impact of rental market participation will depend on the household's endowment of land (A), family labor (L), assets (K), and the off-farm opportunities (O) available locally. The transaction cost of market participation (T in equations 2a-2c) can be decomposed into tow parts, one related to the cost of acquiring information about potential partners and one related to tenure security. The former will affect potential landlords and tenants equally and is assumed to decrease in the level of local land market development. Lower levels of tenure security or a history of redistribution by local authorities, on the other hand, may disproportionately increase the risk of land loss for those renting out - either because tenants may fail to return the land or because renting sends a signal that land can be taken for redistribution (Yang 1997). We thus expect this variable to be more relevant for the decision to rent out.[6] Under these assumptions, the market participation regimes can be expressed as:

$$\left.\begin{array}{ll} \text{I. Rent - in regime:} & \text{f}'(\alpha, A, L, K, O) + \varepsilon_i > r^{in}(T) \\ \text{II. Autarky regime:} & \text{r}^{\text{out}}(\text{T}) < \text{f}'(\alpha, A, L, K, O) + \varepsilon_i < r^{in}(T) \\ \text{III. Rent - out regime:} & \text{f}'(\alpha, A, L, K, O) + \varepsilon_i < r^{out}(T) \end{array}\right\} \quad (8)$$

This switching regime model is estimated using ordered probit with upper and lower thresholds being function of tenure security and market development variables (Sadoulet *et al.* 1998). Transforming (8) into traditional ordered probit model notion, we have:

$$\left.\begin{array}{c} \text{pr(i rented in)} = \text{pr}\{\varepsilon_i > \text{r}^{\text{in}}(\text{T}) - \text{f}'(\alpha, A, L, K, O\}) \\ \text{pr(i stayed autarkic)} = \text{pr}\{\varepsilon_i > \text{r}^{\text{out}}(\text{T}) - \text{f}'(\alpha, A, L, K, O) \text{ and } \varepsilon_i < \text{r}^{\text{in}}(\text{T}) - \text{f}'(\alpha, A, L, K, O\} \\ \text{pr(i rented out)} = \text{pr}\{\varepsilon_i < \text{r}^{\text{out}}(T) - \text{f}'(\alpha, A, L, K, O)\} \end{array}\right\} \quad (9),$$

We assume that the functions $f'(\alpha,A,L,K,O)$, $r^{in}(T)$ and $r^{out}(T)$ are linear, allowing us to express them as:

$$f'(\alpha,A,L,K,O) = \beta_0 + \beta_1\alpha + \beta_2 A + \beta_3 L + \beta_4 K + \beta_5 O$$

$$r^{in}(T) = \delta_0 + \delta_1 S$$

$$r^{out}(T) = \eta_0 + \eta_1 S$$

respectively. The ordered probit model is then estimated by maximum likelihood. Given that differences in the way the data was collected make it difficult to compare total land owned between the two surveys,

[6] Note, however, that having had an administrative reallocation of land in the past would affect demand for land rental directly and, if this increases the probability of such a reallocation occurring again in the future, indirectly as well.

we estimate rental and sales market participation for the 1998 cross section only. In addition to α_i, the regression includes the household's total land endowment and share of irrigated land therein, and the labor endowment as represented by the number of family members between 14 and 60 years of age. The variable *O* is approximated by the years of previous experience in the non-farm labor market, ***K*** includes the value of the household's agricultural assets and whether it owns draft animals or not. Further control variables include household characteristics such as age, sex, the head's education, initial per capita expenditure as a measure of poverty. At the community level, we include dummies for whether in the village temporarily migration is common and whether agriculture constitutes the main source of income. The vector ***S*** in the threshold function includes two elements to measure tenure security and one for the transaction cost of land market participation. The former include the share of cultivated land in the village to which households have a long-term land certificate and whether the village had experienced any land redistribution in the 1993-97 period. The latter include the share of households in the village (excluding the household under concern) who participated in land rental or sales markets. To test the robustness of the results, different combinations of the elements of ***S*** are included in individual regressions.

According to proposition 1, land (rental) markets would transfer land to more productive producers with lower endowments (proposition one) leading us to expect $\beta_1 > 0$ and $\beta_2 < 0$. While a positive sign on the element of β_4 corresponding to agricultural assets would point towards imperfections in markets for these assets. Based on proposition three, we expect households whose past experience in off-farm labor markets reflects greater opportunities for such employment to be less likely to rent in and more likely to rent out and the level of rental market activity in general to increase with development of the off-farm economy in a community as measured by the share of income derived from non-agricultural sources, therefore, we expect β_5 to be negative and the coefficient on the share of village income from agriculture to be positive.

Regarding the thresholds, we would expect δ and η for to be negative and positive respectively, because either longer and more secure tenure land rights or better market development in the community could reduce the transaction cost, therefore reduce the effective rental payment for households who rented in and increase the effective rental received for households who rented out. Past reallocation could also serve as a means to reduce the scope for land transfers that would equalize endowments across households (Kung 2000). Note, however, that the impact of tenure security is expected to differ between landlords and tenants.

The equation to be estimated for participation in land sales markets is similar to the one for rental markets just described. The only difference is that the dependent variable now refers to participation in land sales market during the 5-year period preceding the survey and that a number of dependent variables (including

ownership of assets and draft animals and village level migration) refer to initial conditions rather than, as in the case of rental markets, contemporaneous ones.

3. Data sources and descriptive evidence

Before discussing econometric results, we highlight some salient features of Vietnam's rural economy by describing main sources and characteristics of the data, and presenting evidence on socio-economic characteristics as well as land market participation and changes in these variables over time. The data illustrate that high levels of recent economic growth in Vietnam have contributed to a considerable reduction of poverty and that as part of the socialist heritage inequality in income, as well as land endowments, is rather low. High economic growth and a strong rural non-farm economy are associated with a significant, though regionally differentiated, increase in land market activity.

3.1. Socio-economic characteristics

The data used in the analysis come from the 1992/93 and 1997/98 rounds of Vietnam's Living Standards Surveys (VLSS) which included 4,800 and 6,000 households, respectively. The survey was conducted by Vietnam's General Statistical Office and the sample stratified into 7 administrative areas which we group into four major regions. Our analysis focuses on the 2825 households included in the rural panel of the VLSS who were interviewed in both 1992/3 and 1998. Table 1 reports descriptive statistics for the whole country in 1993 and 1998 and the four main regions in 1998.[7] We note that the size of an average household ranged from 4 to 5 persons, about 3 in the 14 to 60 age category and 0.5 above 60, and the age of household heads about 44 in 1993. About 20% of households, ranging from 17% to 30% depending on the region, were headed by a female. Levels of formal education increased considerably, from 4 years in 1993 to 6.8 years in 1998.

Survey results point towards an average annual increase of per capita expenditure of 5.9% over the 1993-1998 period, from 1.69 Mn. Dong to 2.26 Mn. Dong in the cross section and from 1.30 Mn. Dong to 2.32 Mn. Dong for panel households, something that has been noted by others (van de Walle and Cratty 2004, Benjamin and Brandt 1998, Dollar 2002). Despite this increase, and a highly egalitarian distribution of per capita expenditure, which is characterized by a Gini coefficient of 0.26, the rural economy is still quite poor, with per capita income amounting to between US$153.46 (in the Northern Uplands) to US$ 245.45 (in the South).

[7] In the descriptive table and also for all the econometric regressions, we divide the 2825 households into 4 regions based on the original 7 administrative regions. Region 1 includes 546 households from the Northern Uplands administrative region. Region 2 includes 1326 households from Red River Delta and North Central. Region 3 includes the 298 households from original Central Coast region. Finally Region 4 includes the 655 households from Southeast region and Mekong River Delta region.

The rapid pace of off-farm development is illustrated by the marked increase in off-farm job opportunity and migration (table 1). While the share of household heads who had off-farm experience, defined as working off-farm for someone else or working on non-farm self-employment in the past year, and migration experience, defined as living somewhere else for more than 12 months for work related activities before the current year, increased from 8% in 1993 to 12% in 1998, and 11% in 1993 to 15% in 1998 respectively, the next generation seems to have benefited most from the increase in off-farm employment. The share of households who had at least one member with off-farm experience increased from 30% to 55% between the two periods and the incidence of migration by household members accelerated from 29% in 1993 to 64% in 1998. The level of migration also differs across regions, with only 56% of households having had at least one migrating member in the Red River Delta and North Central, as compared to 75% in the Southeast and Mekong Delta in 1998. However, the increase in the share of households who, since 1993, have had at least one member migrate was fairly uniform across the four regions, suggesting that the variation observed may be due more to pre-existing differences rather than a differential evolution and some regions being left behind. However, the high level of involvement in non-farm activities notwithstanding, agriculture and crop production remain the main sources of income for rural households even though their share has decreased from 83% to 78% or 70% to 66% for agricultural and crop income, respectively.

Against this background, households' endowments with crop land, as well as the scope for exchanging land endowments through formal and informal means, continue to be of great importance for households well-being. Per household land endowments remain small (on average 0.3 ha of annual and 0.06 ha of perennial crops per household and 0.089 ha of annual and 0.016 ha of perennial land per capita), although somewhat variable across regions.[8] Land endowments are largest in the South where the per capita endowment is more than 1 ha (0.85 ha of annuals and 0,23 ha of perennials) and smallest in the Red River Delta (0.26 ha of annuals and 0.02 ha of perennials). We also note that land was quite equitably distributed, with a Gini coefficient of per capita annual land endowments ranging between 0.34 to 0.37 except for Southeast & Mekong Delta where the Gini coefficient is 0.51 as compared to 0.26 for per capita expenditure. At the same time, we note that there was no significant increase in land inequality during the period under concern; in fact the national Gini coefficient for per capita land endowments is estimated to have declined slightly, from 0.53 to 0.50. We also note that, by 1998, 88% of households had obtained a document that would grant them long-term rights to land.[9]

[8] The increase in land endowments between 1993 and 1998 is due to questionnaire design. In 1993 information was collected only for a few categories of land and not always on a plot by plot basis. By contrast, in 1998, information was collected at the plot level and in a more systematic way, both for land planted to annuals and to perennials. This discrepancy, together with the low level of rental market activity, is one of the reasons for analyzing land market participation only for the 1998 cross section.

[9] Note that due to differences in the way land tenure status was disaggregated in 1993 as compared to 1998, it is not possible to obtain a comparable figure for 1993.

Table 1 also highlights the inter-regional variation in broad levels of development noted earlier. This variation is reflected in differences of overall asset endowments, computed as the sum of housing, enterprise, and non-land business assets. In line with what is observed in many developing countries, housing constitutes rural households' main asset while enterprise asset make up only between 6% and 13% of the total. Asset endowments are highest in the South. Our data also indicate that access to formal credit remains limited; while the share of producers reporting to have had access to such credit increased from 9% to 21% between 1993 and 1998, being above one third of the total in the South and Central Coast but relatively low in other regions.[10]

3.2 Land market participation

Information on households' land market participation comes from the agricultural module of the VLSS. This module was answered only by households who responded affirmatively to the question of whether they were involved in agricultural pursuits during the last 12 months.[11] While this captures households who are renting in land for agricultural cultivation, it implies that we do not have information on selling or renting out of land by households who have given up agriculture completely, e.g. by migrating to urban centers. As the standard advice in LSMS-type surveys is to include land transfer information in the agricultural module (Grosh 2000), this is an issue that affects any study of land market activity based on this type of survey, whether in Vietnam (Ravallion and van de Walle 2004) or elsewhere (Deininger *et al.* 2003b).[12] The magnitude and severity of a possible bias this introduced by such an omission will depend on the situation at hand, e.g. the incidence of absentee landlordism or permanent rural-urban migration. More precise inferences on the nature of the bias will be difficult without knowledge on these parameters (which may also change over time); however, a first indication of its magnitude can be obtained from the difference between reported renting in and out or selling and purchasing for certain regions. Although it is most easily justified from a purely methodological perspective, the "solution" of discarding all the information on renting out or selling of land is radical and would imply the loss of a large amount of valuable information (52 sales and about 120 rent-out transactions). To ensure, however, that the results from analysis of both sides of the markets are robust, we complement them with similar analysis for renting in and purchasing of land only which is not subject to the data problems mentioned earlier.

Descriptive evidence on land market participation in both periods as reported in Table 2 points towards a substantial increase in land transactions, together with considerable differences across regions. Rental

[10] Note that in the regressions reported below we use the share of households in a given village (excluding the household under concern) who have access to credit as the right hand side variable to avoid endogeneity.
[11] The precise wording of the question was "During the past 12 months has any member of your household managed agricultural or forestry land or participated in agricultural or forestry cultivation, or raised livestock or seafood on land managed or used by your household?".
[12] While it is common for households to understate the nature of their participation in land rental or sales markets in environments where such markets are prohibited the fact that no such prohibitions exist in Vietnam, together with the difficulty of explaining why households would be willing to reveal information on renting in or purchasing but not on renting out, suggests that this is unlikely to be a key factor in this case.

market participation more than quadrupled from 3.8% in 1993 to 15.8% in 1998. A significant share of rental transactions (1.7% in 1993 and 7.2% in 1998) does not involve a direct payment by the tenant to the land owner. However, in almost all instances where this is the case involved, the current user is responsible for payment of land taxes that can amount to 15-20% of net crop income, implying that access to the land is not really costless for the tenant and that the land owner receives a benefit as well. While, for the reasons discussed earlier, the share of households who rented out land is, with 0.8% in 1993 and 5.8% in 1998, lower than the share of those who rented in, these figures support the hypothesis of a large increase in rental market activity, in addition to pointing towards a narrowing of the discrepancy between the share of renting out and renting in, probably due to the fact that more of the land owners keep at least part of their lands.

The expansion of land sales transactions by households who remained in agriculture was even more pronounced, increasing from a mere 1% of producers who bought land in the 5-year period prior to the survey in 1993 to 7.2%, equivalent to an annual turnover of almost 1.5%, in 1998. Descriptive data point towards marked differences, both in overall participation and in the relative weight of different modalities of land transfer, across regions. Even though rental is quantitatively more important than sales everywhere, the share of producers who purchased land is high in the Northern Uplands and the South and Mekong Delta, whereas purchases are virtually non-existent in the Central Coast. Fixed rent is more important than share cropping but in all regions except the Central Coast and the South, where “free” informal transfers of land (where the renter only assumes the tax burden) are more important than cash rental. In view of these changes and regional differences in the incidence of land transfers, econometric analysis of the factors underlying these outcomes, as well as their likely impact, will be of great interest.

4. Econometric evidence

We report results from estimating the production function to derive households’ agricultural ability as well as the ordered probit for rental and sales market participation equations, complemented by similar regressions for renting in and purchasing land only to test robustness. We find that poorer households with higher level of productivity, greater endowments of family labor, and less connection to the non-farm economy, are more likely to use rental markets as an avenue to access land. Interestingly, it also appears that higher levels of tenure security, as proxied by the share of village land with long-term rights, increases supply of land to the rental market but does not affect demand while past redistribution mainly reduces demand. Even though land sales markets are less accessible to the poor than rental markets, they are still provide an avenue for transferring land to more productive producers.

4.1 Production function

Results from estimating the Cobb-Douglass production function are presented in appendix table 1. To allow us to recover household specific agricultural ability variable, the production function is estimated by panel fixed-effect approach (columns 1 and 2), although similar results were obtained using OLS (column 3). To deal with zero values, we include dummy variables for whether or not a certain input is used and then interact these with the logarithm of the quantity used as suggested in the literature (Battese 1997). The high values of the adjusted R^2 (which ranges between 0.72 and 0.85) indicate a good fit. Land is estimated to be by far is the most important input to crop production; doubling cultivated land area alone would lead to 60% increase in total crop production. Compared to this, returns to labor are moderate with an elasticity that ranges between 5.2% and 8.%.. As long as they are above a certain minimum level (20,000 Dong for seed, 33,000 Dong for fertilizer and 148 kg for organic manure),[13] conventional inputs all make a significant and positive contribution to output. It is worth noting that we are unable to reject the hypothesis that the technology exhibits constant returns to scale. Also, the positive and significant coefficient on a 1998 dummy points towards an improvement in productivity of 24-32% between the two years that is likely to be at least partly due to expansion of perennial area as noted above.

4.2 Land rental markets

Results from ordered probit estimation of the rental market participation equation are reported in table 3. The top panel displays estimated coefficients for the variables affecting marginal productivity of land use (the βs from section 2.4). The middle and lower panel report coefficients on the variables affecting the lower threshold (η) that defines the transition from renting in to autarky or the upper threshold (δ) for marking the transition from autarky to renting out. The only difference between columns 1 to 2 is in the variables that are assumed to affect transaction costs; while column (1) considers only tenure security, column (2) adds availability of land market information and past administrative reallocation of land at the village level as additional variables.

The positive and statistically significant coefficients of agricultural ability (row 1) indicates that, consistent with expectations, households with higher agricultural ability are more likely to join the rent-in regime and less likely to be found among those renting out. The magnitude of this impact is by no means insignificant; to illustrate, comparing the most and least efficient producers in the sample (α=2.16 and α=-3.00), respectively, one finds that the former has a more than 11% higher probability of renting in additional land or a less than 9% lower probability to rent out land than the latter. This suggests that, as expected, land rental markets indeed improve productivity of land use by transferring resources to those

[13] The mean levels of seed, fertilizer and manure (320,000 Dong, 788,000 Dong, and 1450 kg, respectively) are well beyond the point at which the marginal contribution of the input becomes positive.

producers who are able to make better use of them while at the same time allowing those whose comparative advantage is not in agriculture to join the non-agricultural sector where they may be able to obtain higher returns to their labor.

While the coefficient on the initial endowment with cultivable land is negative as expected, it is not significantly different from zero. At the same time, the significance of the number of working age individuals (aged 14-60) in the household suggests that rental markets transfer land to households who are more abundant in family labor and thus have a more limited per capita land endowment, thereby allowing land-scarce households to obtain additional productive resources. The hypothesis of a positive impact of land markets on equity, over and above the effect on efficiency noted earlier, is supported by the negative and significant coefficient on initial per capita expenditure. We also note that there is no bias of land rental markets against female-headed or less educated households as indicated by the insignificant coefficient on these variables.

A positive and significant coefficient on possession of draft animals as well as agricultural assets suggests that, even though rental markets tend to transfer land to poor households with lower land endowments, a minimum level of productive assets is likely to be a precondition for participation in these markets. A likely reason for this is presence of imperfections in markets for animals and other capital equipment for agricultural production that has also been used to explain sharecropping arrangements (Nabi 1985). We also note that rental markets tend to transfer land to producers in the most productive age; the tendency to rent in land increases, though only weakly, up to a maximum of 38 years. However, rental activity is higher rather than lower in villages that depend more heavily on agriculture, as proxied by a variable indicating whether agriculture constitutes the main income source in the community.

The negative coefficients for households with a head who held an off-farm job in the past (significant at 5% or 10% levels, respectively) suggest that off-farm opportunities function as an important driver of land market development. By increasing the probability that households will rent out land to others, such markets allow these staying back to increase their cultivated area over time, thereby allowing a mechanism for gradual increase of operational land holdings that would help transmit the benefits from higher wages in the non-farm sector to those remaining in rural areas. In fact, a household headed by somebody with an off-farm job in the past has a 2.4% lower probability of renting in land and a 2% higher probability of renting out. Past participation in the off-farm sector may be an indicator of better access to capital through a variety of channels; however the results suggest that households with better capital access tend to move into the non-agricultural sector. Returns from non-agricultural activities are generally much higher than what can be obtained from agricultural production. As off-farm employment will reduce the ability to devote full attention to agricultural pursuits, renting land out to others -rather

than accumulating it and working it through wage labor, is an economically rational strategy. Finally, we note that land rental markets are more active in villages that are more dependent on agriculture as compared to other income sources, consistent with the interpretation that productivity improvements will have a greater impact on overall living standards in these environs. There is little evidence of a systematic impact of the share of migration at the village level

Moving from the coefficients on determinants of productivity of land use to those on variables we expect to affect transaction costs (in the bottom panels) provides general support to our hypotheses and, in particular, points to significant differences in the impact of tenure security variables on the upper and lower thresholds of rental market participation, respectively. With respect to tenure security, we note that the coefficient on the share of land to which households in the village have long-term rights is estimated to not affect the lower threshold of rental market participation but to have a very significant negative impact on the upper threshold. In other words, while tenure security is of little relevance to potential tenants, greater land tenure security and the associated decrease in the probability of losing land that has been rented out, seems critical to persuade landlords to participate in land rental rather than stay in autarky. This underscores the need of a minimum level of tenure security as an institutional precondition for the emergence of rental markets and the associated productivity and equity benefits.

A second variable that will affect households' propensity to participate in market-based land transfers is the probability of a village-wide reallocation. If local authorities can interpret renting out as a signal that a household does not require all of its land some of which can therefore be taken away and redistributed to others, tenure security is reduced, discouraging renting out as discussed earlier. On the other hand, to the extent that redistribution is expected to equalize endowments across households, having had a reallocation of land in the past would reduce demand for land rental (Besley 1995, Carter and Yao 1999). This effect could be augmented if tenants had reason to believe that past redistribution is a good predictor of a similar event in the future and that participation in rental markets could result in them becoming ineligible for redistribution. Empirical results support the hypothesis that past land redistribution does have a more significant impact on demand than on supply of land; redistribution during the 1993 to 1997 period is estimated to shift the lower threshold to the left, thereby expanding the region where autarky is preferred.

Finally, our results also lend credence to the importance of informational constraints and other transaction costs (e.g. enforcement) as a significant barrier to rental market participation. As expected, the coefficient on the share of households in the village who participate in rental market is positive (negative) in the lower (upper) threshold functions, suggesting that, presumably due to lower transaction costs, the share of households who remain in autarky is much lower for villages where institutional preconditions for land markets are present, as compared to those where this is not the case.

Although it does not allow us to separate the impact of transaction cost variables on the upper and lower bounds of autarky, respectively, single equation probit and tobit models for renting in, which we perform as robustness checks (columns 1 and 3 of table 5), are consistent with the earlier results. They support a strong positive impact of agricultural ability on households' propensity to rent in land and also suggest that it is those with less land and a higher labor to land ratio who are more likely to demand land. Although only significant at 10%, the negative coefficient on initial per capita expenditure, together with the small coefficients on agricultural assets and ownership of draft animals, is consistent with the notion that rental markets provide opportunities to poor households with abundant family labor endowments. A negative (though insignificant) coefficient on past off-farm participation at the household level is in line with the notion that better access to capital and other opportunities does not prompt households to accumulate land but, to the contrary, makes it less likely for them to rent in. Apart from age, other household level variables are insignificant but, similar to the ordered probit, a higher share of village income from agriculture is estimated to increase the likelihood of land rental market participation (at 10% significance in the probit and slightly less in the tobit).

All this suggests that, in the case at hand, the loss of non-agricultural households who may rent out land does not significantly alter the results, but that use of information on those who supply land to the market provides an opportunity to obtain more precise estimates. This interpretation is supported by the positive but insignificant coefficient on the share of households having long-term use rights and the positive and very significant effect of the share of households, other than the one under consideration, in the village who participate in land rental.

4.3 Land sales markets

Regression results for households' participation in land sales markets, parallel to those for rental, are reported in table 4. The first result of interest is the positive coefficient on agricultural ability which suggests that, by providing access to land for more productive producers, land sales markets in Vietnam have, during the 5 years preceding the survey, helped improve productivity of land use. This is very similar to what had been observed for land rental markets and would imply that fears according to which the impact of capital market imperfections could actually outweigh productivity as a determinant of land sales market participation are not well-grounded in reality.

At the same time, the remainder of the coefficients points to a number of differences to the performance of rental markets which, taken together, suggest a more limited potential for land sales markets to contribute to poverty reduction. One indication for this are the insignificant coefficients on endowments of land and labor which suggest that, even though relatively land scarce producers were more likely to access land through rental markets, they are not likely to do so for sales markets. The negative coefficient

on female headship suggests that, even though they do not face difficulties in renting land, households headed by females are less likely to acquire land through sales. Finally, the lack of significance for the coefficient on initial expenditures points in the same direction and reinforces the view this their more limited poverty impact makes land sales markets a less important tool for poverty reduction (Deininger 2003).

The negative rather than positive (though insignificant) coefficient on past off-farm participation, suggests that, contrary to what was observed for rental, those who obtain non-agricultural employment will not automatically make land available to the market. Thus, while the positive and very significant coefficient on the village-level migration dummy points towards an activation of land sales markets with migration, it is less clear than in the case of rental markets that this will actually transfer more land to the poor. In fact, inclusion of a dummy variable for whether or not a household experienced an unexpected shock, in the form of a death of a household member during the 1993-98 period, (not reported) suggests that those who did are more likely to have sold land.

Concerning transaction cost variables we note that, while the level of activity in land sales and purchase markets (as a proxy for information and presence of relevant institutions) is significant, that is not the case for the two tenure security variables. Taken together with earlier results, this implies not only reduced scope for sales markets to improve equity but also for government to affect the operation of land sales markets through standard policy instruments that would enhance tenure security.

As in the case of land rental, we check the robustness of these results by probit and tobit equations for land purchases by agricultural producers only (columns 2 and 4 of table 5) which are not subject to the truncation problem that might affect land sales in the data at hand. Contrary to the broad confirmation of the results from the ordered probit in the case of land rental, the simple probit and tobit models point to somewhat different conclusions, in particular a slightly more pro-poor impact of land sales markets. This can be seen from the negative and significant coefficient on the land endowment, the negative (though insignificant) coefficient on initial per capita expenditure, and the inconsistent signs of he coefficient on past off-farm employment (positive in the probit and negative in the tobit). It suggests that, at least in the case of Vietnam, and possibly partly as a result of the rather egalitarian land distribution in this country, speculative land purchases seem less of an issue than in many of the cases reported in the literature. While our results support the hypothesis that some land sales may be due to exogenous shocks and that overall land sales are unlikely to be welfare-enhancing, this may be affected by the fact that the sample only includes those who remained in agriculture. More in-depth study of the supply of land to land sales markets is therefore a topic for further research.

5. Conclusion and policy implications

This study was motivated by the fact that, even though many transition countries have taken far-reaching measures to introduce individual land rights, explicit or implicit restrictions on the functioning of land markets also remain widespread. Such restrictions are often motivated by fears that unmitigated operation of land markets may negatively affect equity and possibly also efficiency -even though the applicable evidence as to these phenomena is rather limited. The empirical analysis for Vietnam presented here, building on a framework where ability, levels of local non-farm development, and security of land rights are important determinants for the operation of land markets, allows us to draw conclusions with respect to the commonalities and differences among sales and rental markets, as well as the impact of transaction costs on their operation, that are likely to be of interest to policy makers as well as researchers.

The unambiguously positive impact of land rental market on both equity and productive efficiency is in line with what has been found elsewhere in the literature (Teklu and Lemi 2004, Rozelle and Swinnen 2004). It illustrates that in transition economies where, because initial land endowments were distributed equally and irrespective of individual ability, the scope for making adjustments to increase allocative efficiency and household welfare is likely to be large. This scope for adjustments may be one of the reasons that, even though we find distinct differences between the operation of land rental and land sales markets, these differences are less dramatic or robust than one might have expected. In the case of Vietnam, both rental and sales markets tend to increase productivity of land use by transferring this factor of production to producers with higher levels of ability.

To better understand the dynamics of sales markets, it would be desirable to have more evidence on the reasons underlying land sales and their welfare impact. The indications in our data that uninsured shocks may be one reason for land sales suggest that effective safety nets may be one way to help reduce the incidence of and potential undesirable impacts of involuntary land sales. To the extent that this addresses one of the root causes of such transactions, it could be more effective than administrative restrictions that would only tend to push them underground. At the same time, while the evidence from Vietnam does not contradict the hypothesis that land markets are unlikely to provide an avenue for equalization of endowments in an environment where endowments are highly unequal, it points towards such markets having considerable potential in more post-transition environments with a more egalitarian land distribution. The importance of tenure security as a determinant of households' willingness to supply land to rental markets that emerges from our analysis suggests that, in such environments, measures to increase tenure security will be justified and required not only because of their potential impact on land-related investment but also to allow low-cost and efficiency-enhancing transfers. Ensuring these rights and at the same time providing access to other markets may be a more appropriate role for governments aiming to

foster growth and diversification in rural areas than costly -and in the end often futile- efforts to impose restrictions on the operation of land markets.

Table 1. Household characteristics in 1993 and 1998

	National 1993	National 1998	N Uplands	Red River Delta & North Center	Coastal Central	Southeast & Mekong Delta
Basic household characteristics						
Size of household	5.12	4.86	5.23	4.42	5.04	5.34
Members younger than 14 years	2.00	1.64	1.97	1.51	1.69	1.62
Member 14-60 years old	2.74	2.78	2.87	2.48	2.91	3.25
Members older than 60	0.38	0.43	0.39	0.43	0.45	0.47
Age of head	44.51	47.32	43.53	47.20	50.16	49.44
Education of head (years)	4.03	6.84	7.28	8.10	5.27	4.73
Female headed	20%	21%	17%	22%	30%	21%
Income and its composition						
Per capita expenditure (Mn Dong) 1993	1.69		1.39	1.61	1.80	2.08
Per capita expenditure (Mn Dong) 1998		2.26	1.77	2.29	2.28	2.58
Gini of per capita expenditure	0.263	0.258	0.234	0.251	0.244	0.256
Per capita income (Mn. Dong)	1.30	2.32	2.03	2.01	2.01	3.23
Share of income from agriculture	83%	78%	87%	75%	77%	77%
Share of income from crop production	70%	66%	70%	62%	62%	70%
Head with off-farm job experience	8%	12%	9%	14%	14%	8%
Head with migration experience 1998	11%	15%	13%	16%	18%	15%
Family with off-farm job experience	30%	55%	59%	48%	57%	64%
Family with migration experience 1998	29%	64%	66%	56%	67%	75%
Land endowment						
Area of annual land (m^2)	2983.16	4320.35	3801.10	2635.07	3522.40	8527.96
Area of perennial land (m^2)	600.24	780.28	548.95	212.31	475.06	2261.79
Land with long term use rights		88%	91%	84%	97%	91%
Share of landless	4%	2%	0%	3%	0%	2%
Gini of the per capita land distribution	0.534	0.499	0.343	0.373	0.376	0.515
Asset endowments						
Value of non-land assets (Mn. Dong)	10.63	30.35	25.23	31.27	24.73	35.33
Households w formal credit access 1993	9%		8%	10%	13%	8%
Households w formal credit access 1998		21%	10%	17%	35%	33%
No. of observations	2825	2825	546	1326	298	655

Source: Own computation from 1998 VLSS

[a] The average exchange rate between US dollar and Vietnamese Dong in 1997/1998 is US$ 1 = 13091 Vietnamese Dong

Table 2: Land market participation in 1993 and 1998

	National	N Uplands	Red River Delta & North Central	Coast Central	Southeast & Mekong Delta
			1993		
Rented in land	3.80%	7.20%	2.60%	1.30%	4.80%
Fixed rent	1.70%	2.40%	1.10%	0.30%	2.90%
Share cropping	0.40%	0.20%	0.50%	0.00%	0.80%
Free	1.70%	4.60%	1.00%	1.00%	1.10%
Bought land	1.00%	0.70%	0.50%	0.00%	2.90%
Rented out land	0.53%	0.20%	0.60%	0.30%	0.80%
Fixed rent	0.20%	0.20%	0.20%	0.00%	0.30%
Share cropping	0.03%	0.00%	0.00%	0.00%	0.20%
Free	0.30%	0.00%	0.40%	0.30%	0.30%
Sold land	0.30%	0.40%	0.00%	0.00%	1.10%
			1998		
Rented in land	15.80%	11.00%	22.70%	8.00%	9.40%
Fixed rent	6.20%	2.20%	7.90%	6.40%	6.10%
Share cropping	2.40%	2.00%	3.70%	0.30%	0.90%
Free	7.20%	6.80%	11.10%	1.30%	2.40%
Bought land	7.20%	9.50%	6.10%	0.70%	10.50%
Rented out land	4.10%	2.00%	5.30%	5.00%	3.70%
Fixed rent	1.20%	0.20%	1.40%	1.00%	2.10%
Share cropping	0.60%	0.20%	1.10%	0.00%	0.20%
Free	2.30%	1.60%	2.80%	4.00%	1.40%
Sold land	1.70%	2.00%	0.20%	0.00%	5.00%
No. of observations	2825	546	1326	298	655

Table 3. Determinants of land rental market participation (ordered probit)

	Specification	
	(1)	(2)
Agricultural ability	0.200**	0.200*
	(2.3)	(1.79)
Endowment of cultivable land (log)	-0.026	-0.042
	(1.22)	(1.40)
No. of members aged 14-60 years	0.085**	0.123**
	(2.38)	(2.54)
Value of agricultural assets (log)	0.031**	0.040***
	(2.47)	(2.55)
Draft animal dummy	0.174**	0.166**
	(2.38)	(1.97)
Per capita expenditures (1993)	-0.212**	-0.288**
	(2.35)	(2.44)
Head's age (log)	6.465**	10.045***
	(2.38)	(3.07)
Head's age squared	-0.886**	-1.369***
	(2.49)	(3.17)
Head's education (log)	-0.029	-0.021
	(0.360	(0.23)
Head's education squared	-0.001	-0.006
	(0.05)	(0.35)
Head with off-farm job in the past	-0.240**	-0.222*
	(2.16)	(1.71)
Female headed dummy	0.013	0.0004
	(0.15)	(0.01)
Share of households in village migrating out	-0.036	0.024
	(0.32)	(0.20)
Main income in village from agriculture	0.403***	0.445**
	(2.63)	(2.47)
Estimation for lower bound equation		
Share of households in village transfer land except the current one		2.163***
		(11.13)
Village experienced land reallocation in 1998		-0.425***
		(3.58)
Village land with long term use rights	-0.032	0.399
	(0.18)	(1.62)
Constant		
	2.053	-1.762
Estimation for upper bound equation		
Share of households in village transfer land except the current one		-2.989***
		(15.98)
Village experienced land reallocation in 1998		-0.127
		(1.11)
Village land with long term use rights	-0.297**	-0.659***
	(1.94)	(2.81)
Constant	5.669***	4.052
	(41.12)	(16.05)
Value of log-likelihood	-1047.46	-733.17
No. of observations	2825	2825

Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Region dummies are included but not reported.

Table 4. Determinants of land sales market participation (ordered probit)

	Specification	
	(1)	(2)
Agricultural ability	0.313***	0.306**
	(3.12)	(2.12)
Endowment of cultivable land (log)	-0.029	-0.051
	(1.19)	(1.51)
No. of members aged 14-60 years	0.037	0.019
	(0.93)	(0.31)
Value of agricultural assets (log)	0.047***	0.077***
	(3.22)	(3.89)
Draft animal	0.049	0.074
	(0.64)	(0.65)
Per capita expenditures (1993)	0.081	-0.108
	(0.86)	(0.83)
Head's age (log)	0.953	1.478
	(0.32)	(0.340
Head's age squared	-0.144	-0.199
	(0.38)	(0.35)
Head's education (log)	0.027	0.074
	(0.37)	(0.65)
Head's education squared	-0.006	-0.020
	(0.46)	(0.98)
Head with off-farm job in the past	0.039	0.134
	(0.39)	(1.12)
Female headed dummy	-0.177**	-0.247
	(2.19)	(1.63)
Share of households in village migrating out	0.313**	0.267
	(2.42)	(1.31)
Main income in village from agriculture	0.199**	0.038
	(1.99)	(0.12)
Estimation for lower bound equation		
		4.095***
Share of households in village transfer land except the current one		(10.15)
Village experienced land reallocation in 1998		0.036
		(0.15)
Village land with long term use rights	0.147	0.177
	(0.62)	(0.33)
Constant	9.326***	
	(51.79)	-1.716
Estimation for upper bound equation		
		-4.387***
Share of households in village transfer land except the current one		(18.62)
Village experienced land reallocation in 1998		-0.075
		(0.62)
Village land with long term use rights	-0.417***	-0.366
	(2.56)	(1.38)
Constant		4.388***
	13.457	(9.63)
Value of log-likelihood	-869.61	-427.47
No. of observations	2825	2825

Robust z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Region dummies are included but not reported.

Table 5. Probit and tobit results for renting in of land and land purchases

	Probit Model: Market participation		Tobit Model Amount of land transacted	
	Land Rent-in	Land purchase	Rented in	Purchased
Agricultural ability	0.017***	0.009	12.420**	16.619*
	(3.11)	(1.68)	(2.28)	(1.81)
Endowment of cultivable land (log)	-0.003***	-0.005***	-3.469***	-4.587***
	(3.10)	(4.34)	(4.04)	(3.29)
No. of members aged 14-60 years	0.004*	0.003	4.506**	5.596
	(1.74)	(1.07)	(2.13)	(1.52)
Value of agricultural assets (log)	0.002**	0.004***	1.700**	6.779***
	(2.14)	(4.24)	(2.19)	(4.65)
Draft animal	0.009*	0.005	6.916*	-0.410
	(1.91)	(0.77)	(1.69)	(0.05)
Per capita expenditures (1993)	-0.010*	-0.002	-7.078	-1.341
	(1.76)	(0.27)	(1.28)	(0.15)
Head's age (log)	0.514**	0.098	395.603**	-289.350
	(2.54)	(0.41)	(2.03)	(0.97)
Head's age squared	-0.068**	-0.014	-53.071**	35.772
	(2.56)	(0.43)	(2.07)	(0.91)
Head's education (log)	0.000	0.009	0.301	9.409
	(0.05)	(1.18)	(0.06)	(0.96)
Head's education squared	-0.000	-0.002	-0.236	-1.661
	(0.29)	(1.39)	(0.30)	(1.03)
Head with off-farm job in the past	-0.004	0.002	-5.018	-3.808
	(0.65)	(0.29)	(0.85)	(0.37)
Female headed dummy	0.002	-0.009	0.859	-12.803
	(0.37)	(1.28)	(0.18)	(1.25)
Village with common temporary migration	0.008	-0.005	8.134	-4.576
	(1.34)	(0.58)	(1.08)	(0.38)
Main income in village from agriculture	0.016*	0.012	30.412	10.990
	(1.78)	(0.94)	(1.60)	(0.40)
Village land with long term use rights	0.012	0.007	14.085	6.443
	(1.19)	(0.64)	(1.57)	(0.43)
Village experienced land reallocation in 1998	0.004	0.007	0.230	9.578
	(0.81)	(1.20)	(0.05)	(1.19)
Households renting in	0.130***		110.148***	
	(15.41)		(11.74)	
Households purchasing land		0.185***		205.389***
		(17.97)		(14.23)
Constant			-829.768**	404.631
			(2.22)	(0.71)
No. of observations	2825	2825	2825	2825
Pseudo R^2	0.37	0.51	0.16	0.19
Log likelihood	-416.61	-344.33	-1069.32	-1294.81

Robust z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Note: The share of households renting in or purchasing land excludes the one under concern. Regional dummies included but not reported.

Appendix Table 1: Results from production function estimation

	Household fixed effect	Village fixed effect	Pooled OLS
Total crop area (log)	0.626***	0.624***	0.568***
	(41.26)	(58.74)	(60.08)
Number of laborers (14-60 age)	0.084***	0.054***	0.052***
	(3.28)	(4.23)	(3.85)
Total seed application (log)	0.125***	0.129***	0.152***
	(10.24)	(14.37)	(17.46)
Total fertilizer use (log)	0.143***	0.176***	0.192***
	(11.40)	(19.10)	(21.23)
Total organic manure use (log)	0.054***	0.033***	0.019***
	(5.59)	(4.89)	(2.77)
Total pesticide use (log)	-0.008	0.010	0.041***
	(0.84)	(1.41)	(6.11)
Non-land agricultural assets (log)	0.009	0.025***	0.010**
	(1.25)	(5.15)	(2.03)
Head's age	-0.056	-0.013	-0.018
	(1.39)	(0.82)	(1.04)
Share of total crop area irrigated	0.087***	0.053***	0.202***
	(4.14)	(2.98)	(13.78)
Dummy for seed used	-0.351***	-0.456***	-0.553***
	(5.25)	(9.25)	(10.93)
Dummy for fertilizer used	-0.500***	-0.600***	-0.721***
	(6.49)	(11.10)	(13.23)
Dummy for manure use	-0.252***	-0.110**	-0.036
	(3.71)	(2.29)	(0.74)
Dummy for pesticide used	0.024	-0.049*	-0.083***
	(0.61)	(1.69)	(2.86)
Dummy for agricultural asset ownership	-0.037	-0.086***	-0.018
	(0.90)	(2.97)	(0.60)
Dummy for growing industry crop	0.112***	0.080***	0.046***
	(5.58)	(5.55)	(3.62)
Dummy for growing other crops	0.038*	0.060***	0.036**
	(1.81)	(3.93)	(2.32)
1998 dummy	0.320***	0.301***	0.242***
	(26.67)	(27.45)	(21.10)
Observations	5762	5762	5762
R-squared	0.72	0.81	0.85

Absolute value of t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Note: Coefficients for seed, fertilizer, organic manure, pesticide, and other non-land assets are interacted with the use dummies.

Appendix: Derivation of main propositions

Proposition 1. The amount of land rented in is strictly increasing in ability, α, and strictly decreasing in their land endowment $\overline{A}$. Rental markets will thus transfer land to "poor but efficient" producers.

Total differentiating both sides of (1) with respect to α (again, *i* is ignored for notation simplicity), yields:

$$pf_{l^a}(l^a, A) + p\alpha(f_{l^a l^a}\frac{\partial l^a}{\partial \alpha} + f_{l^a A}\frac{\partial A}{\partial \alpha}) = 0 \qquad \text{(A1)}$$

Total differentiation of both sides of (2) or (2)' with respect to α, yields:

$$pf_A(l^a, A) + p\alpha(f_{AA}\frac{\partial A}{\partial \alpha} + f_{Al^a}\frac{\partial l^a}{\partial \alpha}) = 0 \qquad \text{(A2)}$$

Putting (A1) and (A2) in matrix form yields:

$$\begin{bmatrix} p\alpha f_{l^a l^a} & p\alpha f_{l^a A} \\ p\alpha f_{Al^a} & p\alpha f_{AA} \end{bmatrix} \begin{bmatrix} \partial l^a / \partial \alpha \\ \partial A / \partial \alpha \end{bmatrix} = \begin{bmatrix} -pf_{l^a} \\ -pf_A \end{bmatrix}$$

Solving for $\partial A / \partial \alpha$ by Cramer's rule, yield:

$$\partial A / \partial \alpha = \frac{\begin{vmatrix} p\alpha f_{l^a l^a} & -pf_{l^a} \\ p\alpha f_{Al^a} & -pf_A \end{vmatrix}}{|H|} = \frac{-p^2\alpha f_A f_{l^a l^a} + p^2\alpha f_{Al^a} f_{l^a}}{|H|} > 0 \qquad \text{(A3)}$$

(for $f_A > 0,\ \ f_{l^a} > 0,\ f_{l^a l^a} < 0,$ and we know $|H|>0$ by the sufficient second order condition of maximization problem.)

This implies that for all households that participate in rental markets (on either side), the amount of area operated will increase with ability.

For households renting in, the amount of land rented in is the difference between the amount of operational land and the land endowment, i.e. $A_{in} = A - \overline{A}$ (A4).

Total differentiation of both sides of (A4) with respect to α, yields $\frac{\partial A_{in}}{\partial \alpha} = \frac{\partial A}{\partial \alpha} > 0$, implying that for households who rent in land, the amount of land rented in is increasing in agricultural ability. Total differentiation of both sides of (A4) with respect to $\overline{A}$, yield $\frac{\partial A_{in}}{\partial \overline{A}} = -1 < 0$, implying that for the households who rent in land, the amount of land rented in is strictly decreasing in land endowment.

For those households that rent out land, the amount of land rented out is the difference between the land endowment and the land used for self-cultivation, or formally, $A_{out} = \overline{A} - A$ (A5).

Total differentiation of both sides of (A5) with respect to α, yields $\frac{\partial A_{out}}{\partial \alpha} = -\frac{\partial A}{\partial \alpha} < 0$, which implies that for those households who rent out land, the amount of land rented out will decrease in agricultural ability. Total differentiation of both sides of (A5) with respect to $\overline{A}$, yields $\frac{\partial A_{out}}{\partial \overline{A}} = 1 > 0$, implying that for those households who rent out land, the amount rented out is strictly increasing in land endowment.

Proposition 2. Presence of transaction costs drives a wedge between those renting in and those renting out with any increase in *T* decreasing α_l and increasing α_u, thereby expanding the range of producers who remain in autarky, reducing the number of households who participate in rental markets, as well as the amount of land transacted through rental markets.

Totally differentiating both sides of equation (1) and (2) with respect to T, yields

$$p\alpha f_{l^a l^a}\frac{\partial l^a}{\partial T} + p\alpha f_{l^a A}\frac{\partial A}{\partial T} = 0$$

and $$p\alpha f_{Al^a}\frac{\partial l^a}{\partial T} + p\alpha f_{AA}\frac{\partial A}{\partial T} = -1$$

We obtain $\partial l^a / \partial T$ from the first equation and substitute into the second equation, which yields

$$\frac{\partial A}{\partial T} = \frac{-1}{p\alpha[f_{AA}f_{l^a l^a} - (f_{Al^a})^2]} < 0 \qquad \text{(A6)}$$

Equation (A6) implies that households who rent in will operate less land as the transaction cost increases.

Total differentiation of both sides of (A4) with respect to *T* yields $\frac{\partial A_{in}}{\partial T} = \frac{\partial A}{\partial T} < 0,$ implying that households who still rent in land will rent in less and as the transaction cost increases.

Totally differentiating both sides of equation (1) and (2)' with respect to T and rearranging terms yields:

$$\frac{\partial A}{\partial T} = \frac{1}{p\alpha[f_{AA}f_{l^a l^a} - (f_{Al^a})^2]} > 0 \qquad \text{(A7)}$$

Equation (A7) implies that households in the renting in pool will operate less land as the transaction cost increases.

Total differentiate both sides of (A5) with respect to *T*, yield $\frac{\partial A_{out}}{\partial T} = -\frac{\partial A}{\partial T} < 0$, implies that households who still rent out land will rent out less as the transaction cost increases.

For households who continue to rent in, the optimal operational land holding can be obtained from equation (1) and (2) as $A_i = A_i(\alpha, p, r, T, w)$. Setting A_i to $\overline{A}_i$, yields the identity

$$\overline{A}_i = A_i(a_l, p, r, T, w) \qquad \text{(A8)}$$

Totally differentiating both sides, yields, $d\overline{A}_i = \frac{\partial A_i}{\partial \alpha_i} d\alpha_l + \frac{\partial A_i}{\partial T} dT = 0$ (for $d\overline{A}_i = 0$)

$$\frac{d\alpha_u}{dT} = -\frac{\frac{\partial A_i}{\partial T}}{\frac{\partial A_i}{\partial \alpha}} > 0 \qquad \text{(A9)} \qquad \text{(for } \frac{\partial A_i}{\partial \alpha} > 0 \text{ from (A3) and } \frac{\partial A_i}{\partial T} < 0 \text{ from (A6)), implying}$$

that as the transaction costs increase more households would change from renting in land to autarky.

Similarly for the households who continue to rent out land, and based on (1) and (2)', we can derive the following proposition:

$$\frac{d\alpha_l}{dT} = -\frac{\frac{\partial A_i}{\partial T}}{\frac{\partial A_i}{\partial \alpha}} < 0 \qquad \text{(A10)} \quad \text{(for } \frac{\partial A_i}{\partial \alpha} > 0 \text{ from (A3) and } \frac{\partial A_i}{\partial T} > 0 \text{ from (A7)), implying}$$

that, as transaction costs increase, more households would change from renting out to autarky.

Proposition 3. Increases of the exogenously given wage for off-farm employment will increase the amount of land transacted in rental markets by increasing the amount rented out by households with low agricultural ability (who join the off-farm labor force) and the amount rented in by those with high-ability (who specialize in agricultural production). This will be associated with a decrease in the equilibrium rental rate which, in a risk-free environment, will make everybody better off.

Without loss of generality, we assume that only the households who originally rented land out will take advantage of the increased off-farm opportunities. Those who rented in land originally will continue to rent in land and the their off-farm opportunities are assumed to remain the same as before. In other words, households who rented out land before will face wage increase while those who rented in land before will face the same wage with the increase of the overall off-farm opportunities.

For those households who rented out land, we take the derivative of both sides of equation (1) or equation (2)' with respect to w, yield

$$p\alpha f_{l^a l^a} \frac{\partial l^a}{\partial w} + p\alpha f_{l^a A} \frac{\partial A}{\partial w} = 1$$

$$p\alpha f_{Al^a}\frac{\partial l^a}{\partial w}+p\alpha f_{AA}\frac{\partial A}{\partial w}=0$$

Obtain $\partial l^a \big/ \partial w$ from the second equation and substitute into the first equation, we will have

$$\frac{\partial A}{\partial w}=\frac{f_{Al^a}}{p\alpha[(f_{Al^a})^2-f_{l^al^a}f_{AA}]}<0 \qquad \text{(A11)}$$

which implies that households who rented out land will use even less endowment for self-cultivation and $A_{out}=\overline{A}-A \Rightarrow \frac{\partial A_{out}}{\partial w}=-\frac{\partial A}{\partial w}>0$, implying that amount of land rented out by individual household is increasing in its off-farm opportunity, as consequence, aggregate supply of land increases.

If we also assume that off-farm opportunities will not affect those households who originally rented in, greater supply of land due to increases in the wage rate will lead to a decrease in rental rate. To show this informally, let $a_{in}=a_{in}(\alpha_1,...\alpha_I,p,w^{in},r^*,T)$ be the aggregate rent-in curve, and let $a_{out}=a_{out}(\alpha_1,...a_I,p,w^{out},r^*,T)$ be the aggregate rent-out curve. At equilibrium, set amount of land rented in equals to the amount of land rented out, or

$$a_{in}(\alpha_1,...\alpha_I,p,w^{in},r^*,T)=a_{out}(\alpha_1,...\alpha_I,p,w^{out},r^*,T) \qquad \text{(A12)}$$

Total differentiate both sides of (A11) by allowing r^* and w^{out} to vary, yield:

$\frac{\partial a_{in}}{\partial r^*}dr^*=\frac{\partial a_{out}}{\partial r^*}dr^*+\frac{\partial a_{out}}{\partial w^{out}}dw^{out}$, rearrange terms, we will have $\frac{dr^*}{dw^{out}}=\frac{\frac{\partial a_{out}}{\partial w}}{\frac{\partial a_{in}}{\partial r^*}-\frac{\partial a_{out}}{\partial r^*}}$ (A13)

It is easy to show that the sign of (A13) is negative. We know $\frac{\partial A_{out}}{\partial w}>0 \Rightarrow \frac{\partial a_{out}}{\partial w}>0$, $\frac{\partial a_{in}}{\partial r^*}<0$, and $\frac{\partial a_{out}}{\partial r^*}>0$, and we just showed that the equilibrium rental rate falls as the off-farm opportunities increases.

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